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Integrations and Innovations: An Interdisciplinary Approach to Sport and Exercise Science

Abstract booklet
## Contents

<table>
<thead>
<tr>
<th>Area</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sport and Exercise Biomechanics</td>
<td>3</td>
</tr>
<tr>
<td>Sports Coaching and Pedagogy</td>
<td>20</td>
</tr>
<tr>
<td>Sport and Exercise Nutrition</td>
<td>25</td>
</tr>
<tr>
<td>Sport and Exercise Physiology</td>
<td>42</td>
</tr>
<tr>
<td>Performance Analysis</td>
<td>96</td>
</tr>
<tr>
<td>Sport and Exercise Psychology</td>
<td>106</td>
</tr>
<tr>
<td>Sociology of Sport and Exercise</td>
<td>139</td>
</tr>
<tr>
<td>Strength and Conditioning</td>
<td>148</td>
</tr>
</tbody>
</table>
Falling is a major health concern for older people (Owings et al., 2001: Clinical Biomechanics, 16, 813-819) with one in three over 65 year olds experiencing a fall each year (Tinetti et al., 1998: New England Journal of Medicine, 319, 1701-1707). A successful recovery from a disturbance while walking can be crucial in stopping a person from falling over. Determining how the body responds to a sudden change in momentum can develop our understanding of strategies that may result in a successful or unsuccessful recovery. It has been suggested that step length (Pavol et al., 2001: Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 56, 428-437) and reaction time (Bogert et al., 2002: Journal of Biomechanics, 35, 199-205) can differentiate between a successful or unsuccessful recovery from an imposed perturbation. Therefore, the purpose of this study was to determine step length whilst walking at different treadmill velocities, as well as, the reaction time of participants following an imposed perturbation - in the form of a sudden acceleration - at each of the different treadmill velocities. Fourteen consenting participants (9 male, 5 female, 59.1 ± 3.35 years) walked on a treadmill while wearing a safety harness. A three dimensional accelerometer (MSR 145B, CiK Solutions, Haid-und-Neu-Str. 7, Karlsruhe, Germany) was attached to the participants using wig-tape on the lower part of their back (S1). The accelerometer contained a data logger which recorded the acceleration at 10 Hz. Following a warm-up which was used to determine self-selected walking pace, the treadmill was programmed to start at 0.5 x self selected walking pace, increase to self-selected walking pace, then 1.5 x, 2 x and finally 2.5 x self selected walking pace. The acceleration of the treadmill was 0.5 m.s$^{-2}$. Signal processing was performed in Matlab. The acceleration in the vertical and medio-lateral directions was filtered using a low pass Butterworth filter (5 Hz). The step length was determined from the vertical data, using an unbiased autocorrelation coefficient. The number of data points (n) between the peak value in the correlation and the following maximum value represented the time per step. The sampling frequency of 10 Hz allowed the calculation of step length = n x 0.6. The reaction time was determined by the time taken from the occurrence of the perturbation to the point where the participant returned to steady state, defined by the vertical acceleration returning to within 1 SD of the RMS acceleration for the following steady state. Repeated measures ANOVA revealed significant differences (p < 0.05) between the step lengths of the participants at the different velocities. Post hoc tests, using the Bonferroni adjustment determined that there was a significant increase in step length between 0.5, 1, 1.5 and 2 x self selected walking pace. It was expected that the step length of the participants would increase as the velocity of the treadmill increased and they were required to walk faster. Results also showed a gradual decease in the reaction times from the first velocity to the last. Significant difference was found between the reaction time from 0.5-1 x self selected walking speed and all the other times (p=0.001). The 0.5-1 reaction time was 1.62 seconds and the 2-2.5 reaction time was 0.84 seconds. Relationships were also found were the participants with the longer step lengths recorded faster reaction times and vice versa, the participant with the shortest step length had the slowest reaction time. It is possible that treadmill disturbances could be used as part of a training or rehabilitation program to reduce the risk of falling in the elderly, though this requires further work.
B2O

The relationship between breast displacement, breast pain and treadmill running speed.
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Breast discomfort is often experienced by women when partaking in exercise such as running (Pfeifer & Patrizio, 2002: Sports Medicine and Arthroscopy Review, 10, 2-9). Lorentzen and Lawson reported that 56% of participants experienced breast discomfort whilst exercising (1987: Physician and Sports Medicine, 15, 123-139). These factors could potentially be a barrier to physical activity participation; therefore research into reducing or managing breast discomfort and breast movement is needed. As there is limited research in this area the primary aim of this study is to determine the relationship between running speed, breast displacement and breast discomfort in order to determine when breast discomfort peaks. This information may offer advice to women on when it is important to wear appropriate breast support and the level of support needed. Following ethical approval six female volunteers had retro-reflective markers attached to both their nipples and the suprasternal notch to monitor vertical breast displacement and upper body displacement during two treadmill running trials. Both trials consisted of the participants running for 5 gait cycles at treadmill speeds ranging from 4 km/hr to 14 km/hr (2 km/hr intervals). During the first trial treadmill speed was increased incrementally. During the second trial treadmill speed was varied in a random order and participants were blind to the speed of the treadmill. Participants rated their breast discomfort at each speed using an analogue comfort scale. This scale ranges from 0-10 with 0 being comfortable with no pain, 5 as uncomfortable and 10 as painful. Following data collection and analysis, it is expected that breast discomfort will increase with running speed and that this will be positively correlated to vertical breast displacement. The results from this study may determine which treadmill speed causes the greatest breast discomfort and the strength of the relationship between breast discomfort and breast displacement. This information may be used to advise women about the treadmill speeds that will provide the least breast discomfort, encouraging more women to participate in running. Additionally, this study may provide information on when it is appropriate to wear a sports bra in order to reduce breast displacement and make running as comfortable as possible.

B3O

The effects of elastic and non-elastic tape on ankle range of motion and stability, before and after exercise.
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University of Portsmouth

Prophylactic taping and its effects on performance have been widely studied, however the effect of elastic compared to non-elastic tape on ankle range of motion has yet to be investigated (Albien Vicen et al., 2009: Foot and Ankle International, 30, 218-225). The influence of ankle taping on balance is also not fully understood. The purpose of this study was to compare the effects of elastic and non-elastic ankle taping on ankle range of motion and balance, pre and post-exercise. It was hypothesised that elastic tape would significantly decrease the subtalar joint range of motion in comparison to the inelastic tape, supporting the results of Abian-Vicen et al. (2009), both prior to and post exercise. In addition, it was hypothesised that elastic tape would consistently reduce the maximum centre of pressure sway and sway velocity. Following institutional ethical approval, nine participants volunteered for the study. Subtalar joint ranges of motion were measured in maximal passive plantar flexion and dorsiflexion from the neutral position. The range of motion measurements were measured using a manual goniometer (Cranlea, UK), prior to centre of pressure excursion area measurements being recorded during 10 second single leg balances on a force platform (1000 Hz; 9281CA, Kistler Instrumente AG, Switzerland). All measurements were
recorded pre and post 10 minutes of treadmill exercise at approximately 75% of the participants predicted maximum heart rate. Each participant completed three randomised trials wearing elastic tape (Vulkan Meditex, Mobilis Roylan, Suttin-in-Ashfield, UK), non-elastic tape (Vulkan Meditape, Mobilis Rolyan, Sutton-in-Ashfield, UK) and no tape on the ankle. The ankle was taped using a Gibson basket weave technique with ankle heel lock configuration (Rarick et al., 1962: The Journal of Bone and Joint Surgery, 44, 1183-1190; Firer, 1990: British Journal of Sports Medicine, 24, 47-50). Range of motion measurements, centre of pressure excursion area, maximum sway and sway velocity in the anterior-posterior and medial-lateral directions were analysed using a Friedman Test, with Wilcoxon signed ranks Post Hoc tests. The range of motion measurements showed that significant differences were found in the plantar flexion (p<0.05) and dorsi flexion (p<0.05) positions but not in the neutral position (p>0.05). Prior to exercise plantar flexion range of motion with non-elastic tape and elastic tape were both significantly different to the no tape condition (p<0.05); however when elastic and non-elastic tape were compared there was no significant difference between them (p>0.05). Post exercise ankle range of motion for the elastic and non-elastic tape conditions remained significantly different to the no tape condition. The difference between elastic tape and non-elastic tape became significantly different post exercise (p<0.05). Plantar flexion range of motion was significantly higher in the non-elastic condition. For dorsi flexion range of motion pre-exercise, there was a significant difference between the non-elastic tape and the no tape variables and between elastic tape and non-elastic tape (p<0.05), but not between no tape and elastic tape (p>0.05). After the exercise intervention none of the dorsi flexion measurements were found to be significant (p>0.05). Centre of pressure data were analysed. In conclusion, after exercise both tapes were ineffective in influencing ankle dorsi flexion range of motion. Ankle plantar flexion range of motion was restricted equally when using non-elastic tape and elastic tape after exercise. Prior to exercise both tapes similarly influenced plantar flexion range of motion, but the dorsi flexion range of motion was unchanged compared to the control using elastic tape.

B4O

**Inter-limb biomechanical variability of the cutting manoeuvre.**

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Variability has recently moved from its classification as a negative effect on performance, and thus it classification as ‘noise’, to the idea that it is functional with implications for reducing injury risk (Bartlett et al., 2007: Sports Biomechanics, 6, 224-243). Previous research by Hamill et al (1999: Journal of Clinical Biomechanics, 14, 297-308) recognised that variability during running stride allows for forces to be imparted to various structures in the body; this would suggest a need to maintain high variability in order to reduce overuse injury potential. However there is a significant lack of research attempting to investigate this proposal in traumatic injuries. As Bahr and Krosshaug, (2005: British Journal of Sports Medicine, 39, 324-329) found that females demonstrate a 2-7 times greater risk of suffering an ACL (Anterior Cruciate Ligament) injury over their male counterparts; such an application in research could help explain the incidence rates of non contact ACL injuries in sport. This study aimed to determine mechanical variability of the knee joint and establish differences that may exist between dominant and non-dominant limbs. Ethical approval from the University of Wales, Institute Cardiff Ethics committee was sort following the attainment of which, two healthy elite female footballers (mean age: 19.5 ± 0.7; mass = 58.2 ± 1.06 kg; height: 1.70 ± 0.05 m) were recruited from the student population of (UWIC). A mechanical analysis of the knee joint was collected over two weeks encompassing 40 unanticipated sidestep cutting trials, at a facilitated 45° angle. Data collection was completed using CODA motion analysis (sampling at 200 Hz) and a Kistler force plate (sampling at 1000 Hz). The stance phase of each trial was selected for analysis and defined as heel strike to toe-off, which were normalised to time and thus represented as 100% movement time (MT). Knee joint
angular displacements of all three planes were quantified and analysed for the whole stance phase and weight acceptance (WA), defined as 0-40% MT. Intra-limb variability was determined through the use of co-efficient of variation (CV) and inter-limb variability was determined using the Route Mean Squared Difference (RMSD), significant differences taken at $p \leq 0.05$ were established using one-tailed $t$-test. Both participants were found to display greater kinematic variability in their non-dominant (left) lower limb, with the exception of flexion, where participant one presented higher intra variability (CV-30%) in their dominant limb. Both participants consistently presented a significantly lower loading rates on their non-dominant limb compared with their dominant limb, which is coupled with a slower flexion period. Participants both displayed significantly greater rotational angular displacement on their dominant limb, while presenting consistently higher variability on their non-dominant limb. Participant two presented rapid external rotation on their dominant limb during the weight acceptance, peaking at 15%MT consistently achieving an RMSD in excess of 45 thus displaying a high inter-limb variability. The findings suggested that cutting movements performed with the non-dominant lower limb were more variable than those performed with the dominant lower limb. The higher mechanical variability in the non-dominant limb could suggest that dominance plays a part in the variability of movement; subsequently the lower mechanical variability in the dominant lower limb could indicate an increased knee injury risk. Further investigation should explore the mechanical variability related to overuse and traumatic knee injuries in cutting and use a multi-joint analysis to determine if there is any correlation.

B50
The effect of vibration intensity on upper and lower body range of motion using a vibration plate.
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University of Chester

Research into the effect of vibration on flexibility is relatively scarce (Epperson et al., 2009: Unpublished Master of Science thesis, Brigham Young University). In the limited research, vibration intensities have ranged from 20-50 Hz (frequency) and from 2-8 mm (displacement), with some controversy over whether a low intensity or high intensity vibration would produce enhanced flexibility changes. Sands et al. (2006: Medicine and Science in Sports and Exercise, 38, 720-725) showed that in highly trained gymnasts, a four week stretching-with-vibration (30 Hz, 2 mm) protocol significantly increased right rear split performance after stretching in the same split position. This trend was noted after an immediate stretching session and after a four week (5 times per week) stretching intervention. Cardinale and Lim (2003: Medicine and Sport, 56, 287-292) found that sit and reach performance significantly improved after five minutes of standing on the vibration platform at a low intensity (20 Hz, 4 mm) and a non-significant decrease at a high intensity (40 Hz, 4 mm). Therefore the aim of this study was to compare the effects of a low intensity vibration (30 Hz, 2 mm) and a high intensity vibration (40 Hz, 4 mm) on upper and lower extremity flexibility enhancement after a four week stretching intervention. A secondary aim was to assess the immediate effects of a low intensity vibration (30 Hz, 2 mm) and a high intensity vibration (40 Hz, 4 mm) on upper and lower extremity flexibility enhancement. After ethical approval, fifteen participants ($M = 3, F = 12$, age $31.47 \pm 14.40$) were randomised into three groups; 30Low, 40High and a control group. The sit and reach test (SR) and nine separate range of motion (ROM) measurements; shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), elbow flexion (EF), elbow extension (EE), hip flexion (HF), hip extension (HE), knee flexion (KF) and knee extension (KE), were used to assess flexibility. Six stretches (three each for upper and lower extremities) were completed in the first session. SR and ROM measurements were re-taken immediately after. Following this, a four week stretching intervention, consisting of the same six stretches was completed by participants to assess the long term effects of vibration on flexibility. SR and ROM were reassessed
approximately 72 hours after cessation of intervention. Data will be analysed using a two-way repeated measures ANOVA to determine any interaction effect of time and group on SR and ROM measurements. There were no significant changes in flexibility immediately after one bout of stretching. However, for each group there was a considerable decrease in shoulder extension ROM. The general trend showed a decrease of flexibility in the control group and similar increases, though small in magnitude, in the 30Low and 40High groups. After the four week intervention, total flexibility means for SR and six of the ROM sites (KE, SF, SE, EE, HF, HE) were significant but only for the main effect of time in the ‘time x group’ interaction. The general trend showed larger increases in the 30Low group followed by 40High and control. Comparisons between left and right side ROM showed large variability after one stretching session, and then little variability after four weeks. There was a significant interaction effect for right shoulder flexion (F (4, 24) = 2.921, p = 0.042) and right hip extension (F (4, 24) = 3.072, p = 0.035). The suggested mechanisms for improvement in flexibility by vibration are; circulatory and thermoregulatory changes, antagonist inhibition and an increase in the pain threshold. If caution is taken with choice of vibration intensity and the mechanics of the stretch are properly understood, it is possible that the Power Plate could be used in rehabilitation as a method of decreasing time spent in the recovery process.

B6P
Can pennation angle and muscle thickness be predicted from EMGS for vastus lateralis and rectus femoris during isometric contractions?

Hamzeh, M., Vargas., A.C., & Chauhan, B.
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Football training can have a considerable effect on the development of muscle strength. Previous research suggests that heavy resistance training marks changes in muscle architecture, which can therefore improve muscle quality (Fukunaga et al., 1997: Journal of Applied Biomechanics, 30(5), 457-463). Several studies have investigated EMG muscle activity and muscle architecture using ultrasound in relation to performance and injury (Manal et al., 2008: Journal of Biomechanics, 41(11), 2492-2497; Rudroff et al., 2008: Journal of Applied Physiology, 104, 1720-1726). However, there appears to be limited research surrounding the correlation between these two types of assessment. This study investigated whether there was a significant correlation between EMG muscle activity and muscle architecture using ultrasound. Ultrasound was used to measure pennation angle of the vastus lateralis and muscle thickness of the rectus femoris in addition to electromyography testing (EMG) which was used to record muscle activity. Fifteen male amateur football subjects with no history of musculoskeletal injury participated in this study. The average age, height and body mass were 24.4±4.2 years, 181±6.6 cm and 80.5±7.5 kg respectively. Subjects performed isometric contractions, using the Cybex Norm isokinetic dynamometer, at approximately 25%, 50% and 75% of their maximal voluntary contraction (MVC), while EMG and ultrasound images were simultaneously recorded. Regression equations were used to predict EMG muscle activity and ultrasound muscle thickness for the rectus femoris as well as EMG muscle activity and ultrasound pennation angle for the vastus lateralis. The equations gave a predicted value of the parameter which were then plotted against the actual measures recorded in the study. The $R^2$ value was used to determine whether the correlation was significant or not. The muscle thickness of the rectus femoris presented a linear relationship using ultrasound predictors for EMG muscle activity values with a highly significant correlation with an $R^2$ of 0.702 ($P < 0.05$). The relationship using EMG predictors for ultrasound muscle thickness values was also significant with an $R^2$ value of 0.681 ($P <0.05$). However, there was no significant correlation between ultrasound pennation angle predictors for EMG muscle activity with an $R^2$ value of 0.214 ($P >0.05$). Similarly, there was no significant correlation between EMG muscle activity predictors for ultrasound pennation angle with an $R^2$ value of 0.395 ($P >0.05$). The results of this study established the regression equations to predict the muscle thickness of the rectus femoris muscle from EMG.
Incorporating this relationship into a model may better represent the architecture of this large muscle, which dominates knee extension.

B7O

Do Mechanical Variability Levels Vary Between Barefoot and Shod Conditions for Middle Distance Runners?
Wyatt, H., & Gittoes, M.
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Being that variability is a contemporary issue, it has become an area of focus for many different researchers, each attempting to develop the current understanding of the concept. An additional current topic of interest is the mechanical differences between barefoot and shod running and their effects. Both of these issues are yet to be fully researched, however, through previous findings, each have independent associations with the reduction of overuse injury. The purpose of the conduction of this study was to correlate the two issues, and thus, examine whether movement variability levels vary between barefoot and shod conditions. Six injury-free, sub-elite, male 800m athletes with mean ± standard deviation age, height, body mass and average weekly running distance values of 19.26 ± 0.98 years, 1.18 ± 0.05 m, 68.52 ± 3.90 kg, 24.17 ± 4.92 miles respectively, took part in the study. Sagittal plane kinematic measurements were obtained by use of CODA equipment, operating at 400 Hz, along with the simultaneous acquisition of kinetic information via two Kistler force plates, operating at 1000 Hz. Each participant wore their normal athletic footwear for the ‘shod’ condition trials. Ethical approval and informed consent were gained before the study commenced. From the gained data, both the coefficient of variation (%) and the root mean squared difference (%) were calculated to assess the ‘inter-condition’, ‘intra-condition’ and ‘intra-subject’ variability for various discrete and continuous variables. A normality test was conducted, following which, a paired T-test was employed to assess the significance of the inter-condition variability of the discrete variables. The only difference between the two conditions which was found to be significant, was the coefficient of variation for the knee angle at maximum vertical force ($p = 0.036$). It was further discovered that the shod condition showed a tendency to have higher levels of variability; however, these differences were not found to be significant. From the findings, it was suggested that sagittal plane kinematic and kinetic mechanical variability were not contributing factors to the lower injury rates found in the barefoot condition within previous research, however, as injury rates for were not directly measured, this cannot be fully confirmed. Future research should aim to focus on coordination variability between the barefoot and shod conditions.

B8P

An experimental investigation to determine whether varying levels of head protection reduce the risk of cranio-facial injury.
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*Manchester Metropolitan University*

Cranio-facial injury is a common occurrence within sporting activities, some sports classify headgear as a mandatory regulation to prevent such injuries. However, some governing bodies principally allow the participant to choose whether or not to wear any form of head protection. The thickness of the cranial skull plates has been found to influence the dynamic responses of the head during direct impact, suggesting that thinner areas of the skull are at greatest risk of fracture. Bone toughness has been linked to greater collagen content, this gives bone its elasticity and it therefore absorbs a greater amount of energy pre-fracture during impact. This study investigated the effect of impact mechanics on cortical bone tissue, in relation to the use of polyurethane foam and polypropylene plastic materials (commonly seen in headgear equipment).
Prior to testing, ethical approval was granted by MMU Cheshire’s exercise and sport science ethics committee. A total of three hundred bovine cortical bone samples were sectioned at varying thicknesses of 2 mm, 5 mm and 8 mm both in the longitudinal and transverse plane. These dimensions were representative of human skull plates measured during preliminary investigations and the available literature. Bovine bone tissue was chosen due to its similar mechanical and material properties to human cortical bone. Equivalent sized samples of 3 mm and 5 mm thick polyurethane foam and 2 mm thick polypropylene plastic were impacted alongside bone samples as additional protection. Work to fracture ($W_f$) of each sample was obtained by the use of a double pendulum impact machine as well as material analysis.

The results showed that the three independent variables (thickness of bone, level of protection and the longitudinal or transverse plane) predicted ($p<.001$) the Work to fracture ($W_f$) of cortical bone. Furthermore the covariates (collagen % and porosity values) showed no effect ($p>.05$) on the Work to fracture ($W_f$) of cortical bone. These findings follow previous literature; thinner sections of bone are less tough and are therefore at greater risk of fracture under dynamic impact; thicker layers of foam provided greater energy dissipation. However, the combination of foam and plastic gave greater protection by increasing the $W_f$ on impact; this combination of soft lining and hard shell is widely used in sports head gear, but research comparing its performance has been sparse. The findings from this study suggest a combination of hard outer shell and soft foam lining provides better protection than either material used alone within sports head protection. Athletes participating in any sports that pose a high-impact risk to the skull should therefore consider wearing head protection that has both hard and soft layers of protective materials.

**B9O**  
**A multidisciplinary examination of beginner female runners.**  
Moore, I., Dixon, S., Jones, A., Wiseman, P., & Beare, P.  
*University of Exeter*

Running research has primarily focused upon comparing individuals who either have years of previous experience but differ in standard or have no running experience, i.e. elite and/or good runners vs. controls (e.g. Cavanagh *et al.*,1977: *Annals of the New York Academy of Sciences, 301*, 328-345). Thus far a comprehensive examination of beginner runners and changes in their status with training has yet to be undertaken. The overall aim of this study is to investigate changes over 10 weeks of running in beginner female runners, assessing biomechanical, physiological and psychological parameters. For the purposes of this presentation baseline data collected before commencing the 10 week programme will be explored. Following ethical approval being granted by the University of Exeter ethics committee, 5 sedentary women (age 34.0 ± 5.8 years, stature 1.68 ± 0.09 m, body mass 70.36 ± 16.3 kg) undertook a series of tests before engaging in a 10 week beginner’s running programme. Data were gathered over three visits to the laboratory. Visit 1: A psychological questionnaire was completed which included measures of motivation, psychological well-being and self-efficacy (SE), in addition to specific demographics. Further to this, a PAR-Q and cardiovascular disease risk assessment was completed which included gathering resting heart rate, blood pressure, height and weight. Visit 2: A three-dimensional over-ground gait analysis was performed, with simultaneous collection of force plate and kinematic data. Eleven reflective, spherical markers were placed on each lower limb and participants performed 10 trials for each leg at a speed of 2.53 m/s and the degree of symmetry each participant demonstrated was determined. Lower back and hamstring flexibility was measured using the sit-and-reach test and calf flexibility, of each leg, was individually assessed using a goniometer. Maximal oxygen uptake ($VO_2$ max) was determined using a walking graded-exercise test, with ratings of perceived exertion and heart rate recorded at 1 minute intervals. Pulmonary gas exchange and ventilation were continuously collected using an on-line gas analyser. Visit 3: Running economy (RE) was assessed two to four weeks into
the running programme, on a treadmill, across three speeds: 2.08, 2.31 and 2.53 m/s, with the highest speed equating to the speed utilised during the gait analysis. Participants ran at each speed for 6 minutes in order to ensure a steady state was obtained. Expired air was collected in the final two minutes of each speed condition and an average calculated across this time period. Correlation and regression analysis will be performed between flexibility scores and RE to determine which measure, if any, explains the greater variance in RE. Means and standard deviations will be calculated for the psychological data, in addition to a correlational analysis between SE and VO$_2$ max and, SE and RE. Associations between RE and specific biomechanical variables, such as ground contact time and knee extension at toe-off; will also be examined. Preliminary results failed to show any significant correlations between RE and biomechanical variables, and SE and physiological measures, although several results neared significance. Sit and reach scores, however, were significantly correlated with right foot peak impact force (r = -.27, p < .05). Intrinsic motivation to accomplish (4.65 ± .65) was exhibited as the highest form of motivation and was significantly correlated with subjective vitality (r = .99, p<.01). Huge variability was demonstrated in VO$_2$ max values (33 – 43 ml/kg/min) and RE (186 – 221 ml/kg/km). Positive affect was significantly higher than negative affect (t(4) = 6.36, p < .01). Acquiring baseline values for beginner runners will allow for comparisons against other populations, in addition to allowing investigation of changes in psychological, physiological and biomechanical status following the 10-week training programme.

B10P
Differences in hopping mechanics between children and adults.
Bennett, F., Waugh, C. M., & Korff, T.
Brunel University

Jumping is a fundamental skill learnt as a child and is later utilised in a number of sports. Leg stiffness is an important parameter in jumping performance because is related to the amount of muscular energy required and power produced (Arampatzis et al., 2006; Journal of Experimental Biology, 209, 3345-3357). Leg stiffness can be obtained from ground reaction forces measured during two-leggged hopping. Using this approach, the calculation of leg stiffness is based on the assumption that humans behave like simple spring mass systems (Farley et al., 1991: Journal of Applied Physiology, 71, 2127-2132). This assumption can be quantified by calculating the correlation coefficient between the vertical ground reaction force and the vertical centre of mass displacement; the higher the correlation coefficient the closer the behaviour to a simple spring mass system. It has been previously shown that children aged between 13 and 18 years behave as simple spring mass systems (Korff et al., 2009: Journal of Experimental Biology, 212, 3737-3742). However, it is unknown if younger children behave in a similar way. This is of particular interest, as they are known to be less controlled than adults when performing jumping tasks (Jensen and Phillips, 1994: Research Quarterly for Exercise and Sport, 65, 258-268). Therefore, the first purpose of this study was to investigate if during two-legged hopping younger children behave like simple spring mass systems. Leg stiffness is related to body mass. Therefore it is unsurprising that it increases with increasing age. However, age-related differences in leg stiffness in children between 13 and 18 years of age disappear, once the effects of body mass are accounted for (Korff et al., 2009: Journal of Experimental Biology, 212, 3737-3742). These findings suggest that older children are able to actively modulate their leg stiffness to maximize movement efficiency during jumping tasks. With the goal of gaining insights into the development of lower limb control during jumping tasks (Jensen and Phillips, 1994: Research Quarterly for Exercise and Sport, 65, 258-268), the second purpose of this study was to examine if younger children are able to appropriately adjust their leg stiffness to account for differences in body mass. With institutional ethical approval, 22 adults (AD; 25 ± 5.9 y, m = 13, f = 9) and 38 children (YC; 8.3 ± 0.5 y, m = 20, f = 18) participated in this study. All participants provided written informed consent, and children’s parents provided written assent. Each participant performed 30 two-legged hops on a force platform. For each participant, the correlations between vertical ground reaction force
and the vertical centre of mass displacement were averaged over the 30 hops. An independent t-test was performed to test if these correlations were different between children and adults. Leg stiffness was calculated according to Farley et al. (1991: *Journal of Applied Physiology*, 71, 2127-2132). Two independent t-tests were performed to determine any differences in absolute leg stiffness and mass-specific leg stiffness (i.e., leg stiffness normalized by body mass) between children and adults. The significance level for all t-tests was set to p = 0.05. Both groups demonstrated high correlations between vertical ground reaction forces and centre of mass displacement (r = 0.96 ± 0.01 for AD and r = 0.91 ± 0.08 for YC). However, the t-test revealed that the mean correlation coefficient was significantly lower in YC compared to AD (p < 0.001). Furthermore, AD produced significantly greater absolute hopping stiffness than YC (p < 0.001). When hopping stiffness was normalised by body mass, this effect was reversed, as YC produced significantly greater mass-specific stiffness than AD (p = 0.036). Our results demonstrate that children as young as 8 years of age behave like a simple mass spring system. They further indicate that children refine this behaviour during puberty through to adulthood. The fact that mass-specific stiffness was greater in children than in adults suggests that children use a compensatory strategy, possibly to accommodate an increased demand for greater dynamic stability. Together, these findings suggest that over time, children take an increased advantage of the storage and release of elastic energy in the musculo-skeletal system during complex lower limb motor tasks.

B110

**Risk of anterior cruciate ligament injury in side cutting in football: half-time recovery is mostly incomplete and dependant on the individual.**

Markendale, E., & Vanrenterghem, J.

*Liverpool John Moores University*

Non-contact injuries to the anterior cruciate ligament (ACL) remain a significant problem in sports involving manoeuvres which consist of rapid deceleration where large forces are exerted on the body (e.g. during cutting and landing). A significant amount of disparity surrounds the exact ACL loading risk factors inherent to movement execution and their relationship to neuromuscular control. An integrated approach could further elucidate when risk is increased and hence help in the production of improved prevention programmes (McLean, 2008: *Journal of Athletic Training*, 43, 538 - 540). The purpose of this study was to examine whether any changes occurred in joint kinetics, kinematics and neuromuscular control of the stance limb during side cutting manoeuvres following a 45 min football specific exercise protocol and after a 15 min recovery period. Following ethical approval, 8 male recreational players in dynamic team sports who had suffered no previous lower limb injury volunteered to take part in the study (mean age 21.1 ± 2.0 y, height 184.0 ± 3.2 cm, mass 82.1 ± 12.7 kg). In a repeated measures design, each subject completed five side cutting manoeuvres pre-fatigue, immediately post-fatigue and 15 min post-fatigue. Approach speed was standardized at 4.5 ± 0.23 m.s⁻¹ and cutting angle at 45° from a straight run. A 45 min version of the SAFT90 football specific fatiguing protocol was used to elicit fatigue during which heart rate and RPE were monitored (Small et al., 2010: *Journal of Science and Medicine in Sport*, 13, 120 - 125). Ten ceiling mounted IR cameras (Oqus, Qualysis AB, Gothenburg, Sweden) were used to collect motion data at 250 Hz in synchrony with ground reaction force and muscle activity data, using a 90x60 cm force platform (type 9287BA, Kistler, Amherst, NY, USA) and an 8 channel wireless TeleMyo 2400T DTS system (Noraxon Inc., Scottsdale, AZ, USA), respectively, sampling at 1500 Hz. Joint kinematics and kinetics were computed for the stance limb based on a lower limb and trunk segmental model with functional hip and knee joints (Vanrenterghem et al., 2010: *Gait & Posture*, 31, 517 – 521). Muscle activity of rectus femoris, biceps femoris, gastrocnemius lateralis and soleus lateralis of the stance limb were measured using bipolar Ag/AgCl electrodes (inter electrode distance: 2 cm, Noraxon Inc., Scottsdale, AZ, USA). ANOVA tests demonstrated increased ACL loading risk with fatigue due to reduced average knee flexion angle during
stance ($F(1,15, 8.06 = 5.62, P = 0.04$), reduced maximum knee external rotation (internal muscle) moment ($F(1,17, 8.20 = 8.77, P = 0.02$), and reduced average biceps femoris activity immediately prior to and during the deceleration phase of the manoeuvre ($F(2, 14 = 17.97, P = 0.000$. Post-hoc testing indicated that all of these variables were still reduced following the 15 min rest period, although the average knee flexion angle had partially begun to return to its pre-fatigued level. ANOVA tests however didn’t reach significance for the change in knee internal rotation angle during the deceleration period ($F(2, 14 = 1.03, P = 0.38$). The combined effect of internal rotation loading and lessened flexion at the knee has been shown to greatly load the ACL (Markolf et al., 1995: Journal of Orthopaedic Research, 13, 930 - 935). The fact that in the present study fatigue resulted in such lessened flexion at the knee as well as a decreased external rotation muscle moment but no overall change in the range of knee internal rotation suggests that following fatigue the ACL is at a greater risk of injury, which is still evident following the half time rest period. Considering the results on an individual basis, it was noted that while some subjects did partially recover their joint kinetics and kinematics, this was never accompanied by neuromuscular recovery. These findings support the notion that fatigue seen during football game-play increases the likelihood of an ACL injury through combined adverse joint kinematics, kinetics and neuromuscular control. While some players may partially recover in a mechanical sense, at a neuromuscular level they do not.

B13O

Ability of gait indices to detect variations of gait in response to controlled manipulations that emulate activities of daily living.

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The challenge in gait analysis is the large quantity of data that needs to be analysed including joint angles of several joints in three dimensions. The Gait Deviation Index (GDI) (Schwartz et al., 2008: Gait and Posture, 28, 351-357) is a method that condenses these curves into a single number to facilitate clinical decision making. Even though the GDI was validated to distinguish between different levels of pathology, little is known about its use in the analysis of the small deviations typical of activities of daily living. Potential uses of this approach include detection of movement anomalies in the context of sports injuries. Limitations of the GDI are its restriction to using nine predetermined joint angles, resulting in a single number that represents the deviation from normality. These limitations are addressed by the Movement Deviation Profile (MDP) (Barton et al., 2010: Human Movement Science, In press) which shows deviations throughout the gait cycle in addition to a single number, shown to correlate well with the GDI ($r^2 = 0.927$). The aim of this study was to explore whether the GDI and mean MDP are sensitive enough to detect minor deviations from normal gait, and to explore the added benefits of the MDP over the GDI. With institutional ethics approval, ten male subjects with normal gait walked barefoot over ground, completing ten normal gait trials and ten trials for each of the three gait perturbations: carrying 15% of body weight distributed on the trunk both evenly and asymmetrically, and wearing a shoe on one foot to produce a leg length discrepancy (LLD) of 2.5 cm. Three-dimensional joint angles were reconstructed using a Qualisys motion capture system (Qualisys, Gothenburg, Sweden) and a Kistler force platform (Kistler, Winterthur, Switzerland). For each condition mean left and right pelvic and hip angles in all three planes, flexion and extension angles of the knee, plantarflexion and dorsiflexion angles of the ankle, and foot progression angles were used to calculate GDI and MDP values. Assumptions of normality were met therefore a Two way repeated measures ANOVA for both the GDI and mean MDP was used to determine any significant differences between normal gait and each gait perturbation for the affected and unaffected side. Both GDI and mean MDP values for LLD (GDI: 95.82 ± 0.50; MDP$_{mean}$: 11.17 ± 0.55) were significantly different ($P < 0.05$) to normal gait (GDI: 100.00 ± 2.46; MDP$_{mean}$: 9.27 ± 0.50). The weighted conditions resulted in GDI and mean MDP scores that deviated from normal gait although not significantly ($P > 0.05$). No significant differences
were found between the affected and unaffected leg in all conditions. The MDP was able to
detect changes in gait as a result of perturbations at specific periods of the gait cycle,
indicating greater deviation from normality in the LLD condition during swing phase on the
affected side (mean peak MDP: 16.27° ± 4.55). The data demonstrates that the GDI and mean
MDP are sensitive enough to detect small changes from normal gait. In addition, the MDP
curve is able to highlight phases of the gait cycle in which the greatest deviations occur.

B14P
The effect of distance from a target on force and biomechanics during a martial arts
kick.
Peters, D.
Hertfordshire University

Kickboxing and Muay Thai are forms of martial arts that use various kicks and punches to
overcome an opponent in a fight, with the ‘Push’ or ‘Teep’ being simple yet powerful forms
of kicking (Buse, 2009: Combat sports medicine kickboxing. London: Springer). There is
minimal research investigating the output forces generated by these kicks, especially in the
competitive environment where the opponent is constantly moving altering the target
distance. The varying distance from the target could influence the force being imparted to the
opponent from one of these kicking techniques.

Ethical approval was achieved through the University of Hertfordshire and written consent
was obtained from all subjects. Participants were male aged 23.1 years ± 4.4 and had a
minimum of two years experience in either Kickboxing or Muay Thai. Leg length was on
average 0.97±0.48 m height 1.77±5.77 m and weight 72.8±11 kg were recorded before a short
warm up with dynamic stretching was undertaken. Nine kicks against a hanging bag were
undertaken, three from a comfortable distance chosen by the subject, three from a distance
equal to their total leg length, and three from a distance of 1/3 of the femur length. Each kick
was filmed and analysed and the relative force measured using a Herman Digital Trainer
placed on the back of the bag.

Results showed that heavier individuals with a larger mass had a positive correlation between
mass and force outputs, which was statistically significant. Distance two (total leg length)
created the largest force readings statistically (mean = 5317.61 N), this is due to having
increased time between the starting position and initial contact, thus, allowing greater
acceleration before impact. In contrast distance 3 (1/3 of femur length in from target)
statistically exhibited the lowest force production (mean = 4608.46 N); this was due to the
subject not being positioned to be able to fully extend their leg before contact was made with
the target.

Subjects with increased mass optimally positioned one leg length from the target generating
greater relative acceleratory forces in to the target than those kicking from distances less than
this optimal distance. However, further research needs to be carried out in this field to
accurately conclude the findings.

B15O
Influence of upper body motion on spinal and lower limb kinematics during a single-
legged squat.
Parkhouse, K.
University of Portsmouth

The single-legged squat is a common functional test used to screen for poor hip strength and
trunk control. However, there is very little research into spinal and lower limb kinematics to
support the reliability of this test. Studies have shown that arm position has a substantial
effect on the lower limbs during sporting movements (Ashby & Heegaard, 2002: Journal of
Biomechanics, 35, 1631-1637; Chaudhari et al, 2005: American Journal of Sports Medicine,
It has been suggested that motion at one segment will influence that of all other segments in the chain, but the effect of upper limb and proximal stability on the lower limbs has not been investigated in functional movements. Therefore, the purpose of the study was to investigate the influence of sport-dependent variations in arm position on knee valgus and spinal lordosis during a single-legged squat and to assess the reliability of 3-Dimensional measurements during a single-legged squat. Before commencement, the University Ethics review board approved the study. Nine physically active males performed four sets of single-legged squats: a control (no arm motion) and then squats with arm motion in each of the three planes of motion. The timing of each squat was standardised using a metronome. 24 reflective markers were attached to the lower limbs, trunk and shoulders. 3-Dimensional kinematic data was obtained using a calibrated optoelectronic system consisting of eight Oqus cameras. Knee valgus at the deepest point of knee flexion and spinal lordosis range of motion is currently being analysed by Qualysis Track Manager and Q Tools. Reliability data will also be analysed and data entered into SPSS (18.00).

B160

A biomechanical assessment between the variation of muscle activity, within the upper extremities, during a topspin and slice serve.

Webster, F.
University of Chester

The tennis serve is the stroke of greatest importance (Girard et al., 2005: Journal of Medicine and Science in Sport and Exercise, 37, 1021-1029). During the last decade modifications to the traditional tennis serve have been introduced and used as an offensive weapon, in order to decrease the opponents’ reaction time and their ability to return the ball. The two most widely used today are the slice serve and the topspin serve, which enable the server to hit with greater accuracy. Despite the fact professionals use spin or slice on over 90% of their serves the biomechanical knowledge is limited; no data exists portraying the difference in muscle activity between the slice serve and the topspin serve, which could not only be beneficial for understanding performance but it is also key for injury and rehabilitation (Kibler et al., 2007: British Journal of Sports Medicine, 41, 745-749). Seeley et al., (2008; Sports Biomechanics, 7, 248 – 259) compared the muscle activity between traditional and abbreviated serves. No significant differences were found for muscle activations, in the anterior and posterior deltoid, infraspinatus, middle deltoid, latissimus dorsi, the serratus anterior and the pectoralis major, when compared for each phase of the serve, indicating that the traditional and abbreviated serves involve similar shoulder muscle activation. The purpose of this study was to compare upper extremity muscle activations between the slice and the topspin serve. EMG data was collected for 4 right handed female participants (Noraxon, sample rate 1000 Hz). The muscles compared were the anterior and posterior deltoid, infraspinatus, middle deltoid, latissimus dorsi and the serratus anterior. Sagittal plane video footage was collected (sample rate 50 Hz). The participants performed 20 successful serves altogether, 10 slice serves and 10 topspin serves, all from the right hand side of the court. Each serve was determined successful by a set of cones placed within the opposite serve box. By using a radar gun the speed of the serves could be controlled, any serves above or below 60-85 mph were discarded. The EMG data was then rectified, smoothed using a Butterworth filter with a low pass cut off frequency of 250 Hz and a high pass cut off frequency of 10 Hz and then smoothed using the root mean squared algorithm and time duration of 50 ms. Maximal isometric contractions were performed by the participant in order to normalize the data. Data will be analysed using a paired sampled T-test to determine any differences between peak, mean and onset and offset for each muscle during a topspin and a slice serve. It is hoped that the results from this study could have an implication for both performance and injuries related to the current modifications to the serve technique.
B17P
In-shoe Plantar Pressure Distribution during Football-specific Movements: Effect of Shoewear and Playing Surface.
Davidson, C.
Edge Hill University

The Tekscan F-scan system allows recording instant field-based in-shoe plantar pressure distribution for clinical applications, shoewear design and injury risk evaluation in sport (Hsiao et al., 2002: Ergonomics, 45, 537-555). However, the majority of past research has focused on in-shoe pressure analysis during running and there is a lack of research in specific sports such as football (Wong et al., 2007: British Journal of Sports Medicine, 41, 93-100). Thus, the aim of this study was to assess in-shoe pressure distribution during football specific movements as a function of shoewear type and playing surface. The findings have implications for the design of boots and the prevention of lower limb injury in football. Eight semi-professional footballers (mean ± SD age = 20.5 ± 0.76 years; height = 1.74 ± 0.05 cm; mass = 71.3 ± 4.9 kg) performed football-specific movements (maximal velocity kick, 45o cutting manoeuvre & deceleration from a sprint) while wearing three types of football boots (moulded, metal & bladed studs) on two types of playing surface (grass & astro-turf); yielding a total of 18 trials per participant. Peak force, Impulse, Peak pressure and Pressure integral were obtained using the Tekscan F-Scan system using 12 anatomical areas of the foot. Three-way ANOVA’s (p < 0.01) and Scheffe post-hocs were conducted to identify the combination of playing conditions that yield the highest foot plantar loading in football. Statistically significant differences in Impulse (F2,115 = 5.66; p = 0.005) and in Pressure integral (F2,102 = 5.52; p = 0.005) were found between the maximal velocity kick and the sprint deceleration. The highest Impulse was recorded for the moulded boot during the maximum velocity kick on grass (mean = 258.9 N • s) and the largest Pressure integral was found when using metal studs during the maximum velocity kick on grass (mean = 43.0 kPa • s). The highest Peak forces (mean = 1427.4 N) were recorded for the moulded football boot during the sprint deceleration on Astro-turf and the highest Peak pressure (mean = 1443.5 kPa) was found for the moulded boot during cutting on Astro-turf surface. The results correspond with previous research (Wong et al., 2007) that suggests that football-related movements influence the magnitude of plantar force and pressure. The findings suggest that Bladed boots should be worn when playing on grass and Astro-turf as they produce low forces and pressure and reduce the risk for overuse injuries in football players. Training plans and injury rehabilitation programs should be adjusted to prevent the high forces and pressure that develop when performing sprint decelerations and cutting manoeuvres on Astro-turf. Future work may assess the role of insole design in reducing the load in the foot regions that show excessive plantar pressure.

B18P
The difference in weight transfer between professional and 2 groups of amateur golfers and the effect on ball velocity and launch angle.
Tate, M.A., & Fletcher, I.
University of Bedfordshire

The differences between amateurs and professionals weight transfer have not been studied in sufficient depth; with work either having insufficient participants or a lack of statistical analysis published. Until recently most of the studies had been completed in the 80’s and 90’s before Ball and Best (2007, Journal of Sports Sciences, 25, 757 – 770), however there has been little research into the effect on ball velocity and launch angle at impact before now. The purpose of this study was to test if the findings in this study were similar to the early work and to see if there was a relationship between the movement of a person’s weight through a golf swing and the effect on the ball velocity and launch angle. Following institutional ethical approval 12, right handed, male subjects (age 30 ± 10.7 years), that had either an official
Congu Handicap certificate or where registered with the PGA participated in the study. The 12 subjects were separated into three independent groups; professional golfers, low handicap amateur golfers (0 – 9) and mid handicap amateur golfers (10 – 21). Subjects completed 20 swings with each foot on a Kistler force plate (set at 2000 Hz), the data collect from these was synchronised with a camera set at 50 Hz to define each point on the swing (address, top of the back swing, impact and follow through). There was a second camera set at 50 Hz as well that was used to calculate the ball velocity and launch angle using and KA2D. The mean results for the percentage body weight on each foot at the 4 set points through the swing will be analysed using a 3 by 4 mixed factorial ANOVA. Relationships between the ball velocity and average weight and the average launch angle and average weight transfer will be determined using a bivariate correlation to find if the relationships between the variables are significant. It has been hypothesised by that there will be no significant differences, based on Ball and Best (2007); however earlier work by Robinson (1994, Science and Golf II: Proceedings of the Second World Scientific Congress of Golf, London: E & F.N. Spoon) and by Wallace et al. (1990, Science in Golf: Proceedings of the First World Scientific Congress of Golf London: E. & F.N. Spoon,) stated that there would be a significant differences between the different ability groups. There has been very little work done focusing on the effect weight transfer has on the launch angle and ball velocity, this study hopes to focus on adding to the work of Okuda et al. (2010, Journal of Sports Medicine, 9 127 – 133) and Hume et al. (2005, Sports Medicine, 35 429 – 449).

B190
Identification of gait events without a force plate during walking, running and sprinting: A comparison of methods.
Spargo, I., & Gittoes, M.
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When analysing gait, the identification of the period of stance is often needed. Traditional methods of identifying gait event (foot-strike/toe-off) times have used force platform recordings, however as force plates only have a small surface area multiple strides cannot be analysed. Recent literature has used kinematic methods to identify stance and it has been suggested that event times could be accurately predicted within both walking (Hreljac and Marshall, 2000: Journal of Biomechanics, 33, 783-786) and running (Fellin et al., 2010: Journal of Science and Medicine in Sport, Article in Press) contexts. The purpose of this study was to investigate if kinematic methods could be used to accurately identify gait event times within a sprint running context in comparison to the 'gold standard' force platform recordings, and also clarify how kinematic methods of identification alter between walking, running and sprinting. Following ethical approval, six volunteer (males) healthy university level middle distance runners (age 19.3 ± 0.9 years; body mass 68.5 ± 3.9 kg; height 177.9 ± 4.6 cm) performed three standing trials and five walking, five running and five maximal sprinting trials over an active force platform (1000 Hz). Kinematic data was collected using a CODA automatic motion analysis system (400 Hz) and marker coordinate information and peak vertical acceleration recordings from active markers located on the heel and fifth MTP were examined to identify gait events times. RMS differences between kinematic methods and criterion force plates method were calculated. Peak vertical acceleration algorithm most accurately identified touchdown and take-off within sprinting trials to between 0.003 and 0.006 seconds compared to criterion times. Marker coordinate data was able to identify gait events between 0.008 and 0.028 in the sprint trials. These findings revealed that kinematic methods could be used to identify events within a sprint running context to the same accuracy to that of walking and running. The study also highlighted that whilst methods of stance identification remain consistent for both walking and sprinting trials, this is not the case within a running context and the need to clarify landing techniques of different individuals is essential before using the proposed methods within this study.
B20P
A comparison of lower limb muscle activity when wearing Masai Barefoot Technology® shoes and standard running shoes.
Patel, S., Barker, N., & Hughes, G.
University of Hertfordshire

Masai Barefoot Technologies® (MBT) is a relatively newly developed type of shoe and has been the subject of limited research. MBT claim that the shoe develops the strength of lower extremity muscles when used for locomotion activity. The purpose of this study was to evaluate the muscle activity in the lower leg while walking and jogging in MBT shoes compared to the same activity while wearing standard running shoes. With institutional ethics approval, 9 volunteers (6 female, 3 male, age mean 21.8 ± 1.3 years, height mean 172.6 ± 6.1 cm, weight mean 63.5 ± 4.0 kg) performed 3 trials of a 7 m walk, followed 3 trials of a 7 m jog. Timing gates were used to control the speeds of walking (4.2-5 km/h) and jogging (5.4-10.8 km/h). The speeds were calculated in accordance with previous research by Nigg et al. (2006: Clinical Biomechanics, 21, 82-88) Two surface electrodes were placed on the subject’s dominate leg, one on the Gastrocnemius and one on the Tibialis anterior muscle to record muscle activity during the trials. The electrodes were placed in accordance with SENIAM guidelines and a Biometrics Data Log system was used to record muscle activity. Paired-samples t-tests found no significant differences in peak amplitude of tibialis anterior when walking (P=0.535) and jogging (P=0.237) in the MBT® shoe compared to the standard running shoe. Wilcoxon tests also found no significant differences in peak amplitude of gastrocnemius when walking (P=0.164) and jogging (P=0.652) in the MBT® shoe compared to the standard running shoe. Since there was no significant differences found in muscle activity of the tibialis anterior and the gastrocnemius when walking and jogging with either shoe, the results suggest that MBT® shoes have no enhanced effect on lower limb muscle activity compared to standard running shoes.

B21P
A biomechanical investigation into the different trajectories used for a penalty kick in soccer.
Collinson, A.
University of Lincoln

The technique of kicking in soccer has received a great deal of attention in recent years. The majority of this research has focused on the analysis of variables that will increase the resultant ball velocity. However, there has been no previous research into how kicking the ball at different trajectories may affect the resultant ball velocity. Therefore the aim of this study was to analyse the effect that aiming at different trajectories may have on resultant ball velocity and also the biomechanical effect that this may have on technique. It was hypothesised that the greater knee extension at ball contact produced by kicking at a higher trajectory would result in greater shank angular velocity, resulting in greater resultant ball velocity. Nine subjects of a high amateur status were used. Three different trajectories (higher, middle and lower) were used from a standard football goal with each subject completing three successful trials for each trajectory. Resultant ball velocity, together with full body kinematics and the kinetics of the support leg were recorded using four cameras (200Hz) and one forceplate. A One Way Anova (parametric) and Mann-Whitney U (non-parametric) were used to analyse whether there were any significant differences (p < 0.05). Analysis found that there were no significant differences (p > 0.05) in resultant ball velocities between the three trajectories. However, the peak thigh angular velocity occurred significantly earlier (p < 0.05) for the trials completed at the higher trajectory compared to the lower trajectory. Also, peak thigh angular velocity, back extension and knee extension at ball contact were on average greater at the higher trajectory compared to the lower trajectory.
Analysis of the support leg revealed greater posterior force at ball contact for the higher and middle trajectories compared to the lower trajectory. There was also greater dorsiflexion in the ankle, knee flexion and hip extension at ball contact in the support leg at ball contact at the higher trajectory compared to the lower trajectory. The foot was also on average further from the ball at ball contact at the higher trajectory compared to the lower trajectory. The results indicated that whilst there were no significant differences ($P > 0.05$) between the three trajectories for resultant ball velocity, there were subtle differences in technique. It was speculated that the greater back extension for the trials completed at the higher trajectory caused the earlier peak thigh angular velocity, which resulted in the greater knee extension at ball contact. However, surprisingly the greater knee extension did not result in an increase in shank angular velocity. It was speculated that this may have been caused by errors in the smoothing and filtering process (Numone, Lake, Georgakis and Stergioulas, 2006: Journal of Sports Sciences, 24, 11-22). Future research should analyse differences in the soccer kick at different trajectories focussing primarily on the ankle joint of the kicking leg.

B22O

**2D analysis of breast movement in water during vertical jumping.**

Walker, J., Ayers, B., Mills, C., Hedger, W., Black, D., & Scurr, J.

*University of Portsmouth*

There is limited research regarding breast movement during jumping with even fewer research articles detailing breast movement in water. To reduce embarrassment, breast pain and the risk of ptosis it is important to understand the amount of breast movement to provide the correct support for larger breasted women when taking part in recreational water activities, e.g. water aerobics. The aim of this study was to quantify breast displacement when vertical jumping in water in three breast support conditions; bare-breasted (no support), swimsuit and sports bra. It was hypothesised that there would be significantly more breast displacement in the air than in water, with the most breast displacement occurring in the bare-breasted condition, followed by the swimsuit condition, with the least movement in the sports bra condition. Following institutional ethics approval, 6 women (age 29 ± 4.8 years) with bra sizes ranging from 34F to 34HH provided informed consent before taking part in the study. Two 25 Hz underwater cameras (Colour Submergible Camera, CCTV System) recorded breast displacement from the water line to the highest point of the jump and from the water line to the lowest point of the jump. Cameras were calibrated using a two dimensional array of markers (1 m x 1 m) to assess lens distortion. An active marker set was attached to the sternal notch and left and right nipples. A 2 minute warm up was completed following both land and water familiarisation with the jumping technique. When in the water, to control hand/arm position and maintain body-positioning subjects held a float above their head against a wire. Five continuous maximum vertical jumps were then completed. Marker coordinates during the three middle jumps were digitised using SIMI Motion 6.5 (without calibrating). Coordinates were exported and processed through MatLab, using a lens correction programme and correction for distortion of water and DLT reconstruction. Reconstructed data was then exported into Microsoft Excel, spliced and amalgamated so that the data demonstrated a continuous movement. Data was then put into SPSS 18.0 and checked for normality. Results are yet to be finalised.

B23P

**The effect of starting block offset and angle on the sprint start.**

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*Aberystwyth University*

The crouch start is obligatory in the 100m sprint under International Association of Athletics Federation rules. Several practices exist for the setting of the block angle and the offset
between the two blocks. For example, a widely used simple rule of thumb for setting the offset between the two blocks is that the knee of the back leg should be level with the front foot. It is reasonable to suppose that altering the block angle and offset would have an effect on the joint moments produced since these block settings change the limb configuration and therefore alter mechanical properties such as the muscle moment arms and the muscle fibre length. Therefore it is conceivable that the block settings could affect the velocity achieved over the first few steps of the race. The purpose of this study was to examine the change in limb position as a result of altered block settings, and simultaneously determine the magnitude and direction of the resultant ground reaction force vector to identify how changes in limb position affect the ground reaction force vector. The time to reach 10m and the limb kinematics and whole body centre of mass position over the first step were also measured.

Eight participants were recruited to the study following ethical approval by the Research Ethics Committee at Aberystwyth University. All participants provided written informed consent. The participants were involved in club level sprint activities and were familiar with starting from sprint blocks. Standard aluminium sprint blocks were separated so that each block could be attached by screws into two AMTI force platforms (AMTI BP400600HF, Watertown, MA, USA). The ground reaction force for each limb could therefore be measured independently. Known forces were applied to the blocks to assess the effect on the measured ground reaction force. The force plates were sampled at 2,000 Hz and synchronised with three dimensional kinematic data collected using an eight camera digital Eagle motion capture system (Motion Analysis Corporation, CA, USA) sampling at 200 Hz. Fifty retro-reflective markers were attached to bony landmarks to define a 13 segment whole body model. The whole body centre of mass position was identified using the equations for the segment centre of mass positions of de Leva (de Leva P., 1996; Adjustments to Zatsiorsky–Seluyanov’s segment inertia parameters. Journal of Biomechanics; 29, 1223–1230). Brower timing gates and footswitchs (Brower Timing Systems, UT, USA) were used to measure the time from leaving the blocks to passing 10m from the start line which was placed just in front of the participant’s hand position. The angles of the hip, knee, and ankle were determined in the start position and the angle-time profile was determined over the first step using Cortex 2.0 (Motion Analysis Corporation, CA, USA). Before performing the sprint trials, participants performed a five-minute jog warm-up. The participant performed three sprint trials in five different conditions, which were randomly ordered. The blocks were set at angles of 30, 40 and 50 degrees with the inter-block distance being the preferred distance of the participant. The final two conditions the inter-block distance was changed by increasing and decreasing the distance by 25% of the preferred distance and keeping the blocks angle at 40o. In total each participant performed 15 maximal sprints with a recovery period of two minutes between each trial and ten minutes between each condition. A two way repeated measures ANOVA will be used to examine the differences in the joint angles, force vector parameters and timing to 10 m with different block angles and offsets. Data will be presented as mean ± standard deviation and the significance level is set at p < 0.05. If the results show some form of significant difference a post hoc test (Tukey’s pairwise comparisons) will be required to find where the difference lies. It is hypothesised that the block position will influence the time to 10m, and that the fastest times will be associated with an increased ground reaction force magnitude. It is thought that this improved force generating capacity will be associated with a more optimal lower limb joint configuration.
Sports Coaching and Pedagogy

C1P
An investigation into student perceptions of the attributes of an effective physical education teacher.
Gundry, L., & Cunliffe, D.
Southampton Solent University

The growing number of school aged children dropping out of sport has risen over the years (Handman, 2008: Kinesiology, 40, 5-24), with a variety of reasons being cited: the quality of teaching being implemented; students not being fully engaged in PE lessons; or a child’s learning style not being catered for (Blevans et al., 2010: Journal of Teaching Physical Education, 29, 399-417). In addition, the affect of non-participation in regular physical activity is having detrimental effects on individual health issues across the UK with an estimated 32% of boys and only 24% of girls reaching the recommended daily exercise guidelines (NHS, 2010: Statistics on Obesity, Physical Activity and Diet: England, 2010). The purpose of this study is to examine the different school year groups 7 and 11 and establish their perceptions of key attributes and characteristics a physical education teacher should possess for effective teaching to encourage lifelong participation in regular physical activity. Appropriate ethical clearance was sought and granted from a University’s ethical committee, and permission from the Head Teacher was given, as well as written informed consent from parents and children from a secondary school on the south coast. A total number of pupils (n=207) across school years 7 (male n=65; female n=39) and year 11 (male n=57; female n=46) participated in the study. Each pupil completed an adapted version of Revised Leadership Scale for Sport (Zhang et al., 1996: Journal of Sport Behaviour, 19, 105-122), with some 22 common and reoccurring attributes associated with effective teaching being used within the questionnaire. The data collected will be analysed using PASW (version 18) and the analysis will involve the Kruskal-Wallis test and Man Whitney tests. Data has been collected from all participants and currently being analysed with conclusions expected within the next 3 weeks. Provisional findings from this study suggest that confidence, skilful and leader are attributes being considered as essential characteristics by both Year 7 and Year 11 pupils and perceived as beneficial for engagement in physical education and further physical activity.

C2O
Should teaching dance to children continue to be done kinaesthetically?
Cunliffe, D.
Southampton Solent University

The art, or skill, of teaching often breaks down at the point of transferring the information from the teacher to the pupil and varying methods of teaching dance have been used, such as a Movement-Based approach (Marx, 2009: Recreation & Dance, 80, 12-17) and the Kinaesthesis method (Geber & Wilson, 2010: Journal of Dance Medicine & Science, 14, 50-57). Yet neither of these authors had addressed the issue of teaching dance to a child’s preferred learning style. The issue of preferred learning styles has been recently addressed (Myers, 2010: Physical Education Matters, 5, 21-24) when in a teaching domain, and as such, dance teachers who only educate through direct movement appear to be failing to maximise the potential of their pupils’ ‘understanding’ of what they are asked to perform. Therefore, as suggested by dance practitioners, the purpose of this study was to investigate whether children had a kinaesthetic learning style and prefer to be taught via direct movement. Appropriate ethical clearance was granted from a University’s Ethical Committee before permission was sought and granted to assess the preferred learning styles of each pupil across school years 7-13 (n=194) from one Music and Dance Excellence (MAKE) school within the
UK. The Learning Styles Questionnaire for Children - LSQ-C (Cunliffe, 2011: *Journal of Sport & Exercise Psychology, under review*) was selected as it divides preferred learning styles into three distinct categories, either Visual, Auditory or Kinaesthetic learners over a 30-point questionnaire. To improve reliability, the LSQ-C was administered three times over a six week period and the mean score for each child was obtained. The mean scores for each preferred learning style (Visual, Auditory and Kinaesthetic) for all children across all seven year groups exhibited a marked variation; Visual (14.23, SD 4.19); Auditory (6.51, SD 2.71); Kinaesthetic (9.26, SD 3.87). When differences in preferred learning styles were analysed using a One-way ANOVA, there was no significant difference for kinesthetic learning style between all seven year groups (\(F(6,186) =1.425, p< .207\)). Whilst these results support the work of dance teachers who educate children through the practical delivery of movements, it must be stressed, that from this study, only using the kinaesthesis teaching method could alienate the learning of children who prefer a different mode of learning. Therefore, teachers of dance need to ensure they select a differentiated delivery strategy to allow all children to learn together without any disadvantage being placed upon them.

C3O

*A study into the coach-athlete relationship based upon Role Theory.*

Taylor, H., & Nichols, T.

*University of Wales Institute, Cardiff*

The coaching process is an under-theorised, ill-defined area, which as a result causes conflict when researchers have discussed the nature of the process. Indeed, no academic framework exists that depicts the multifaceted environment that a coach operates in. Therefore, an enhanced understanding of the coaching process may lead to a universal improvement in coaching standards. It is, therefore, necessary to explore and expand upon previous research in order to provide a more in-depth insight into effective coaching, so that the information can be used for the benefit of new and conscientious coaches. In particular, more research is required into the coach-athlete relationship, with particular reference to the coaches’ roles (i.e., how they are developed) and how this influences the relationships with players. Four participants who coached a UWIC performance sport in both team and individual sports were obtained for the study. A focus group was used to prompt discussion between the coaches in order to gain an insight into their perspective on the coach-athlete relationship and the role they play within the coaching environment. Thematic content analysis was used to explore the focus group transcripts (findings to be provided prior to March Deadline). Preliminary analysis suggests that the environment within which they coach dictates the players’ behaviour and responses to authority. In addition, the coaches identified that they were very aware of their behaviour and the implications of their actions on the coach-athlete relationship. The findings will have implications for coach development.

C4O

*Developing team decision-making capabilities in a professional football team.*

Bate, B., & Richards, P.

*Glyndwr University*

This investigation reports on the development of team decision making in a professional football team. The paper aims to enhance the development of decision making capabilities of professional footballers, with the specific focus of retaining the ball from turnover situations. A total of 22 male footballers, aged 17-32 years of age participated in this investigation. Six league football matches where videoed during the 2010-2011 season. Using Gamebreaker Pro Software performance indicators where identified and each game was notated. From each match 10 clips relating to turnover situations were identified. These clips were reviewed by a panel of expert coach’s working in the club environment to establish correct decisions.
relating to the turnover situations. The first contact session with the players established a team playing philosophy in relation to retaining possession from attacking turnovers. Over the period of six games 10 clips from each of the previous weekend league games were reviewed by the players in a team environment. Players completed a decision making book at each session, which required them to state the correct team decision for each of the 10 clips, based on previous defined attacking playing philosophy. Questions 1 – 4 and 6 – 9 required an identification of the correct action which was then verbally discussed as a group. Question 5 and 10 required the players to elaborate on their response, encouraging identification of their own role within the situation and the role of team mates. Both qualitative and quantitative analysis were conducted on the data. Repeated Measures ANOVA with Tukey’s Post hoc test was used to establish statistical significance. With content analysis being applied to assess the depth of the player’s responses. Results are discussed in relation to the development of a team decision making model targeting the effectiveness of a football teams attacking play and possession retention from turnover situations.

C5P

**Influence of age-grouping and track distance on relative age effects in athletics.**

Bradley, L., & Northcott, S.R.

*University of Chichester*

The relative age effect (RAE), which has been revealed in a wide range of sports, describes the observation of an over-representation of performers born early in a selection year relative to expectations based on national birth rates (Morris & Nevill, 2006: *A Sporting Chance – Enhancing Opportunities for High Level Sporting Performance : Influence of ‘Relative Age’*). The only research found on athletics was by Morris and Nevill (2006). They analysed finalists at the 2002 English Schools Championships and concluded that (i) RAE’s were more prominent in young male athletes than females and (ii) that RAE’s persisted into adulthood. The current study, approved by the local ethics committee, investigated the profiles of birth dates in male and female athletes with a specific focus on different age-group categories (U13, U15, U17 & U20) as well as different event distances (100-m, 200-m, 300/400-m, 800-m & 1500-m). The UK Athletics results database www.thepowerof10.info was used to select samples for each category (by age-group, track distance & gender). The top 50 ranked UK athletes with detailed birth dates, as of 31st September 2010 were chosen for analyses. Month of birth for each competitor was noted but overall results are reported as quartiles (Sept-Nov; Dec-Feb; Mar-May & Jun-Aug). Chi squared ($\chi^2$) goodness of fit tests were performed using percentage quartile counts as the dependent variable. Sub-population samples by age-group (table 1) and track distance were compared with the national averages for related age of birth (www.statistics.gov.uk).

**Table 1: Mean (SD) Quartile Birth Counts (%) across Age-Groups (*p<0.01)**

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U13*</td>
<td>U15*</td>
<td>U17*</td>
<td>U20</td>
</tr>
<tr>
<td>Sep-Nov</td>
<td>53.8 (7)</td>
<td>51.4 (3)</td>
<td>44.4 (3)</td>
<td>31.9 (5)</td>
</tr>
<tr>
<td>Dec-Feb</td>
<td>25.1 (1)</td>
<td>24.4 (1)</td>
<td>27.4 (3)</td>
<td>28.3 (1)</td>
</tr>
<tr>
<td>Mar-May</td>
<td>14.4 (4)</td>
<td>15.0 (2)</td>
<td>16.2 (4)</td>
<td>23.7 (1)</td>
</tr>
<tr>
<td>Jun-Aug</td>
<td>8.7 (3)</td>
<td>9.1 (3)</td>
<td>12.1 (2)</td>
<td>16.1 (3)</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>U13*</td>
<td>U15*</td>
<td>U17</td>
<td>U20</td>
</tr>
<tr>
<td>Sep-Nov</td>
<td>41.2 (7)</td>
<td>38.5 (4)</td>
<td>31.9 (4)</td>
<td>19.0 (4)</td>
</tr>
<tr>
<td>Dec-Feb</td>
<td>28.3 (3)</td>
<td>27.3 (0)</td>
<td>21.8 (3)</td>
<td>27.4 (3)</td>
</tr>
<tr>
<td>Mar-May</td>
<td>20.7 (4)</td>
<td>18.7 (4)</td>
<td>22.5 (3)</td>
<td>29.6 (3)</td>
</tr>
<tr>
<td>Jun-Aug</td>
<td>9.8 (3)</td>
<td>15.5 (2)</td>
<td>20.8 (3)</td>
<td>24.0 (4)</td>
</tr>
</tbody>
</table>
Statistical analyses associated with table 1 indicated that RAE’s existed in the U13 and U15 age groups for males and females (p < 0.01). The male U17’s also revealed a relative age effect (p < 0.01) but the statistical analyses failed to reveal an RAE in the male U20 or female U17 & U20 age-groups (when track events were combined). Separate analyses of individual track distances (with age-group combined) suggested that RAE’s existed in all selected events for males (p < 0.01) but only in 100-m (Sep to Nov = 36%) and 200-m (Sep to Nov = 37%) for females. The exact causes of the apparent disparities in RAE’s between young male and female athletes are currently unknown but it is recommended that any future long term research project should consider monitoring markers of biological growth (e.g. peak height velocity) and talent identification/selection procedures within developing high performance athletes; as the causes of RAE’s are speculated to be associated with physical, cognitive, emotional, biological and sociological factors (Morris and Nevill, 2006).

C6P
A quantitative analysis of the coaching behaviour within elite and non-elite kayaking.
Sims, M. Newell, E.
Loughborough College

Following a literature review it was identified that there was a scarcity of behavioural data on the coaching of individual sports (Gilbert & Trudel, 2004: Research Quarterly for Exercise and Sport, 75, 388-399). No data was evident which assessed the coaches’ behaviours in canoe sprint and slalom kayaking. The study conducted utilized quantitative description and systematically analysed the coaching behaviours of the canoe/kayaking coaches in the practice environment. The purpose of this study was to analyse the coaching behaviour between coaches of elite and non-elite athletes, from the Olympic canoeing/kayaking disciplines of sprint and slalom. The intention of this analysis was to look at two areas, firstly to ascertain if there was a trend of coaching behaviours between sprint and slalom; and secondly to discover if there was a trend between the coaching behaviours of the two levels of athlete. To compile the data of four coaches; two coaching elite paddlers and two coaching non-elite paddlers, the Arizona State University Observation Instrument (ASUOI) was used (Lacy and Darst 1984: Journal of Teaching in Physical Education, 3, 59-66). Within the ASUOI fourteen categories of coaching behavioural characteristics were observed. Ethical approval was granted by Loughborough College, with consent forms signed by all participants. The study results indicated that the category of ‘silence’ represented 75.27% of total recorded behaviours for the elite coaches and 29.46% for the non-elite. Results of ‘pre-instruction’, ‘concurrent instruction’ and ‘post instruction’ showed that non-elite coaches displayed 18.22% of instruction, whereas, elite coaches only displayed 10.34% of instruction. It was also observed that the sprint coaches’ recorded 59.42% ‘silence’ of total behaviours compared to 40.19% in slalom coaches. Sprint coaches presented 17.35% of instructional behaviour and slalom coaches represented 12.47% of instruction. The results stated above are a sample of behaviours observed; further results will be expanded upon within the discussion. There is a lack of available research on the coaching behaviours of coaches who work in elite level sport. Research has been encouraged to study elite level coaches in order to establish a clearer understanding of coach behaviour in this domain. These findings provide a unique insight into elite coach behaviour in an under-researched sport and how they compare with non-elite coaches. This study is the first of its kind to examine the behavioural differences between sprint and slalom coaches in kayaking. Further research into the specific behaviours of coaches working at an elite level is encouraged to help improve understanding of elite coaches. It is hoped that by providing these results a foundation for a database can be established for further research to build on. Development of this information can help to provide guidance for individual coach development within canoe/kayaking in sprint and slalom.
Participant confidence levels and views on training preparation for Entry Level ‘open water dives’ in scuba diving.

Bennett, J.
University of Chester

In recent years, there has been growing concern over the level of training and experience necessary to gain a recreational scuba diving qualification. An Entry Level course in scuba diving normally consists of a Knowledge Development and Theoretical Component, followed by a Confined Water Dive Component and an Open Water Dive Component. Under most Entry Level programs such as the Professional Association of Diving Instructors (PADI) and the British Sub-Aqua Club (BSAC), divers can complete a recreational diver certification with as few as four ‘open water’ dives (Barker & Roberts, 2004: *Biological Conservation*, 120, 481-489). PADI require four open water dives, whereas BSAC require five. The approach taken in much scuba research has been towards the risk and challenge involved, and this attention has possibly obscured opportunities to examine other aspects of the scuba diving experience, such as confidence. It has been suggested that four dives is too few to prepare new divers for such a level of responsibility (Medio *et al.*, 1997: *Biological Conservation*, 79, 91-95). Therefore, this study addresses a gap within the literature by investigating beginner scuba divers levels of confidence within the completion of open water dives at Entry Level. A mixed method, qualitative and quantitative methodology was used to examine the experiences of eighteen beginner scuba divers, eight female and ten male. Four focus Groups were conducted; two with PADI associated schools and two with BSAC associated schools. All focus groups were carried out following the ‘theoretical’ aspect of both courses and prior to the Open Water Dive Component of each course to examine how confident they felt prior to commencing their first dive. Questionnaires were then filled in approximately two weeks after each group had completed the open water dive component and subsequently finished the course in an attempt to gather a more adequate understanding of the varying issues that come to impact on diver confidence. Following a thematic analysis of the data from the focus groups, four common issues emerged that appeared to have impacted upon the participant’s confidence to dive prior to the completion of the ‘course’. These were; having a positive relationship with their instructor, theory aspects of the course, equipment and anxiety of breathing underwater. The data from the follow-up questionnaires following the open water dives suggests that gender related influences may relate to diver confidence with only 63% of female participants feeling confident to complete the range of skills learnt within an open water situation (compared to 90% of male participants). The data was further analysed to assess any differences between the two course providers (PADI and BSAC). Findings indicated a difference between the variations in delivery, content, support and the resultant impact upon which they have relating to diver confidence. The paper concludes by suggesting that the relationship between a student diver and their instructor is a key component in participants feeling confident prior to the first open water dive. Follow up data following the actual completion of the open water dives also highlight gender related confidence issues as well as varying rates of satisfaction and resultant levels of confidence for participant divers between the two dive institutions. This also appears to have impacted upon the participant’s future desire and confidence to complete open water dives. The study suggests extending research to incorporate additional components of participation with confidence. In doing so, a broader view of what transpires during scuba diving engagement becomes available.
The effect of fish oil supplementation upon the immunological response to exercise.
Mactier, I.

University of Aberdeen

Epidemiological evidence suggests that intensive physical exercise increases the risk of developing upper respiratory tract infection (Nieman, 1994: International Journal of Sports Medicine, 15, S131-S141). Many elements of the immune system exhibit change after strenuous exercise which could account for increased susceptibility to viral infection: these include the inflammatory cytokine interleukin-6 (IL-6) and eicosanoids such as prostaglandin E2 (PGE2). The calcium-zinc binding protein calprotectin also rises in response to exercise and may have immunomodulatory effects (Mortensen et al., 2008: The Journal of Physiology, 586, 3551-3562). Nutritional interventions could potentially modulate changes in the immune system in response to exercise, but research to date has been largely inconclusive (Nieman, 2008: Nutrition Reviews, 66, 310-320). Previous research has found fish oil supplementation attenuates increases in PGE2 levels in response to exercise (Andrade et al., 2007: Prostaglandins, Leukotrienes, and Essential Fatty Acids, 77, 139-145) but has no effect upon IL-6 levels (Toft et al., 2000: Journal of Applied Physiology, 89, 2401-2406). The aim of this study was to investigate the effects of fish oil supplementation upon the response of inflammatory markers to exercise in healthy volunteers.

Following ethical approval, 16 male subjects (age (mean ± SD) 22.6 ± 2.3 years, height 1.81 ± 0.07 m, weight 76.09 ± 9.08 kg and BMI 23.29 ± 2.44) were randomly assigned either fish oil supplementation 6 g/day (n=8) or an olive oil control 6 g/day (n=8) for 6 weeks in a double-blinded method. Groups did not differ with regard to age, height, weight, BMI, maximal oxygen uptake (VO2max) or resting and maximum heart rate (HR). At the end of the supplementation period subjects performed 1 hr of cycling exercise at 70% VO2max. Blood samples were drawn pre-exercise (T0), immediately post exercise (T1), and after ½ hour (T2), 1½ hour (T3) and 3 hours (T4) of recovery. Samples were analysed for IL-6, calprotectin, and PGE2. For all subjects IL-6 (fish oil P=0.0006, control P<0.0001) and calprotectin (fish oil P<0.0006, control P<0.0001) rose in response to exercise. PGE2 rose in the fish oil supplemented subjects (P<0.0001), and tended to rise in control subjects (P=0.03). Fish oil lowered levels of PGE2 at T0 (P<0.0004) and T4 (P<0.0007) compared to control and accelerated the return of IL-6 to baseline levels during recovery (T3-T4). These data suggest that fish oil supplementation may modulate parameters of the immune response. To our knowledge, this is the first study to report on the effects of fish oil supplementation upon calprotectin levels following exercise. Lack of concordant research means further studies into the effects of fish oil supplementation upon immunological responses to exercise are required before it can be recommended as a nutritional intervention in regards to exercise immunology.

Carbohydrate Ingestion During Team Games Exercise: Current Knowledge and Areas for Future Investigation.
Phillips, S.M., Sproule, J., & Turner, A.P.

University of Edinburgh

There is a growing body of research on the influence of ingesting carbohydrate-electrolyte (CHO-E) solutions immediately prior to and during prolonged intermittent, high-intensity exercise (team games exercise) designed to replicate field-based team games. This review presents the current body of knowledge in this area, and identifies avenues of further research. Searches in MEDLINE (PubMed) were performed. The ‘related citations’ service in PubMed was explored for each highlighted abstract to locate additional relevant articles, and the
reference list of each article was also hand searched for other appropriate studies. Only studies related to the field-based team games soccer, rugby and field-hockey were incorporated. Studies using additional supplementations (for example, carbohydrate (CHO) with caffeine, CHO with protein) that did not include a direct comparison between a CHO-E solution and a placebo (PLA) solution were excluded, as were studies that supplemented the first bolus of CHO >1 hr prior to the start of exercise. Based on these criteria, a total of 32 articles were included. Almost all early work supported the ingestion of CHO-E solutions during prolonged intermittent exercise, but was subject to methodological limitations. A key concern was the use of exercise protocols characterised by prolonged periods at the same exercise intensity, the lack of maximal or high-intensity work components, and long periods of seated recovery, that failed to replicate the activity pattern or physiological demand of team games exercise. The advent of protocols specifically designed to replicate the demands of field-based team games enabled a more externally valid assessment of the influence of CHO ingestion during this form of exercise. Once again, the research overwhelmingly supports CHO ingestion immediately prior to and during team games exercise for improving time to exhaustion during intermittent running. While the external validity of exhaustive exercise at fixed prescribed intensities as an assessment of exercise capacity during team games may appear questionable, these assessments should perhaps not be viewed as exhaustive exercise tests *per se* but as indicators of the ability to maintain high-intensity exercise, which is a recognised marker of performance and fatigue during field-based team games. Possible mechanisms of enhancement include sparing of muscle glycogen, glycogen resynthesis during low-intensity exercise periods, and attenuated effort perception during exercise. Most research fails to show improvements in sprint performance during team games exercise with CHO ingestion, perhaps due to the lack of influence of CHO on sprint performance when endogenous muscle glycogen concentration remains above a critical threshold of ~200 mmol/kg dry weight. Despite the increasing number of publications in this area, few studies have attempted to drive the research base forwards by investigating potential modulators of CHO efficacy during team games exercise, preventing the formulation of optimal CHO intake guidelines. Potential modulators may be different to those during prolonged steady-state exercise due to the constantly changing exercise intensity and frequency, duration and intensity of rest intervals, the potential for team games exercise to slow the rate of gastric emptying, and restricted access to CHO-E solutions during many team games. Important factors include fluid volume, CHO concentration, CHO composition and solution osmolality; glycaemic index of pre-exercise meals; fluid and CHO ingestion patterns; fluid temperature; CHO mouthwashes; CHO supplementation in different ambient temperatures; and investigation of all of these areas in different subject populations are important avenues for future research to enable a more comprehensive understanding of CHO ingestion during team games exercise.

N3O
O’Leary, T. J.
University of Portsmouth

It is well-documented that caffeine ingestion enhances exercise endurance during prolonged exercise. However, controversy remains as to whether caffeine improves high-intensity exercise performance. The aim of this study was to identify the effect of caffeine and carbohydrate co-ingestion (Caf+CHO) on 2000-m rowing performance compared with a carbohydrate placebo (CHO). A randomised, counterbalanced, single-blind, cross-over study was conducted involving 13 moderately-fit males (mean ± SD, age 21 ± 2.42 years, height 1.78 ± 0.04 m, mass 77.45 ± 9.09 kg, a mean caffeine intake 82.42 ± 58.72 mg·d⁻¹). All participants completed one familiarisation trial followed by two experimental trials at 3 to 14 day intervals, performed 10 min after ingesting a CHO gel (367.2 kJ, 21.6 g CHO) or a Caf+CHO gel (367.2 kJ, 21.6 g CHO, 100 mg caffeine). Trials were completed following a 2
min self-paced warm-up. Heart rate (HR), oxygen consumption (VO\textsubscript{2}), respiratory exchange ratio (RER), rating of perceived exertion (RPE), gastrointestinal discomfort (GI) and thirst perception (Thirst) were recorded every 200-m. Blood lactate [La-] was recorded immediately before and after exercise. A paired samples t-test identified a significant treatment effect for 2000-m performance time (P = 0.034). Caf+CHO resulted in a mean improvement of 5.2 ± 3.9 s (1.1%). The inter-individual range of performance change was +1 to -28 s relative to the CHO gel. A two-way repeated-measures ANOVA revealed no treatment effect for HR (P=0.817), VO\textsubscript{2} (P=0.490), RER (P=0.984), RPE (P=0.881), GI (P=0.584) or Thirst (P=0.981) throughout exercise. A paired samples t-test revealed no treatment effect for [La-] pre- (P=0.117) or post-exercise (P=0.534). It was concluded that Caf+CHO improves 2000-m rowing performance in a controlled laboratory setting.

N4P
An Investigation Analysing the Effects of a High Alkaline Diet versus Sodium Bicarbonate on High Intensity Performance.
Kaya, S., & Kass, L
University of Hertfordshire

Vegetarian diets have been shown to increase blood pH (Hunter & Bamman, 1991: National Strength and Conditioning Association Journal, 13, 61-65; Ball & Maughan, 1997: British Journal of Nutrition, 78, 683-693; Deriemaeker et al., 2010: Plant Foods for Human Nutrition, 65, 77-82.) and may be able to produce similar improvements in high intensity performance, as demonstrated by sodium bicarbonate (NaHCO\textsubscript{3}) (Douroudos et al., 2006: Medicine & Science in Sports & Exercise, 38, 1745-1753), however further research is required. The purpose of this study aimed to compare the effects of a 3 day high alkaline diet with NaHCO\textsubscript{3} consumption (0.3g/kg/bw) on repeated 30 second Wingate performances. Following institutional ethical approval, six male subjects (age 21.5 ± 1.9 years, height 176.3 ± 6.7 cm, body mass 72.0 ± 6.7 kg) were randomly assigned to an experimental (NaHCO\textsubscript{3}), control (placebo), high alkaline diet or generalised diet group in a randomised, crossover design undertaken in two sections. In the first section, subjects consumed either NaHCO\textsubscript{3} or placebo 1 hour prior to completing two 30 second Wingate tests, with 180 seconds recovery between. The second section involved subjects following either a 3 day generalised or high alkaline diet followed by the Wingate testing protocol on the fourth day. Mean anaerobic power (W) was measured following repeated Wingate performance. For both groups, blood pH, blood lactate (mmol) and end-tidal CO\textsubscript{2} (mmHg) were measured prior and immediately after testing. Wilcoxon Signed Ranks Test revealed no significant differences in resting blood pH between the high alkaline diet and generalised diet groups (P<0.05). Two way and one way ANOVAs demonstrated no significant reductions in exercise induced pH decrease between sodium bicarbonate supplementation and the high alkaline diet group (P>0.05). Changes in mean anaerobic power (W) between Wingate sprints 1 and 2 for all conditions were not significant (P<0.05). Sodium bicarbonate ingestion significantly increased post exercise blood lactate (mmol) (P=0.003) compared to the high alkaline diet group and end-tidal CO\textsubscript{2} (mmHg) (P<0.027) compared to both the generalised and high alkaline diet group. While previous research has displayed high alkaline diets to increase blood pH (Hunter & Bamman, 1991: National Strength and Conditioning Association Journal, 13, 61-65; Ball & Maughan, 1997: British Journal of Nutrition, 78, 683-693; Deriemaeker et al., 2010: Plant Foods for Human Nutrition, 65, 77-82), the current findings displayed no clear evidence to confirm this effect of the diet, as well as no improvement in mean anaerobic power compared to a generalised diet. Sodium bicarbonate supplementation displayed noticeable increases in post exercise blood lactate and end-tidal CO\textsubscript{2}; however this did not affect blood pH and mean anaerobic power. To conclude, high alkaline diets do not improve anaerobic performance through changes in blood pH, as previously shown by sodium bicarbonate (Douroudos et al., 2006: Medicine & Science in Sports & Exercise, 38, 1745-1753).
Acute or habitual breakfast consumption: associations with cardiorespiratory fitness (CRF).
McMillan, J., Voss, C., Ayodele, O., & Sandercock, G.
University of Essex

Persistent physical activity (PA) is associated with lower risk of several chronic diseases. Habitual breakfast eating is associated with higher physical activity in children and adolescence. A recent large study found that habitual breakfast consumption is association with higher cardiorespiratory fitness (CRF) (Sandercock et al., 2010: European Journal of Clinical Nutrition, 64,1086-92). Performance on a CRF test is dependent on both chronic PA patterns and acute performance of an often strenuous assessment. Breakfast eating may be associated with higher CRF via higher habitual PA, but skipping breakfast on the day of a CRF test may also potentially negatively influence test performance. The aim of this study was to determine whether acute or habitual breakfast consumption was associated with CRF. We sampled 4548 12-15 year old English schoolchildren. We measured CRF using the 20 m shuttle-run test, expressed as a z-score (Olds et al., 2006: Journal of Sport Sciences, 24,1025-1038) and classified as ‘Fit’ and ‘Unfit’ based on established norms (Meredith & Welk, 2004: FITNESSGRAM / ACTIVITYGRAM ADMINISTRATION MANUAL. 4th ed. Champaign, IL: Human Kinetics). Participants self-reported breakfast consumption. Habitual breakfast consumption was used to classify participants as ‘Eaters’ (consuming breakfast everyday) or ‘Skippers’. We also assessed whether breakfast was consumed on the day of testing. Male eaters had higher CRF than skippers (P<0.001) but there was no difference in CRF between female eaters and skippers (P=0.08). Consuming breakfast on the day of testing showed no significant association with mean CRF (P>0.05). There was no association between fitness category and consuming breakfast on the day of testing (No Breakfast eaten, OR 0.11, 95% CI 0.65-1.91). In multivariate analysis, male eaters were more likely to be fit even when controlling for breakfast consumption on day of testing (OR 1.90, 95%CI 1.30-2.76). There was no such association between CRF and breakfast eating habits in girls (OR 0.91, 95% CI 0.59-1.41). These findings support the health benefits of habitual breakfast consumption in boys support recent findings showing higher CRF in children who regularly eat breakfast (Sandercock et al., 2010). These data also refute the suggestion that assessing schoolchildren’s CRF on a day when they have not eaten breakfast may negatively impact on their performance. Research into how different breakfasts and their nutritional value may be associated with CRF is warranted.

Effect of low glycaemic index meals on appetite sensation and energy balance of male adult athletes.
Wu, D.M.Y., Rowlands, A.V., & Williams, C.A.
University of Exeter

A concept of low glycaemic index (LGI) carbohydrate containing foods which provide higher satiating effects than foods with high glycaemic index (HGI) has emerged recently (Bornet et al., 2007: Appetite, 49, 535-53). Consumption of LGI meals may be beneficial for athletes to promote satiety so as to achieve optimal body weight. Therefore, the purpose of this study was to investigate the short term effect of GI meals on subjective appetite sensation and energy balance in adult male athletes. Fourteen recreationally active males (mean ± SD; age 34.5 ± 8.9 y, BMI 22.8 ± 2.1 kg /m²) participated in a randomised crossover design with LGI and HGI meals. On each trial day, participants consumed a breakfast in the laboratory, then left one hour post prandially with a food bag containing lunch, dinner and snacks. Subjective appetite sensations were recorded regularly using a visual analogue scale during the first postprandial hour in the laboratory and hourly throughout the trial days. Resting energy expenditure (REE) was measured in the fasted state during both trial days and 24 hr later.
Energy intake (EI) and expenditure (EE) of the trial days and 24 hr later were assessed by self-report food intake and accelerometry. The overall calculated GI values for the HGI and LGI meals were 76.2 ± 2.8 and 39.6 ± 1.0 respectively. Energy, macronutrients, fibre content and the caloric density were similar between LGI and HGI at each mealtime. Participants reported a higher appetite score after the consumption of the LGI breakfast than the HGI breakfast throughout the first postprandial hour in the laboratory (P=0.03) and throughout the remainder of the trial day (P=0.006). The mean appetite score after 20 minutes for all LGI meals was significantly higher than for the HGI meals (34.0 ± 15.6 vs. 27.5 ± 12.6, P=0.027). No significant differences were found in the REE, EI and the EE between the corresponding trial days and the post-trial days. These results indicate that in the short term frequent consumption of HGI mixed meals can suppress appetite compared to that of LGI mixed meals which is inconsistent with previous findings. As GI may also depend on the exercise level of participants (Mettler et al., 2007: European Journal of Clinical Nutrition, 61, 9-24), further investigation of the relationship between GI and appetite for the regulation of food intake in trained athletes is required. These results also indicate the importance of matching the protein, fat and fibre contents relative to the GI values for mixed meals.

N7O
The effect of carbohydrate and protein ingestion during variable-intensity cycling on hydration status.
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There has been some evidence to suggest that the addition of protein to a carbohydrate beverage post-exercise may enhance fluid balance (Seifert et al., 2006: International Journal of Sport Nutrition and Exercise Metabolism, 16, 420-429; Watson et al., 2008: European Journal of Applied Physiology, 104, 633-642), but this has not yet been investigated during exercise. Dehydration greater than 2% body weight can significantly impair aerobic exercise performance (Sawka et al., 2007: Medicine & Science in Sports and Exercise, 39, 377-390), highlighting the importance of limiting fluid loss during exercise. Therefore, the purpose of this study was to compare the effects of isoenergetic carbohydrate (CHO) and carbohydrate-protein (CHO-P) supplements on hydration status during variable-intensity cycling exercise. Following ethical approval, seven recreational male athlete volunteers (mean ± SD; age 23.1 ± 6.6 y, stature 1.78 ± 0.087 m, body mass 77.7 ± 15.8 kg, VO2peak 44.6 ± 6.9 ml·kg⁻¹·min⁻¹) performed an incremental test to exhaustion on a cycle ergometer to determine VO2peak and the power output corresponding to VO2peak (Pmax). Participants then completed two main trials separated by a minimum of 7 days, ingesting either a carbohydrate protein (5.4% CHO, 2.2% PRO) or an isocaloric carbohydrate (6.6% CHO) beverage immediately before and during exercise in a randomised, single-blind, counterbalanced design. Following a 5 min warm-up in each trial participants performed a 60 min variable intensity exercise protocol at power outputs ranging between 60-90% Pmax on a Lode cycle ergometer. Heart rate and metabolic data were recorded during all tests, in addition to ratings of perceived exertion and gut fullness. Measurements of urine volume over a 30 min period post-exercise and urine osmolality pre and post-exercise were recorded, accompanied by changes in plasma volume, body mass and sweat rate. The amount of ingested fluid retained was negative following the ingestion of both the CHO and CHO-P beverages and there was no difference in the percentage of fluid retained between conditions (P > 0.05). Similar to previous findings reported by James et al. (2011: British Journal of Nutrition, 105, 393-9), there was a tendency (P = 0.061) for a reduced urine production post-exercise in the CHO-P trial, but this warrants further investigation. Whilst the ingestion of a CHO-P beverage has been shown to improve fluid retention post-exercise compared to CHO alone (James et al., 2011: British Journal of Nutrition, 105), 393-9; Shirreffs et al., 2007: British Journal of Nutrition, 98, 173-180), these findings suggest that CHO-P ingestion during variable-intensity cycling exercise did not
improve fluid retention over that seen with an energy matched CHO solution, although the effect was comparable to that observed with a CHO beverage.

N8P

**The effect of caffeine on high-intensity, intermittent sprint performance in male collegiate rugby players using a work: rest ratio of 1:20.**

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There is currently little research on the ergogenic effect of caffeine during repeated bouts of high-intensity exercise. There has, however, been speculation about the magnitude of these benefits at differing work: rest ratios (Davies and Green, 2009: *Sports Medicine, 39*, 813-832). Therefore, the purpose of this study was to investigate the effect of caffeine on high-intensity, intermittent cycling performance with a work: rest ratio of 1:20 in collegiate rugby union players. With institutional ethical approval, six male collegiate rugby players (mean ± standard deviation; age 20.5 ± 0.55 years, height 184 ± 0.89 cm, mass 98.83 ± 8.64 kg) volunteered to participate in this study. After a familiarisation trial subjects performed 17, 5-second sprints on a cycle ergometer interspersed with a 100 second active recovery period. Using a randomised, double blind, placebo-controlled cross-over experimental design subjects consumed half a dose of 6 mg·kg⁻¹ body mass of caffeine or placebo (glucose) one hour before testing and the second half 10 minutes before testing. Peak power output (PPO) (Watts) and mean power output (MPO) (Watts) were measured during every bout. Blood lactate concentrations (BLA) (mmol·l⁻¹) and Borg rating of perceived exertion (RPE) were recorded after every fourth sprinting bout. Data were analysed using a two-way (treatment by bout) repeated measures analysis of variance (ANOVA). There was no difference in PPO (P=0.997) or MPO (P=0.526) between caffeine or placebo treatments, however there was an increase in BLA concentrations with caffeine by 14.3% compared to placebo (P=0.000). RPE showed no difference between caffeine and placebo results and no interaction between the treatments consumed over time (P=0.732). However, results that were obtained from one particular subject in this investigation showed increases in PPO and MPO by 8% and 10.9% respectively after caffeine supplementation. RPE was also two scores lower during the caffeine trial, which was the largest difference seen amongst the participants. Results from this study established no overall change in PPO, MPO or RPE during sprinting bouts between placebo and caffeine consumption. These findings suggest that a work: rest ratio of 1:20 (5:100 seconds) is inadequate in promoting the ergogenic effects seen after caffeine supplementation during high-intensity, intermittent exercise. This work: rest ratio cannot be readily compared with other studies, as they incorporate either shorter rest periods (Stuart et al., 2005: *Medicine and Science in Sports and Exercise, 37*, 1998-2005) or longer recovery durations (Schneiker et al., 2006: *Medicine and Science in Sports and Exercise, 38*, 578-585). A study that supports the findings from this investigation was conducted by Crowe et al. (2006: *International Journal of Sports Nutrition and Exercise Metabolism, 16*, 528-544) who noted no change on PPO during two, 60 second bouts of maximal cycling with caffeine consumption, and additionally reported an increase in blood lactate concentrations. Conflicting studies found significant enhancements in power output with caffeine compared to a placebo during high-intensity bouts of cycling (Wiles et al., 2006: *Journal of Sports Science, 24*, 1165-1171) and also during intermittent bouts of maximal cycling (Schneiker et al., 2006). Analysing the literature concerning caffeine and high-intensity, intermittent exercise, it can be argued that protocol, duration and intensity used are the key factors behind discovering benefits with caffeine supplementation or not. By examining individual results, it can be speculated that the effects of caffeine consumption vary widely amongst athletes due to individual variation and could be a key factor for inconsistencies in literature (Astorino and Roberson, 2010: *Journal of Strength and Conditioning Research, 24*, 257-265). In conclusion, these results show that caffeine did not improve high-intensity, intermittent sprint performance with a work: rest ratio of 1:20 in team sport athletes. Future research should
investigate caffeine supplementation with other work: rest ratios in order to determine an optimal protocol in which the full effects of caffeine can be observed.

N9P

The effects of oral Magnesium supplementation on muscular recovery.
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There is an abundance of literature supporting the effects of nutritional supplements on muscle recovery; however the effects of magnesium on muscle recovery are less well established. Brilla & Haley (1992: Journal of the American College of Nutrition, 11, 326-329) suggested that magnesium plays a role at the ribosomal level of protein synthesis; having found significant strength gains in subjects orally supplemented with magnesium. Cinar et al., (2006: Acta Physiologica Hungaria, 93, 137-144) reported that subjects supplemented with magnesium elicited a reduced post exercise blood lactate response following exercise to exhaustion. To the best of the investigators knowledge this is the only study covering this area. The purpose of this current investigation was to determine the effects of magnesium oxide supplementation on post-exercise blood lactate response, and selected performance measures following a resistance exercise protocol. Following institutional ethical approval, 8 male, recreationally weight trained volunteers (age 21.4 ± 1.51 y, height 176.6 ± 5.52 cm, body mass 76.09 ± 6.63 kg, body composition 12.56 ± 5.18%) were randomly assigned to either a supplementation, or a placebo group in a randomised double blind, placebo-controlled crossover design. Anthropometric measurements and technical assessment of bench press and back squat technique were carried out during familiarisation. Subjects returned to the laboratory after 7 days for baseline data collection, where resting HR, BP and capillary blood samples were obtained. After a 5 minute warm up at 65% HRmax, 1 Repetition Maximal (1RM) bench press and back squat were established. Subjects then completed 2 sets of 15 reps, and a 3rd set at 60% 1RM to momentary failure of both exercises, with 1 minute rest between sets. Post-exercise BP data were collected and blood lactate analysis completed. Subjects repeated the protocol after 48 h recovery and were then given either placebo (500 mg Corn Flour) or magnesium oxide (500 mg MgO) for 7 days. Participants then returned to the laboratory to repeat the protocol. Subjects completed a washout period for 7 days, after which they were asked to ingest the alternative supplement for 7 days, and returned post-supplementation in order to repeat the protocol for a final time. Mean and peak power outputs were recorded in all trials and post-recovery. One way ANOVAs revealed no significant differences (P > 0.05) between peak bench press and back squat powers, mean bench press and back squat powers, and blood lactate concentration pre and post recovery between conditions. Contrary to research by Cinar et al., (2006: Acta Physiologica Hungaria, 93, 137-144), results of the current study suggest that 7-day oral MgO supplementation had no effect on blood lactate concentration post resistance exercise after 48 hours recovery.

N10P

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Staffordshire University

It has been suggested (e.g., Hulston & Jeukendrup, 2009: International Journal of Sport Nutrition & Exercise Metabolism, 19, 275-285) that carbohydrate-electrolyte (CHO-E) beverages improve performance over 90 min. In swimmers, however, Langill et al. (2002: International Journal of Sport Nutrition & Exercise Metabolism, 12, 136-144) found that CHO-E consumption increased blood glucose concentration, yet did not improve performance time over 80 min. The purpose of this study was to further examine the effects of sports drinks on blood glucose and endurance performance among experienced swimmers.
Following institutional ethical approval, 12 swimmers (mean±SD; age 25.5 ± 16.8 years) completed two 90 min training sessions, one-week apart, following consumption of either 500 ml of Lucozade Sport (6.4% CHO solution, 0.2 g of sodium per 500 ml solution), or placebo (200 ml orange squash plus 300 ml of water) in a randomised, cross-over, double-blind design. Performance was assessed by a 200 m timed front crawl swim which was completed after the 90 min training session. Capillary blood samples (50 µl) were removed from the fingertip for the determination of glucose before, during and after each training session. Hydration was assessed via change in body mass. A dependent t-test was be used to analyse the effect of CHO-E or placebo on 200 m performance time (placebo = 194.24 ± 28.56 sec vs CHO-E = 195.82 ± 33.49 sec, t = .474; NS). Blood glucose was be analysed using a two-way ANOVA with repeated measures. No significant variation was identified between treatment conditions (placebo vs CHO-E). However a significant (F₂,₁₈ = 8.85; p ≤ .01) variation was identified between before, mid and after testing blood glucose values. On this evidence, sports drinks versus placebo did not have a beneficial effect within the population group. However using a cohort with a higher performance standard may have produced differing results.

N11P
Effects of rehydration strategies on physiological performance in club swimmers.
Glyndwr University

Research suggests swimmers are prone to dehydration as training for competitive swimming requires regular training at high intensities (Coyle, 2004; Journal of Sports Sciences, 22, 39–55). Therefore the purpose of this study was to examine the effects of 3 different fluids; Lucozade Sport (LS), Lucozade Lite (LL) and a sugar free juice placebo (SF) on physiological and performance measures. Following ethical approval 19 swimmers (age 11.1 ± 2.2 years; stature 154.9 ± 12.2 cm; body mass 46.6 ± 11.8 kg) volunteered to take part in the study. Swimmers undertook a standardised 1-hour training session and then completed a 60 m freestyle time trial (TT). Upon arrival a urine sample (US) was collected and body mass (BM, in swimwear) recorded. During the training session the swimmers drank 150 ml every 15 min (total 600 ml). Immediately following a timed 60 m time trial heart rate (HR) was recorded, then a second US was collected and BM was recorded. This was repeated over 3 weeks for each of the 3 drinks. Subjects did not know which drink they were consuming. Data will be analysed using a repeated measures ANOVA to examine the differences in HR and TT performance between the 3 conditions. A two-way repeated measure ANOVA was used to determine any interaction effect of time (pre versus post) and drink on urine osmolality and BM. There was a significant reduction in osmolality during the training session; (Pre LL 554.21 ±244.38 mmol.l⁻¹; LS 657.37 ±286.53 mmol.l⁻¹; SF 585.226 ±279.95 mmol.l⁻¹; Post, LL 233.68 ±164.59 mmol.l⁻¹; LS 270.53 ±237.33 mmol.l⁻¹; SF167.89 ±159.39 mmol.l⁻¹; F[2, 36] =98.65, P<0.001). However there were no differences in the change in osmolality between the 3 conditions (F[2,36] =0.864, P=0.43). There was no difference between the performance trials for the 3 conditions (LL 53.50 ±6.46 s; LS 52.54 ±5.79 s; SF 52.81 ±4.84 s; F[1,24.4] =0.590, P=0.499), nor was there a significant change in BW (LL -0.90 ±1.35 kg; LS -0.65 ±0.29 kg; SF 0.13 ±2.602 kg; (F[1.8, 23.6] =1.888, P=0.182). There was a significantly higher HR during the LL performance trial (173 ±16.12 b.p.m) compared to the LS (159.2 ±26.33 b.p.m) and the SF (159.3 ±26.38 b.p.m) trials (F[1,8, 33.3] =4.196, P=0.026), although this has been attributed to performance anxiety. The hydration strategy resulted in a reduction in urine osmolality during the training session; however the type of solution had no significant impact on the level change.
**N12O**

**The role of vitamin D in type 2 diabetes; work in progress.**

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Vitamin D deficiency and type 2 diabetes are both increasing in prevalence as a consequence of changing lifestyles. Low vitamin D status is associated with impaired β-cell function, insulin resistance, and glucose intolerance all of which are central to the pathogenesis of type 2 diabetes (Song & Manson, 2010: *Current Cardiovascular Risk Reports*, 4, 40-47). The purpose of the study is to measure vitamin D levels (25(OH)D) in individuals with type 2 diabetes (n = 50), impaired glucose tolerance (n = 50) and a healthy control group (n = 50). Following NHS and University ethical approval participants will attend the lab three times over a twelve month period; the first data collection point will be cross sectional, the second to explore seasonal variations between 25(OH)D and insulin sensitivity (IS) as measured by HOMA-IR (a surrogate measure of whole body insulin sensitivity), and the third to identify if there is a relationship between serum 25(OH)D and IS over time (12 months). Venous blood samples will be obtained and analysed to assess 25(OH)D status, IS and HbA1c values. In addition to demographic data, lifestyle information will be collected via three questionnaires; Typical time spent in sunlight per week (Hanwell *et al.*, 2010: *The Journal of Steroid Biochemistry and Molecular Biology*, 121, 334-7); food and energy intake Food Frequency Questionnaire (Compeat, Nutrition Systems, U.K); and the International Physical Activity Questionnaire (IPAQ) will be completed.

Results will be presented as mean ± standard deviation. To identify any significant differences between the groups a one way ANOVA will be performed, with post-hoc independent t-tests where appropriate. Statistical comparisons over time will be made using a 2 way mixed ANOVA (‘repeated measures’ for time points and ‘between for groups’) with post-hoc tests where appropriate. Relationships between variables will be evaluated using Pearson’s product-moment correlation coefficient. If data are not normally distributed log transformation will be carried out to normalise them, if this is not possible the equivalent non-parametric tests will be performed. Tests will be considered statistically significant at the 5% level. It is hypothesised that serum 25(OH)D concentrations will be progressively lower in control subjects, people with impaired glucose tolerance and type 2DM, respectively. Furthermore, there will be a correlation between concentrations of serum 25(OH)D and insulin sensitivity as measured by HOMA-IR. It is also predicted that there will be between groups differences in serum 25(OH)D concentrations and insulin sensitivity. It is hypothesised that concentrations of serum 25(OH)D will be higher for the summer data collection point when compared to winter values in all groups. It is predicted that these lower values will be reflected in poorer insulin sensitivity as indicated by HOMA-IR, and poorer glucose control as indicated by HbA1c measurements across all three experimental groups. It is hypothesised that reductions in insulin sensitivity (HOMA-IR) will have a direct correlation with mean concentrations of serum 25(OH)D over the data collection period.

**N13O**

**The effect of acute bovine colostrum supplementation on neutrophil responses to prolonged cycling.**

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It has been suggested that in the hours or days following prolonged exercise an individual has increased susceptibility to upper respiratory tract infections (URTI) due to alterations in many immunological components (Nieman, 2001: *Canadian Journal of Applied Physiology*, 26, 45-55). Bovine colostrum (BC), consumed daily for 4-8 weeks, has been shown to be of benefit to the immune system and URTI risk (Brinkworth & Buckley, 2003: *European Journal of Nutrition*, 42, 228-332; Davison & Diment, 2010: *British Journal of Nutrition*, 103, 1425-
The purpose of this study was to identify whether acute BC supplementation (i.e. hours) prior to a bout of prolonged exercise has any effect on neutrophil function. Seven healthy males (age: 23.3 ± 3.9 years, body mass: 74.3 ± 6.6 kg, stature: 1.8 ± 0.06 m, VO\(_2\) max: 4.3 ± 0.6 L/min; values are mean ± SD) participated in 2 main trials in a randomised order. Subjects consumed either BC or placebo (PLA) 1 hour prior to 2.5 hours of cycling at approximately 55% VO\(_2\) max (30 g), immediately prior (5 g) and midway through the exercise (5 g). Venous blood samples were obtained on the morning prior to consumption of the supplement (BAS), 1 hour post drink (immediately pre-exercise: PRE), immediately post-exercise (POST) and 1 hour post-exercise (1-POST). Total and differential leukocyte counts were measured using an automated haematology analyser. In-vitro stimulated neutrophil oxidative burst responses (OBA) to PMA and fMLP were measured by chemiluminescence (CL) assay and expressed per neutrophil. To maintain blinding procedures, the effect of trial on cell counts was not investigated so only overall time effects are reported. Repeated measures 1 way ANOVA demonstrated a main effect of time for both neutrophil count and neutrophil:lymphocyte ratio (P ≤ 0.001). Post hoc paired t-tests (Bonferroni corrected) revealed significant increases from BAS at POST/1-POST for blood neutrophil count (P = 0.004/ P=0.005) and neutrophil:lymphocyte ratio (P= < 0.001/ P= < 0.001). For fMLP-stimulated OBA 2-way repeated measures ANOVA showed there was a main effect of time (P < 0.001) and a trend for a main effect of trial (P = 0.068) but no time × trial interaction (P > 0.05). For PMA-stimulated OBA, there was a main effect of time (P = 0.01) but no main effect of trial or time × trial interaction (P > 0.05). Post hoc comparisons demonstrated significant decreases from BAS at both post-exercise timepoints for fMLP-stimulated OBA (P < 0.05) while only at POST (P <0.001) was there a significant decrease from BAS for PMA-stimulated OBA. These results suggest that fMLP-stimulated OBA is generally higher with acute BC supplementation but the overall temporal pattern (a post-exercise decrease) is similar between trials. These preliminary results show trends to support the idea that BC may enhance neutrophil functions by a direct and immediate mechanism, in agreement with the in-vitro findings of Sugisawa et al. (2001: Biology of the Neonate, 79, 140-144). At present statistical power is low and the intention is to increase the sample size to 12 to determine whether the observed trends are meaningful or not.

Evaluation of nutritional knowledge and dietary intake of cricket players participating in an individualised nutrition education programme.

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There is little research surrounding the nutritional knowledge, dietary habits and impact of nutritional education within the sport of cricket. Although the importance of nutrition has become increasingly prevalent within sport and an essential constituent in achieving competitive athletic performance (Economou et al., 1993: Sports Medicine, 16, 381-399), many athletes are unaware of correct nutritional practices (Dunn et al., 2007: Sport Journal, 10, 45-53). The purpose of this study was to assess nutritional knowledge and dietary intake (energy; carbohydrate; protein; fat; fluid; fruit and vegetable and alcohol intakes) within cricket players and evaluate the efficacy of an individualised nutrition education programme. A convenience sample of 12 male cricket players (professional players, n=5 and university players, n=7) volunteered to participate in the study. The professional players were assigned to the experimental group (EXP), with the university players enlisted as the control group (CON). Following ethical approval, all participants completed the same baseline measures, comprising of a validated nutritional knowledge questionnaire (Zinn et al., 2006: International Journal of Sport Nutrition and Exercise Metabolism, 16, 214-225) and a 7 day semi-weighed diet and exercise diary. A series of one-to-one consultations, consisting of six regular sessions, were delivered to the EXP over a three month period, with the CON receiving no contact for the duration of the study following the pre-test session. Dietary
intakes were analysed and compared to individualised calculated values based on current evidence based sports nutrition guidelines, to determine any observed changes. Repeat nutritional knowledge questionnaires and diet diaries were completed by both groups post intervention, with an additional evaluation questionnaire for the EXP. On study completion, the CON were offered similar nutritional support and education, and provided with the relevant information on the study outcomes. An independent t-test was conducted to compare and standardise pre-intervention nutritional knowledge between the EXP and the CON. The test revealed no significant difference in preintervention nutritional knowledge between groups (p=0.92). Paired samples t-tests were conducted and revealed a significant improvement in nutritional knowledge (p=0.03, eta=0.73) and fruit and vegetable intakes (p=0.00) within the EXP from pre- to post-nutrition education programme. Although non-significant, there were improvements in energy (p=0.37, eta=0.20), carbohydrate (p=0.60, eta=0.08) and fluid intakes (p=0.58, eta=0.09) within the EXP following the intervention. In comparison the CON demonstrated no significant differences in nutritional knowledge (p=0.51, eta=0.08) or dietary intake values from pre- to post-intervention. Additionally, a moderately strong, positive correlation was observed between post-intervention nutritional knowledge and energy intake in the EXP (r = 0.32, r² = 0.32). The findings illustrate that positive improvements in nutritional knowledge and areas of dietary intake are consistent with previous studies and other investigated populations (Abood et al., 2004: Journal of Nutrition Education and Behaviour, 36, 135-139). The results suggest that the delivery of an individualised education programme can induce positive short-term changes in nutritional knowledge and improvements in energy, carbohydrate and fluid intakes. It can therefore be proposed that the inclusion of an individualised education programme will enhance knowledge and dietary behaviours among professional cricket players.

N15P
Does the perceived intake of caffeine have an effect on aerobic performance?
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Caffeine has been shown to increase aerobic performance, despite there being no clear scientific proof of the mechanism behind the ergogenic effect. It has been suggested that the increase could be due to the placebo effect; a positive outcome that arises because the subject believes that they are taking something beneficial (Guess et al, 2002: The Science of the Placebo. London: BMJ Books). The present study explored the effects of caffeine in comparison to the perceived intake of caffeine on aerobic performance.

Ethical approval was granted by the University of Hertfordshire’s Ethics board. Ten active males aged between 20.6 and 22.4 years (mean 21.36 ±0.76) each undertook a VO2max test, a familiarisation trial and 3 experimental 15km time trials on a cycle ergometer (racemate inc). Subjects were informed that in the experimental trials they would each receive a placebo, 3mg.kg.bw⁻¹ and 9mg.kg.bw⁻¹ of caffeine, randomly assigned. In one of the two caffeine trials (randomly allocated), the participants were deceived and given a placebo instead. Semi structured interviews and questionnaires were conducted following each trial and after revealing the deception. The experimental hypothesis states that there will be a significant dose response improvement in time trial performance when caffeine is ingested (p=>0.05). A second experimental hypothesis states that there will be a significant increase in time trial performance when caffeine is thought to be ingested in comparison to placebo (p=>0.05). The results were then statistically analysed using a one way within-subjects anova test. In experimental group A, the subjects who actually ingested 3mg.kg.bw⁻¹ caffeine showed a time trial improvement of 56.0 (±41.1) seconds on placebo (p=0.115). When the same subjects ingested the 9 mg.kg.bw⁻¹ deception pill (actually placebo), their time improved by 72.6 (±44.9) seconds on the placebo time (p=0.067). In experimental group B, the subjects improved by 35.8 (±52.6) seconds (p=0.60) when they believed they were on 3mg.kg.bw⁻¹ pill (actually placebo). An improvement of 87.0 (±66.7) seconds was recorded when the
subjects ingested the 9 mg.kg.bw⁻¹ caffeine supplement (p=0.130). It is worth noting that statistical significance was found (p=0.005) between the actual ingestion of 9 mg.kg.bw⁻¹ caffeine in comparison to the 3mg.kg.bw⁻¹ (placebo). The post experiment questionnaires found that 8 of the 10 subjects agreed to a belief behavior relationship; the feeling that this tablet must contain something beneficial so it will improve the subject’s performance. The same 8 subjects also stated that they expected caffeine to positively affect their performance. Both quantitative and qualitative measures suggest that aerobic performance is improved by the belief of ingesting a beneficial substance, although performance is enhanced furthermore when caffeine is actually ingested.

N16O
The effect of milk protein addition to a carbohydrate-electrolyte rehydration solution consumed after exercise in the heat: Is there a dose response relationship?
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Milk has been shown to be a more effective post-exercise rehydration solution than a carbohydrate-electrolyte sports drink (Shirreffs et al. 2007: British Journal of Nutrition, 98, 173-180). Recent research (James et al., 2010: British Journal of Nutrition, 105, 393-399) has found that a carbohydrate-milk protein solution is more effective at enhancing fluid retention after exercise-induced dehydration than a carbohydrate solution that is matched in terms of energy density and electrolyte content. This suggests that milk protein may augment greater fluid retention than carbohydrate. It is currently unknown whether there is a dose-response effect of milk protein on rehydration after exercise-induced dehydration. Therefore the aim of the current study was to investigate whether increasing the milk protein content in energy and electrolyte matched carbohydrate or carbohydrate-milk protein rehydration solutions, can increase fluid retention. Following ethical approval, eight male volunteers (age 22 ± 2 y, height 1.77 ± 0.08 m, body mass 76.96 ± 8.73 kg) completed intermittent exercise in a warm environment (35.0 ± 0.1 °C, 51.8 ± 5.9 relative humidity) until they lost 1.8 ± 0.1 % of their initial body mass. Participants then ingested a volume of drink in litres equivalent to 150% of their body mass loss in kg. This drink was provided in four equal boluses over 1 h, and participants then remained in the lab for a further 4 h. Participants completed three trials, during each trial they consumed either a 60 g/l carbohydrate solution (C), a 40 g/l carbohydrate, 20 g/l milk-protein solution (20CP), or a 20 g/l carbohydrate, 40 g/l milk-protein solution (40CP). Rehydration beverages were matched in terms of energy and electrolyte content. Urine samples were collected before and after exercise, as well as after rehydration and each hour of the 4 hour recovery period. Urine samples were measured for volume and osmolality by freezing point depression. Trials were administered in a double blind, randomised, crossover design. Total cumulative urine output after rehydration was greater for trial C (1150 ± 245 ml) than for trial 20CP (857 ± 270 ml) (P = 0.007) and 40CP (769 ± 129 ml) (P = 0.006), with no difference between 20CP and 40CP (P = 1). As a result, total drink retention was greater for 20CP (58 ± 9 %) (P = 0.002) and 40CP (64 ± 7 %) (P < 0.001) than C (43 ± 7 %) (P = 0.008), but was not different between 20CP and 40CP (P = 1). At the end of the study period, whole body net fluid balance (estimated from fluid lost through sweat and urine production, and fluid gained through drink ingestion) was less negative for trials 20CP (-203 ± 315 ml) (P = 0.029) and 40CP (-97 ± 146 ml) (P = 0.001) than for trial C (-487 ± 149 ml), but was not different between 20CP and 40CP (P = 1). Although mean net fluid balance was negative for all trials at the end of the study, it was only statistically negative after ingestion of drink C (P = 0.002). Results for the study suggest that there is not a dose response relationship between milk-protein ingestion and drink retention, as there was no difference between the drinks containing 20g/l and 40g/l milk protein, in any of the measurements taken. However, this study confirms that after exercise in a warm environment, a carbohydrate-milk protein solution is better retained than a carbohydrate
solution, when solutions are matched for energy density and electrolyte content. This study confirms that some of the beneficial post-exercise rehydration effects of milk may be specifically attributable to milk protein.

**N17O**

**A Comparison of short (2 days) and longer term (14 days) of Bovine Colostrum Supplementation on Exercise Induced Changes in Gut Permeability.**

March, D., Davison, G., & Thatcher, R.

*Aberystwyth University*

Exercise has previously been shown to increase gut permeability. This increase in gut permeability has been associated with gut complaints during exercise and has been suggested as a pathway to exertional heatstroke (Lambert, 2009: *Exercise and Sports Science Reviews*, 32, 185-190). There are a number of ‘functional foods’ or bioactive food products that can potentially improve (treat or prevent) gut injury and promote gastrointestinal health and repair in the event of a gut injury. For example bovine colostrum the milk produced by cows in the first few days post parturition and is a rich source of nutrients, immune and growth factors and has previously been shown to truncate exercise induced rises in gut permeability after 14 days of supplementation (Marchbank *et al.*, In press). However immediate effects on heat induced permeability and gut cell health have been observed in vitro. It is not commonly known whether effects in vivo can be induced with shorter periods of supplementation. Therefore the purpose of this study is to compare the effect of a short (2 day) against a long term (14 day) bovine colostrum supplementation period on exercise induced changes in gut permeability. With institutional ethics approval three volunteers (to date) completed a single blind, placebo controlled, crossover protocol. Subjects supplemented (20 g/day) with a placebo for a 48 h period followed by a four day ‘wash out’ period and then a further 14 day period of supplementation with bovine colostrums (20 g/day). Gut permeability was determined using 5 hour urinary lactulose:rhamnose ratios at baseline before each arm and then following 20 minutes of treadmill running equivalent to 80% VO\textsubscript{2max} after 48 h during the placebo arm and then again after 48 h and 14 days during the bovine colostrums arm. Venous blood samples were obtained pre, immediately post and following the commencement of the 5 h urine collection during each main exercise trial to determine haematocrit, plasma bacterial endotoxin, gut hormones, and blood glucose and lactate concentrations. Data will be analysed using a one-way repeated measures ANOVA to determine any time effect on measures of gut permeability including the lactulose:rhamnose ratios and plasma bacterial endotoxin. Post-hoc t-tests will be run where appropriate to identify where the differences lie. It is hoped that the results of this study will ascertain whether a shorter term period of supplementation can afford similar protective effects on exercise induced changes in gut permeability compared to a longer period. Further data will be collected.

**N18O**

**The effects of carbohydrate-protein ingestion on multiple-sprint sport performance.**

Highton, J., Nicholas, C., Twist, C., & Lamb, K.L.

*University of Chester*

Decrements in performance associated with fatigue are commonly observed over the course of multiple-sprint sports such as soccer, rugby and hockey. It has been established that the ingestion of carbohydrate can improve endurance capacity following simulated multiple-sprint sport activity when compared to water (Nicholas *et al.*, 1995: *Journal of Sports Sciences*, 13, 283-290). However, little is known about the potential for the addition of a small amount of protein to a carbohydrate beverage to enhance performance further during this form of exercise. Therefore the aim of this study was to examine the effect of a 6%
carbohydrate plus 2% whey protein isolate drink on responses to simulated multiple-sprint sport exercise and endurance capacity in comparison to carbohydrate alone. Following ethical approval, 10 (6 males and 4 females); age 21.7 ± 2.1 y, stature 1.77 ± 0.1 m, body mass 72.03 ± 13.15 kg, VO₂max 51.0 ± 7.6 ml·kg⁻¹·min⁻¹) healthy university level multiple-sprint sport players volunteered to participate in the study. Participants initially performed the 20 m multi-stage fitness test and were then familiarized with the Loughborough Intermittent Shuttle Test (LIST). Thereafter, they completed the LIST (Parts A and B) on three separate days during which they consumed either a carbohydrate-protein (CHO-P), a 6% carbohydrate beverage matched for carbohydrate content (ISOCHO) or an 8% carbohydrate beverage matched for energy content (ISOEN) in a double-blind, crossover design. Part A of the LIST consisted of five blocks of intermittent shuttle running consisting of walking, sprinting, jogging at 55% VO₂max and cruising at 95% VO₂max, whereas Part B involved alternating between a jog and a cruise until volitional exhaustion. Average 15 m sprint times and heart rates (HR) were recorded over each 15 min block of the LIST, whilst measurements of rating of perceived exertion (RPE) and gut fullness were taken at 15 min intervals during the LIST. ANOVA revealed a significant (P < 0.05) main effect of time on sprint performance, HR and gut fullness, but no significant effect of type of drink or a time x drink interaction. Thus, sprint times, HR and gut fullness increased over the course of the LIST, with no influence of consuming each of the different beverages observed. In contrast, there was a significant main effect of time (P = 0.0001), drink (P = 0.042) and a drink x time interaction (P = 0.025) observed for RPE, with RPE significantly lower (P = 0.0001) in the final block of Part A of the LIST in the CHO-P condition (16.9 ± 1.4) than in either the ISOCHO (17.8 ± 1.1) or ISOEN (17.7 ± 1.3) conditions. However, time to exhaustion was not significantly different (P = 0.29) between CHO-P (468.3 ± 268.5 s), ISOCHO (443.4 ± 286.3 s) and ISOEN (446.2 ± 282.08 s). Whilst these findings suggest that CHO-P confers no effect on multiple-sprint sport performance over carbohydrate ingestion alone, the lowered RPE observed towards the end of the current exercise might reflect a reduction in central fatigue mediated by an increased availability of branched-chain amino acids and reduced free tryptophan levels with CHO-P ingestion. Such a change may attenuate increases in brain serotonin concentration and subsequent feelings of fatigue (Saunders, 2007: International Journal of Sport Nutrition and Exercise Metabolism, 17, S87-S103), the implication of which might be manifested in how individuals regulate their exercise intensity during the later stages of this form of exercise.

N19P
The effect of acute ingestion of ginseng on the immune response to prolonged exercise in healthy males.

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It is generally accepted that moderate exercise helps to prevent or reduce the likelihood of contracting a viral infection (Nieman, 1994: Medicine and Science in Sport and Exercise, 26, 128-139). However, undertaking regular prolonged or intensive exercise has been shown to increase the risk of developing Upper Respiratory Tract Infections (URTI) compared to the risk in non-active individuals (Nieman & Pedersen, 1999: Sports Medicine, 2, 73-80). Therefore it has become increasingly popular for athletes to use herbal supplements to reduce this risk (Block & Mead, 2003: Integrative Cancer Therapies, 2, 247-267). One such herbal supplement is ginseng. It is perceived to boost the immune system response and so decrease an individual’s risk of contracting an URTI, as well as increasing their energy levels (Bahrke et al., 2009: International Journal of Sport Nutrition and Exercise Metabolism, 19, 298-322.). Although previous studies have investigated daily ingestion over several months before the trials, there is little research on acute ingestion of ginseng. The aim of the current study is to determine whether there is any effect, on the immune response to exercise, after acute ingestion of ginseng before prolonged exercise. Eight participants were recruited to the study.
following ethical approval by the Research Ethics Committee at Aberystwyth University. All participants provided written informed consent. The participants were involved in several hours of physical activity a week. The participants then attended the laboratory on 3 separate occasions. During the first visit, participants performed a ramp test on the cycle ergometer (Corival 1000 Watt, Lode BV, Gronigen, Netherlands) while connected to the breath by breath gas analyser (Ultima CPX Express, Medical Graphics Corporation, St Paul, Minnesota, USA) to establish their VO\textsubscript{2max} From this test the 70% VO\textsubscript{2max} was calculated for each participant. The subsequent visits involved 60 minutes of exercise at 70% VO\textsubscript{2max}. In a double-blind crossover design, participants ingested either a placebo or the ginseng supplement 60 minutes prior to cycling on a cycle ergometer (Monark, 874E, Varberg, Sweden) for a further 60 minutes. Blood and saliva samples were obtained one hour prior to exercise as well as immediately post and finally one hour post exercise.

N200
The effect of a carbohydrate mouth rinse on 10 km running performance.
Flannigan, A.
University of Chester

Previous research has reported improvements in performance from carbohydrate (CHO) ingestion during short duration (~ 45 – 60 min), high intensity (> 75% VO\textsubscript{2 max}) exercise (Anantaraman et al., 1995: International Journal of Sports Medicine, 16, 461–465). The metabolic reason for this improvement is unclear. Carter et al. (2004; Medicine and Science in Sports and Exercise, 36, 2107–2111) hypothesised that mouth rinsing rather than ingesting a CHO solution may effect short duration, high intensity exercise via central activation mediated by sensors on the tongue. Previous research on fasted participants reveals an increase in performance when rinsing a CHO solution in comparison to a placebo (Chambers et al., 2009: The Journal of Physiology, 587, 1779-1794). Research thus far on the effects of a CHO mouth rinse in comparison to a placebo on performance in a fed state have shown no significant difference (Beelen et al., 2009: International Journal of Sport Nutrition and Exercise Metabolism, 19, 400-409: Whitham & McKinney, 2007: Journal of Sports Sciences, 25, 1385 – 1392). However no study has examined the effects of a CHO-electrolyte mouth rinse in comparison to ingestion of the same CHO-electrolyte solution in a fed state. The present study examines the effect of a CHO-electrolyte mouth rinse on time to complete a 10 km run, in comparison to ingesting the same CHO-electrolyte solution and rinsing a placebo in a fed state. Following institutional ethical approval, six recreationally active male University soccer players (mean age 21.17 ± .98 years, stature 176.6 ± 5.7 cm and body mass 72.40 ± 7.82 kg) volunteered to take part in the study. Participants completed a 24 hr food diary before the first exercise trial and they were instructed to eat within two hours of each exercise trial and to replicate their diet prior to each run. Preliminary tests involved a lactate threshold test on a motorised treadmill and familiarisation to the test procedures. All participants possessed a lactate threshold ≥ 10km/hr. Thereafter, participants completed the three self-paced 10 km trials with 6-8 days separating each trial. The three exercise conditions were CHO-electrolyte mouth rinse (CHO-R), CHO-electrolyte rinse and ingest (CHO- R+I) and a PLA mouth rinse (PLA-R). The study was counterbalanced, double blind in two trials (CHO-R and PLA) and blind in one trial (CHO- R+I). Upon completion of a one-way repeated ANOVA test it is expected that results will show a significant difference between trials (P < 0.05). Post hoc analysis is expected to reveal no significant difference between CHO-R and PLA-R trials (P > 0.017) in accordance with previous literature (Beelen et al., 2009: International Journal of Sport Nutrition and Exercise Metabolism, 19, 400-409: Whitham & McKinney, 2007: Journal of Sports Sciences, 25, 1385 – 1392), but both rinse trials are expected to be completed significantly faster than the CHO-R+I trial (P < 0.017). It is postulated that there is no difference between the CHO-R and PLA-R trials due to no central activation being present in a fed state. The expected finding that 10 km running time is
significantly slower in CHO-R+I is possibly due to the observed minor weight gain and gastrointestinal problems (Place, 2009: *Journal of Physiology, 587, 2425–2426*).

**N21O**

**Associations between school-day breakfast habits and clustered metabolic risk in British schoolchildren.**

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Chronic diseases such as cardiovascular disease, type two diabetes and metabolic syndrome all share similar risk factors which have recently become more prominent in children. These risk factors can coexist, referred to as clustering, and cumulatively these create a greater risk than one individual factor alone. There are many predictors of chronic diseases, including: fitness, fatness and physical activity levels. Breakfast habits have been shown to be associated with each of these factors (Sandercock *et al.*, 2010: *European Journal of Clinical Nutrition, 64, 1086-1092*). Despite this link there seems to be a lack of research investigating the relationship between breakfast skipping and clustered metabolic risk scores in children. The purpose of the current study was to examine the effects of habitual school-day breakfast consumption on composite metabolic risk. Following ethical approval and parental consent, mass, stature and waist circumference were measured in 3,717 schoolchildren (1913 M and 1804 F) aged 10 – 16 years. Body mass index was calculated. Blood pressure was measured and mean arterial pressure calculated. Cardiorespiratory fitness (CRF) was measured using the 20m shuttle run and physical activity (PA) was measured using the Physical Activity Questionnaire (PAQ; Kowalski *et al.*, 1997: *Paediatric Exercise Science, 9, 174-186*). PA was expressed as a population-specific z-score, all other measures were expressed as age-sex-corrected z-scores based on available reference data. We took the inverse z-scores of CRF and PA, then took the sum of the five z-scores to create composite risk score with a higher value indicating greater metabolic risk. Habitual school-day breakfast consumption was assessed by self report, with six possible answers ranging from 0-5 times per school week, collapsed into rarely (0-1), sometimes (2-4) or always (5). Differences in metabolic risk between groups were calculated by ANCOVA controlling for age and deprivation. There was a significant main effect for breakfast (F=7.61, *P* = 0.001). Post hoc analysis revealed that schoolchildren who always ate breakfast had a lower risk score than the sometimes (*P* = 0.019) and rarely (*P* = 0.005) groups. In sex-specific analyses, boys who always ate breakfast had a lower risk score than those in the rarely and sometimes groups. In girls there was a significant main effect for breakfast (F = 4.80, *P* = 0.008). In post hoc analysis, those who rarely ate breakfast had a higher risk score than those who always did (*P* = 0.020). The relationship observed between breakfast habits and composite risk score was less profound in boys than girls and therefore further investigation into boys’ breakfast habits may be beneficial. Previous studies examining metabolic risk in children include blood samples as cholesterol, high and low density lipoprotein cholesterol and triglycerides are also known to be predictors of chronic diseases (Reed *et al.*, 2007: *Journal of Sports Science and Medicine, 6, 142-148*). The use of non-invasive measures in the current study may limit the accuracy of the composite risk score as these known factors are not included. The present data are the first to show a significant association between breakfast consumption and a composite measure of metabolic health. These data add further support to the notion that eating breakfast is associated with good health in children. This may be because breakfast habits are associated with other modifiable behaviours such as snacking and physical activity, or breakfast consumption may be indicative of an overall healthier lifestyle. Breakfast consumption may be one of the modifiable behaviours associated with metabolic health. The encouragement of regular breakfast consumption in this age group may be beneficial.
Exercise referral schemes (ERS) or ‘exercise on prescription’ are one of numerous established physical activity (PA) interventions the Government has implemented to reduce sedentary behaviour and improve health. However, despite the Government’s enthusiasm and policy for such schemes, their effectiveness lacks underpinning evidence (Sowden and Raine, 2007: Journal of Epidemiology and Community Health, 62, 835-841). The new Coalition Government has announced radical re-organisational changes to the NHS in England. These changes promise an ‘opportunity for general practitioners (GPs) to work with community leaders and their local authorities to take the reins and steer local services to improve quality standards and outcomes’ (Smith and Thorlby, 2010: Giving GPs Budgets for Commissioning: What Needs to be Done? London: Nuffield Trust) and in particular to re-evaluate exercise on prescription. The study reported here examined the impact of a new model of ERS, where the GPs have commissioned the scheme and are therefore ‘custodians’ rather than ‘gatekeepers’. The objectives of the study were to: (i) determine whether the short-term intervention was effective in producing a significant increase in self-reported PA levels, (ii) evaluate the magnitude of changes in physiological and anthropometric variables that occurs from increased PA levels, and (iii) assess the effectiveness of the intervention for changes in measured parameters of mental health. The protocol was approved by the NHS Research & Development Ashton Leigh & Wigan PCT, and NHS National Research Ethics Service; North West 12 Research Ethics Committee. 20 adult volunteers (male n=8, female n=12, age 53.5 ± 15.1 yrs, weight 104.4 ± 17.8 kg, height 1.69 ± 0.1 m, BMI 36.8 ± 6.5 kg/m², % Fat 43.5 ± 9.9 %) were recruited by GPs from the patient population during routine consultations at Pennygate Medical Centre in the Wigan Borough of North West England. The eligibility criteria were: a body mass index (BMI) ≥ 30 (or 28 in Asian population), or ≥ 25 with co-morbidities. Baseline measurements were collected for body mass index, resting systolic blood pressure (SBP) and diastolic blood pressure (DBP), fat mass (FM), fasting blood lipid profile, PA levels (IPAQ-long form), and mental health (CORE-10) after informed consent was obtained. Following the baseline measurements the group participated in a 12 week supervised exercise programme. The circuit class was performed once per week for one hour. In addition to this session, each participant was encouraged to increase their weekly amount of PA. The objective was to progress participants from low to moderate intensity, and progress aerobically from short intervals with active recovery to 30 minutes continuously. Moderate intensity was assessed by Borg’s original rating of perceived exertion (12 – 13), metabolic equivalents (3-6 METS), and/or 40 – 59% of heart rate reserve, medication dependent. The modes of aerobic exercise included rowers, cycles, elliptical cross-trainers and treadmills. A total of 17 participants (85%) adhered to the 12 week exercise programme, and the average percentage of classes attended calculated at 84.31 ± 11.39%. On completion of the intervention all measurements were repeated. Paired t-tests revealed participants increased the number of MET-minutes for walking (417.4 ± 589.4 to 742.5 ± 774.0; P = 0.03), and moderate activities (35.3 ± 101.9 to 498.8 ± 261.6; P = 2.64x10⁻⁶) within leisure time PA from baseline. There was a significant reduction in resting blood pressure for both DBP (87.4 ± 13.8 to 81.2 ± 10.9 mmHg; P < 0.05) and SBP (132.0 ± 14.7 to 127.1 ± 14.5 mmHg; P < 0.05). Furthermore, there was a significant decrease (P < 0.01) in FM of 2.0 ± 3.1 kg. As well as a clinically significant change for total cholesterol (TC) from 5.2 ± 1.2 mmol/L to 4.9 ± 1.1 mmol/L (P = 0.05). The CORE-10 score significantly decreased (P < 0.01) from baseline (9.5 ± 8.1) to the final assessment (3.4 ± 3.3) for the group. The results of this study demonstrate a GP centred ERS can be effective in significantly increasing self-reported
leisure time PA (LTPA) at the 12 week assessment point. In particular, walking within the LTPA domain was significantly increased outside of the class. High-adherence also produced demonstrable reductions in SBP, DBP, BMI, FM, TC, and improvements in mental health.

P2P
Use of the session-RPE method for assessing training demand in elite standard junior rugby league players.
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The Session-RPE method for assessing exercise training was proposed as a simple alternative to heart rate-based measures of training demand (Foster et al, 2001: Journal of Strength and Conditioning Research, 15, 109 - 115). Session-RPE has been used as a measure of training demand in senior elite standard rugby league players (Coutts et al, 2008: In Science and Football VI, edited by T. Reilly and F. Korzusuz Oxon, Routledge), but its usefulness for elite standard junior rugby league players has not been reported. The purpose of the study was to assess the: i) validity of the Session-RPE method against heart rate measures; ii) differences in Session-RPE training demand between sessions; iii) reliability of heart rate measures during training sessions prescribed using Session-RPE, and; iv) identify the agreement between coaches target RPE and players actual RPE responses. With Institutional Research Ethics Committee approval, 10 elite standard junior rugby league players (age 15.7 ± 0.7 years; stature 175.0 ± 7.0 cm; body mass 71.2 ± 8.8 kg; estimated VO2max 46.4 ± 3.4 ml·kg⁻¹·min⁻¹) participated in the study. Players completed a multi-stage fitness test to estimate maximal aerobic capacity and determine maximal heart rate. Two coaches planned six conditioning sessions over six weeks, using the modified Borg CR-10 scale as a measure of the intensity of exercise. The six sessions comprised two moderate, two hard and two very hard sessions, and these were delivered in a randomised order. Heart rate was recorded during all sessions. For the reliability trials, coaches were asked to plan sessions that had similar training demands but avoided repetition. Thirty minutes after the conditioning session the players were asked to provide an overall RPE using the Borg CR-10 scale. Assumptions for parametric analysis were assessed and when violated non-parametric tests were performed. The validity of Session-RPE method was assessed using a one-way repeated-measures ANOVA, with Tukey's HSD post-hoc analysis used to compare differences in heart rate measures between sessions. Differences in Session-RPE training load between sessions were analysed using the Wilcoxon signed-rank test. Coefficients of variation (CV) were calculated to assess the reliability of heart rate measures, and the agreement between target and actual RPE responses was identified using limits of agreement (95% confidence) (LOA). Statistical significance was set a $P < 0.05$. Effect sizes (Cohen's $d$) were evaluated according to small (0.2), medium (0.5) and large effects (0.8). Heart rate measures were higher in hard and very hard sessions than moderate ($P$ at least 0.04, $d$ at least 0.79), with no difference between hard and very hard sessions ($P$ at best 0.44, $d$ at best 0.34). Session-RPE was higher in hard and very hard sessions than moderate ($P$ at least 0.01, $d$ at least 3.84), with no difference between hard and very hard sessions ($P = 0.72$, $d = 0.13$). Moderate (CV ≤ 26%), hard (CV ≥ 80%) and very hard sessions (CV ≥ 59%) had poor reliability. The difference in session duration between the two moderate, hard and very hard sessions was 10, 19 and 13 min, respectively. LOA revealed strong concordance between target and actual RPE at moderate (2.8 ± 0.4) and hard (5.0 ± 0.1) intensities. Less agreement was evident at very hard intensity (6.3 ± 1.3). Using the Session-RPE method, coaches could prescribe conditioning sessions that differed in demand between moderate and hard/very hard sessions but not between hard and very hard sessions. The generally poor reliability of heart rate measures between sessions was because of large differences in session duration. However, LOA data tended to indicate congruence between target and actual RPE, suggesting that if duration was similar between sessions of the same intensity, reliability would be improved. The Session-RPE method that accounts for
both intensity and duration is useful for quantifying the training demand of elite standard junior rugby league players.

P3O
The core temperature response to base-layer clothing during an incremental treadmill protocol.

Black, M.
University of Gloucestershire

Specific base-layer clothing, designed with enhanced “wicking” properties has been reported to influence thermoregulation (Roberts et al., 2007: International Journal of Sports Science and Engineering, 1, 29-38). However, the effect of differing clothing on thermoregulation is equivocal (Gavin et al., 2001: Medicine and Science in Sport and Exercise, 33, 2124-2130). The purpose of the current study was to provide further insight into the influence of base-layer clothing with enhanced “wicking” properties on thermoregulation. Following ethical approval 12 healthy male University football players (mean ± SD; age 20 ± 1y, height 1.77 ± 0.05 m, mass 74.9 ± 7.2 kg) volunteered for the study. Participants reported for testing on 3 separate occasions and performed an intermittent treadmill protocol that reflected the energy demands of a football match (Drust et al., 2000: Journal of Sports Sciences, 18, 885-892), in 3 separate clothing conditions; a long-sleeved base-layer garment (Under Armour® Baltimore MD), a long-sleeved 100% cotton top, and bare-chested condition, in a counterbalanced order. The environmental conditions were controlled at 20°C and 47% relative humidity. Measurements of tympanic core temperature were recorded at baseline, following 45 min of treadmill activity, prior to a 15 min rest period, immediately post test following a further 45 min of treadmill activity. Clothing effects were investigated using 2-way repeated measures ANOVA, separate one-way ANOVA on each time period and post-hoc Bonferroni corrected paired t-test. 2-way repeated measures ANOVA revealed an interaction effect (P < 0.001). There were no differences until time point 4. There was a difference between the bare-chested and cotton condition (P < 0.001), and base-layer and cotton condition (P < 0.001). No differences were observed between the bare-chested and base-layer clothing condition at any time points. The findings of the current study support the findings of Roberts et al. (2007) and provide evidence that clothing impacts thermoregulation. The findings of the current study show that wearing a base-layer in thermo-neutral conditions reduced tympanic core temperature at time point 4 compared to a cotton clothing condition, and was comparable to the bare-chested condition.

P4P
The effects of NaHCO₃ ingestion on time to task failure and rate of increase in RPE during constant load exercise.

Raybould, S., Dewar, R., Roche, S., & Scriven, M.
University of Worcester

It has been suggested that there is a linear relationship between the perception of effort and the duration of constant load exercise that remains (Noakes, 2004: Journal of Applied Physiology, 96, 1571-1573) and that this acts on both an absolute and a scalar level. For example, during constant load exercise to task failure glycogen depletion results in a greater rate of increase in RPE and earlier fatigue when compared to a glycogen replete condition, suggesting RPE ultimately determines the fatigue point. If this is true, then any physiological mechanism that favourably changes peripheral physiological status may be expected to increase exercise tolerance through delaying the time taken to achieve the maximal sustainable RPE. The aim of this study was therefore to investigate the influence of NaHCO₃ ingestion on rate of increase in RPE and time to task failure during constant load exercise. All procedures received prior approval from an Institutional Ethics Committee. Following
identification of individual Lactate Turnpoint (LTP), six trained cyclists (37.33 ± 16.06 yrs, 74.83 ± 7.17kgs) performed two fixed workload trials until volitional exhaustion at a workload 20% above LTP following ingestion of 0.3 kg\(^{-1}\) body mass of NaHCO\(_3\) or CaCO\(_3\) placebo. Blood pH was measured pre- and post exercise and RPE was recorded at 1 minute intervals during exercise. Trials were performed in a randomised double blind manner. Paired samples T-Tests for repeated measures were used to assess differences in performance and blood parameters between trials. Blood pH was significantly higher (t=3.38, P<0.01) following ingestion of NaHCO\(_3\) than CaCO\(_3\) pre-exercise (7.47 ± 0.03 v 7.44 ± 0.03) and post-exercise it was higher (NS) (7.30 ± 0.04 v 7.29 ± 0.06). Time to task failure was 17.47 ± 27.6% longer following NaHCO\(_3\) (NaHCO\(_3\): 950 ± 285s v CaCO\(_3\): 820 ± 184.6s). Time to reach maximum sustained RPE was also greater in NaHCO\(_3\) than CaCO\(_3\) (NaHCO\(_3\): 732±198s v CaCO\(_3\):642±180s). However, the increase in RPE throughout exercise was non-linear, and in both conditions participants spent 22.7±12.3% and 22.7±7.2% of total trial duration at maximum sustained RPE for NaHCO\(_3\) and CaCO\(_3\) respectively. The findings of this study support the notion that manipulation of peripheral physiological status influences the rate of increase in RPE during constant load exercise, but not the suggestion that achievement of maximum sustainable RPE ultimately determines the fatigue point.

P5P

Effect of diet, stress and physical activity on weight change during the first year of undergraduate study.

Wheeler, A.

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In the UK 66% of men and 57% of women are overweight or obese (The NHS Information Centre, 2010). As weight gain and eating habits start in young adulthood Steptoe et al. (2002: Preventive Medicine, 35, 97–104), the first year as a student has been identified as important. It has previously been identified that mean weight gain is 15lbs in the first year of study in American undergraduates (Brown 2008: Health Information and Libraries Journal, 25, 1–12), although there is little consensus on this figure in the academic literature. Therefore the purpose of this study is to assess changes in body weight in the first year students at a UK university. In addition it aims to investigate the role of diet, stress and physical activity on the weight change of students. With University of Worcester Sport and Exercise Science institutional ethics approval 27 volunteer (male = 10 female = 17) first year students (age 19.44 ± 1.42 y, stature 1.70 ± 0.11 m, body mass 68.29 ± 17.65 kg) agreed to participate in the study. Participants completed an online questionnaire 3 months apart during their first year. The questionnaire included four separate sections; demographics (including height and weight self reported), Undergraduate Stress Questionnaire Crandall et al. (1992: Journal of Behavioural Medicine, 15, 627-662), the Revised Restraint Questionnaire Herman and Polivy (1980: Obesity, 208-220) and the International Physical Activity Questionnaire Short-form Craig et al. (2003: Medicine & Science in Sports & Exercise, 35,1381-1395). Results so far, have found that mean weight increased slightly by 1.32kg between collection point one (68.29kg) and two (69.61kg). BMI, meanwhile remained virtually the same with collection point one mean BMI = 23.36 and two = 23.19, both which fall into the ‘normal’ category BMI weight. Stress questionnaire results showed a drop between point one and two (18.11 ± 8.47 in point one and 14.00 ± 6.10 two). Another factor measured of dietary restraint found again a slight decrease between the two time points (point one 11.50 ± 6.69 point two 11.19 ± 7.20) however participant classification scores of restraint showed higher (point one 9 restrained, point two 13 restrained). The hypothesized weight gain in line with the other similar UK study by Serlachius et al. (2007: Physiology & Behaviour, 92, 548-553) has been seen with a small mean weight gain occurring, however the other factors investigated have not shown, so far any big changes between the two time points.
A number of protocols associated with endurance performance have been presented in the literature where participants have had to endure a ‘preload’ phase (at a fixed relative intensity) followed by a ‘performance’ self-paced phase (Doyle & Martinez 1998: Research Quarterly for Exercise and Sport, 69, 304-307; Russell et al., 2004: Medicine & Science in Sports & Exercise, 36, 717-724). These protocols potentially could be used to assess athletic ability, to track changes in training status, and to assess the effect of ergogenic supplementation on performance. Identifying the reliability of this type of exercise protocol enables researchers to contextualise the responses observed with the random variation of measurement. Therefore the aim of this study was to assess the reliability of physiological responses prior to, during and post a preload endurance protocol, and assess the reliability of subsequent performance. Twelve recreational endurance runners (8 male, 4 female, age 41.8 ± 6.1 years, height 1.74 ± 0.09 m, mass 72.9 ± 13.3 kg) completed five visits to the laboratory. During the initial visit maximal oxygen uptake ($VO_{2\text{max}}$) was assessed and each of the remaining four visits consisted of a 90 minute run at 65% $VO_{2\text{max}}$ (preload phase), immediately followed by a 5 km time trial (performance phase) where participants could only view their distance completed. Pre and post the preload phase, body mass (kg), haemoglobin (g dL$^{-1}$), haematocrit (%), core temperature ($^\circ$C), urine specific gravity and blood lactate concentration (mMolL$^{-1}$) were recorded. At 30 minute intervals during the preload phase, running economy (kcal km$^{-1}$) estimated through indirect calorimetry, and blood lactate concentrations were assessed. Heart rate (beats min$^{-1}$) was measured throughout the preload phase at 5 s intervals. The reliability of all of these measures and time to complete the trial phase of the protocol were then assessed. The coefficient of variation (CV) and 95% confidence intervals were calculated across the four trials. The reliability coefficients (%) of pre and post measures are shown in Table 1. During trial measures for running economy, blood lactate concentration and heart rate derived CVs across the four trials of 3.1% (2.5-4.1%), 24.0% (19.4-31.6%) and 2.8% (2.3-3.7%) respectively. A CV of 3.7% (3.0-4.9%) was calculated for the time (s) to complete the 5 km time trial.

Table 1. The coefficient of variation of four repeated measures pre and post the preload phase.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre Preload phase</th>
<th>Post Preload phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nude Body Mass</td>
<td>0.81% (0.65-1.07%)</td>
<td>0.79% (0.64-1.04%)</td>
</tr>
<tr>
<td>Kitted Body Mass</td>
<td>0.80% (0.65-1.05%)</td>
<td>0.79% (0.64-1.04%)</td>
</tr>
<tr>
<td>Haemoglobin</td>
<td>5.5% (4.4-7.2%)</td>
<td>5.8% (4.7-7.6%)</td>
</tr>
<tr>
<td>Haematocrit</td>
<td>4.2% (3.4-5.5%)</td>
<td>2.7% (2.2-3.6%)</td>
</tr>
<tr>
<td>Core temperature</td>
<td>0.7% (0.6-0.9%)</td>
<td>0.8% (0.7-1.1%)</td>
</tr>
<tr>
<td>Urine Specific Gravity</td>
<td>0.3% (0.2-0.4%)</td>
<td>0.4% (0.3-0.5%)</td>
</tr>
<tr>
<td>Blood Lactate</td>
<td>19.2% (15.5-25.3%)</td>
<td>33.2% (26.8-43.7%)</td>
</tr>
</tbody>
</table>

Overall this data indicates high reliability of some key measurements used in the assessment of athletes in the laboratory. This data can be used to inform sample size estimations for future studies, and for the calculation of reference intervals for analysing and interpreting single case client data for scientific support.
P70
Endurance training intervention and heat acclimation for a female runner: A case study.
Gerrett, N. & Purvis, A.
Sheffield Hallam University

This case study describes methods of conducting a needs analysis and applying a training intervention for a female amateur runner (23 years, 52.2 kg) competing in half-marathons. A heat acclimation protocol was also implemented due to the location and expected climate of the competition. Following ethical approval, a needs analysis was conducted using triangulation approach, by means of a questionnaire, performance profile and physiological assessment. This approach identified the athlete’s goal (improve half-marathon time to <1:40:00) and identified endurance, speed and speed-endurance as areas for improvement.

Physiological assessment provided data for performance markers (V\textsubscript{O2 max}, speed at lactate threshold (LT) and running economy (RE). A lactate/ventilatory threshold test (LT/VT) consisting of 4 minute exercise stages interspersed with 1-minute rest periods was conducted. The initial speed was set at 9 km·hr\(^{-1}\) and after each stage the speed was increased by 2 km·hr\(^{-1}\). Respiratory gases using a Med-Graphics CPX-D respiratory gas analysis system, (Cardiokinetics Ltd, Salford, UK) were collected during the final 30 seconds of each stage and after the 4th minute the participant stopped exercising, whilst a 20μl capillary blood sample was obtained from the fingertip for the analysis of blood lactate using YSI Blood lactate analyser (1500 Sport, YSI Incorporated, USA). Heart rate was monitored continuously using a Polar Electro OY (S610) heart rate monitor. LT was identified by plotting the blood lactate concentration at the LT/VT was 31% and 12.5% lower than pre-improved by 11.6% (48.3 to 42.7 ml·min\(^{-1}\)·kg\(^{-1}\); 1:43:03 to 1:40:01. Her

...continued...
athlete moved closer to her performance goal, probably a result of an improved RE and, or a
greater ability to remove lactate due to improved fatigue resistance.

P8P
The effect of upper leg precooling, on single bout sprint performance on a cycle
ergometer in hot, humid conditions.
Watkins, S., & Castle, P.
University of Bedfordshire

Heat induced fatigue is a major issue in sports performance. Exercise in the heat leads to a
reduction in central volume, through increased cutaneous blood flow by means of
vasodilatation, in-turn reducing blood availability to the working muscles. Precooling induces
vasoconstriction reducing subcutaneous blood flow, increasing central volume, which in turn
allows increased blood flow to the working muscles. Upper leg precooling has shown to be
ergogenic to performance in the heat, although this method is not widely used in the
literature. The purpose of the study was to investigate whether upper leg precooling, would
lead to increased mean power output during a 70 second sprint, on a cycle ergometer, when
performed in hot, humid conditions. Seven male University students (mean (SD) body mass
80.81 (± 7.59)) participated in 3 conditions. The 3 conditions were as follows: control (no
precooling), precooling (30 minutes precooling prior to warm up, and warm up precooling
(30 minutes precooling prior to, and during the warm up). Each condition involved sitting for
30 minutes, with either no precooling (control) or upper leg precooling. All conditions then
completed a 10 minute warm up, and a 70 second sprint. The warm up and sprint were
performed in hot, humid conditions (29°C, 60% relative humidity). In all trials, core (rectal)
temperature, skin temperature (calf, thigh, chest, arm), heart rate, ratings of perceived
exertion, and thermal sensation were recorded. The conditions were conducted in a
randomised order. Statistical analysis used was a two-way ANOVA with repeated measures
(condition x time). Ethical approval was granted by the Institutional Ethics Committee. Mean
power output was improved in both precooling conditions (control = 471.6 W ± 19.6;
precooling = 503.1 W ± 13.1; Warm up precooling = 516.6 W ± 10.1) (P<0.05). In the pre
warm-up in both precooling conditions a reduction skin temperature at 2 sites (calf & thigh)
was recorded (P<0.05). Post warm-up calf and thigh skin temperatures were lower in the
warm up precooling condition when compared to the other 2 conditions (P<0.05). Post sprint
heart rate was lower in the warm-up precooling condition when compared to the other 2
conditions (P<0.05). Peak power output was also improved after precooling, with the warm
up precooling condition displaying the highest values (P<0.05). Improvements in mean power
output and peak power output were observed, it is conceivable that this improvement was due
to cold induced vasoconstriction. A reduction in skin temperatures (thigh & calf) after
precooling may indicate increased vasoconstriction, as a reduction in cutaneous blood flow
decreases radiation and convection reducing skin temperature. Vasoconstriction increases
central volume, improving stroke volume, this means strain on the heart is reduced. Post
sprint a reduced heart rate in the warm up precooling condition was observed indicating
reduced strain on the heart. The results suggest that upper leg precooling enhances single bout
sprint performance on a cycle ergometer and further improvements in performance can be
attained through precooling during a warm up.
High-intensity interval training versus endurance training in a sedentary population; physiological adaptations and exercise enjoyment.

MacLeod, K., & Dekerle, J.
University of Brighton

It has been demonstrated that short duration, high intensity exercise may cause similar physiological adaptations to endurance exercise (Gibala et al., 2006: Journal of Physiology, 575, 901-911). A common reason people fail to exercise is a perceived lack of time. If the physiological benefits of aerobic training could be achieved with a smaller overall time commitment, exercise could be considered more applicable to a busy schedule. The aim of the current study was to determine whether 2 weeks of short duration, high intensity training (HIT) could elicit comparable improvements in peak oxygen uptake (VO$_{2\text{peak}}$), lactate threshold (LT), and cycling economy ($\Delta$eco) to a work-matched endurance training protocol (ET) in a sedentary population.

Ten sedentary individuals (age: 20.2 ± 0.9; mass: 66.82 ± 11.4 kg; VO$_{2\text{peak}}$ 36.5 ±6.0 ml.kg$^{-1}$.min$^{-1}$) were divided into 2 groups matched for VO$_{2\text{peak}}$. Five participants completed HIT which consisted of 3 sessions per week of 8-12 x 60 second “all-out” sprints on a cycle ergometer at the power output of the final stage of a ramp VO$_{2\text{peak}}$ test, followed by 75 sec low intensity recovery (30 W) (Little et al., 2010: Journal of Physiology, 588, 1011-1022). The other 5 participants completed ET training, consisting of 32-56 minutes of cycling at LT. Measures of VO$_{2\text{peak}}$, LT, and cycling delta efficiency (slope of the VO$_2$ – power output relationship) were measured pre- and post-training. Both normality and sphericity of each set of data were assumed. Data was analysed using an independent t-test or a 2-way (group x training) repeated-measures ANOVA. Significance was accepted at $p\leq0.05$.

Baseline values for VO$_{2\text{peak}}$, LT and $\Delta$eco were not significantly different between the two groups [VO$_{2\text{peak}}$: 36.1 ± 7.5 (HIT) vs 36.9 ± 4.8 ml.kg$^{-1}$.min$^{-1}$ (ET), t=0.21, P>0.05; LT: 111 ± 43 (HIT) vs 94 ± 21 W (ET), t=-1.12, P>0.05; $\Delta$eco: 9.0 ± 2.3 (HIT) vs 11.8 ± 1.8 ml.min$^{-1}$.W$^{-1}$ (ET); t =1.96, P>0.05]. LT (expressed in ml.min$^{-1}$) and $\Delta$eco remained significantly unchanged post-training ($F_{2,2}=0.13$, P>0.05 and $F_{2,2}=0.01$, P>0.05, respectively). However, the power output at LT changed significantly with training (~27% for ET and ~13% for HIT; $F_{2,2}=36.2$, P<0.05). The improvement was not significantly greater in the HIT group ($F_{2,2}=2.67$, P>0.05). VO$_{2\text{peak}}$ was also significantly improved with training (~3% for ET and ~8% for HIT; $F_{2,2}=7.24$, P<0.05) with no greater enhancement in the HIT group ($F_{2,2}=1.65$, P>0.05).

Two weeks was sufficient for VO$_{2\text{peak}}$ and LT (in W) to improve in both groups. However, neither the metabolic rate at LT, nor $\Delta$eco were affected by the training intervention. The HIT was not more effective in enhancing the aerobic profile of the participants. More participants would need to be tested to confirm these preliminary findings.

Does Beetroot Juice supplementation limit or delay the onset of muscular soreness?

Sansom, J. H., & Ross, E. Z.
University of Brighton

Delayed onset of muscular soreness (DOMS) presents itself ~2 days after unaccustomed exercise. DOMS is often caused by the controlled lengthening phase of the muscle under tension, such as during downhill running. Cherry juice has recently been shown to reduce inflammation and muscle damage following marathon running due to its antioxidant properties (Howatson et al., 2009: Scandinavian Journal of Medicine and Science in Sports, 20, 843-852). Concentrated beetroot juice (BR) is high in antioxidants, but is also rich in nitrate, which is quickly converted to nitric oxide (NO) once consumed. The effects of NO on recovery are unclear, despite it playing a role in localised inflammatory reactions and...
neuromuscular function. Therefore the purpose of this research was to determine the efficacy of BR in aiding recovery, reducing muscle damage and neuromuscular impairment following a trail marathon. Twenty one endurance runners (mean ± SD age, height and weight; 42.2 ± 7.1, 179.2 ± 3.6 m and 74.49 ± 10.4 kg respectively) were pair-matched according to running speed at lactate threshold and then each pair was randomly divided into one of two groups (placebo [PLA] or beetroot [BG]). PLA consumed 150 ml.day⁻¹ diluted fruit squash (2% mixed fruit concentrate) and BG consumed 70 ml.day⁻¹ 100% BR for a week prior to the marathon and until 3 days post marathon. Maximal voluntary contraction (MVC) and voluntary activation (VA) of the quadriceps and handgrip strength (HG) were measured before, 24 and 72 h post marathon. Subjective measures of muscular soreness were also assessed by algometry and modified pain questionnaires, and inflammation estimated by changes in leg volume. A 2-way mixed design ANOVA analysed the effects of time and supplementation on physiological and subjective measures of muscular strength and damage. The marathon induced muscle soreness as indicated by a significant increase in leg pain scores (4.0 ± 4.5 %, p<0.05) and a significant decrease in pressure - pain threshold (-10.7 ± 22.8 %, p<0.05) but did not affect strength or muscle activation. No difference between groups was observed. These results demonstrate that the threshold and intensity at which muscle pain is reported following a trail marathon is not altered by BR.

P11P
Effect of lower body cold water immersion on self-paced endurance rowing in hot, humid conditions in females.
Fitch, N., & Castle, P.
University of Bedfordshire

When exercising in the heat, the increase in body temperature can result in premature fatigue (Marino, 2002: British Journal of Sports Medicine, 36, 89-94). Therefore precooling the body can lessen the impact of hot environments on performance (Duffield et al., 2003; British Journal of Sports Medicine, 37, 164-169). Duffield et al. (2010: Medicine and Science in Sports and Exercise, 42, 577-584) investigated the effects of precooling on self-paced endurance exercise performance of males. The author stated that precooling was designed to reduce skin, muscle and core temperature. They further suggested that the longer the cooling, the greater the improvement in performance and physiological functions. Females have a smaller body size, greater surface area to body mass ratio and a lower sweat rate than males (Wright et al., 2002: American Journal of Physical Anthropology, 118, 285-291). This potentially gives females an advantage over males when exercising or competing in a hot, humid environment as they have more effective heat loss to the environment (McLellan, 1998: European Journal of Applied Physiology, 78, 28-37). Therefore, precooling may be more beneficial to females when exercising via lower internal body temperature, an increased potential for heat storage and delayed fatigue (Quod et al., 2006: Sports Medicine, 36, 671-682). However, a female population has not been studied. Therefore the purpose of this study was to investigate whether precooling has an effect on self-paced 2000 m ergometer rowing performance in hot, humid conditions in females. Following ethical approval, 5 physically active females (age = 19.2 ± 1.3, stature = 166.74 ± 4.27 cm and body mass = 67.38 ± 3.67 kg) volunteered to participate in this study. The participants were asked to attend four sessions in order to complete the study. Session one was used to collect anthropometric data using the BodPod; and isometric and isokinetic measurements of leg strength using the KinCom. A familiarisation test was also carried out and consisted of a 2000 m row on a rowing ergometer in a temperate environment. Session two was carried out in the environmental chamber at a temperature of 20°C and 40% relative humidity. For session three, the 2000 m row was carried out in a hot, humid environment at 35°C and 60% relative humidity. The final session was also in hot, humid conditions (35°C, 60% relative humidity) but with 20 minutes precooling preceding the row. Precooling was administered by lower body water immersion at a temperature of 22±2°C. Sessions two to four were completed in a
randomised order. Performance measures included time to completion of the 2000 m row and split times to gauge pacing strategies. Further, muscle temperature, skin temperature, core temperature and heart rate were measured throughout the protocol and precooling where necessary. Data collection is ongoing and will be analysed using a two way repeated measures ANOVA. The initial findings of this study (N=2) show an improvement in the 2000 m row after precooling by at least 2 seconds. Muscle temperature decreased by 1.2 °C after precooling. Mean core temperature during the temperate condition was 37.74 ± 0.1°C and during the precooling condition it was 37.7 ± 0.1°C. Complete data will be presented, but it is expected that a thermoregulatory advantage will be conveyed by precooling and that this will be ergogenic.

P12P
The effect of oral contraception on isokinetic leg strength.
Rankine, B.
Staffordshire University

Oral contraceptive (OC) use has been found to both increase (Phillips et al. 1996: Journal of Physiology, 49, 551- 557) and decrease (Elliot et al. 2003: British Journal of Sports Medicine, 39, 15 -24) isokinetic leg strength, with the discrepancy in findings suggested to be because of the progestin dose within the OC pill (Peters et al. 2006: Contraception, 74, 487 - 491). The purpose of this study was to further examine the effect of two different types of OC (2nd generation and 3rd generation) on isokinetic leg strength. With institutional ethics approval, 11 moderately active OC users (mean ± SD of age 21.8 ± 1.17 years, stature162.7 ± 5.1 cm and mass 59.7 ± 5.4 kg), who participated in a range of sports, volunteered for the study. Peak maximal isokinetic leg extension and flexion in the dominant leg was assessed using an isokinetic dynamometer (Kin Com) at a speed of 150°/s. Testing took place on three separate occasions (one familiarisation session, once on the placebo week of the cycle and once on the first week taking the pill) in a counter – balanced, cross – over study design. Mean ± SD for hamstring and quadriceps strength relative to body mass for both phases of the pill cycle and for both generations of pill are given in Table 1.

<table>
<thead>
<tr>
<th>Pill Type</th>
<th>Pill Taking week</th>
<th>Placebo week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hamstring (Nm/kg)</td>
<td>Quadriceps (Nm/kg)</td>
</tr>
<tr>
<td>2nd Generation</td>
<td>1.37 ± 0.42</td>
<td>1.73 ± 0.29</td>
</tr>
<tr>
<td>3rd Generation</td>
<td>1.46 ± 0.40</td>
<td>1.90 ± 0.54</td>
</tr>
</tbody>
</table>

Using a two-factor ANOVA, there was no significant difference in mean hamstring strength (Nm/kg) for the two pill types tested, and between the time of testing (placebo week versus pill taking week), F(3, 21) = 0.054, p = 0.972, nor for mean quadriceps strength, F (3, 21) = 0.265, p = 0.850. Isokinetic leg strength does not appear to be affected by OC use, or by different generations of OC, although further research on a larger group of females using these two contraceptive pill types could be carried out.
P13O

**Does an increase in carbohydrate intake improve performance in female soccer players?**

**Tiernan, C., & Smith, P.**

*University of Wales Institute, Cardiff*

There have been many studies that have investigated how carbohydrate can improve performance, however this research has primarily focused on male soccer players, providing information that cannot be transferred to female players. Indeed, there is little research on the nutritional habits of female players, in particular soccer – due to it being a male dominated sport. The purpose of this study was to find out if ingesting carbohydrate before and during a soccer match would improve the player’s performance. This study tested 14 female soccer players, in two competitive full 11-a-side matches. Each player consumed a carbohydrate drink and placebo drink on before and during the half time interval the match, consuming the drinks within a cross over design (carbohydrate one game, placebo the next). Each player was tested before and after the match using Smartspeed equipment, for 15-m sprint, Illinois agility test and a standing vertical jump. They also wore a heart rate monitors to ensure the same level of performance is being made in both games. The results showed that the agility test was very significant (P<0.05) when having the carbohydrate drink compared to the placebo. The 15-m sprint results found that there was a difference between pre and post testing but not a significant (P<0.05) difference between carbohydrate and placebo. The standing vertical jump found no significance (P<0.05) at all between any of the tests. Finally, the heart rate of the players significantly (P<0.05) varied during the game, but no difference was found between carbohydrate and placebo groups. From the results, it can be concluded that ingesting a carbohydrate solution before and during a match will improve performance in agility and maintain heart rate, but no effect on jumping or sprint performance. These results have applied implications in through the provision of how carbohydrate can improve performance.

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P14O

**The effects of repeated bouts of muscle-damaging exercise on sub-maximal endurance performance.**

**Burt, D., Twist, C., Lamb, K., & Nicholas, C.**

*University of Chester*

It is well established that bouts of resistance exercise, which cause symptoms of exercise-induced muscle damage (EIMD), have a detrimental effect on endurance exercise performed in the days following (Davies et al., 2009: *European Journal of Applied Physiology*, 107, 11-19). However, it is unknown whether such effects remain following a repeated bout of resistance exercise. Therefore, the purpose of this study was to evaluate the effects of repeated bouts of muscle damage on the physiological and perceptual responses during sub-maximal running in male recreational runners. Following ethical approval, 9 male participants (Age 25.8 ± 4.1 years, Stature 1.80 ± 0.09 m, Body Mass 79.6 ± 9.9 kg, \(\dot{V}O_2\text{max} 54.2 ± 3.2\) ml·kg\(^{-1}\)·min\(^{-1}\)) performed an exhaustive incremental running trial to establish lactate turn-point (LTP) and \(\dot{V}O_2\text{max}'). Participants returned to the laboratory between 24 and 72 h later and completed baseline measurements of perceived muscle soreness, peak isokinetic knee extensor torque at 60 deg·s\(^{-1}\) and creatine kinase (CK). Additionally, they completed a 10-minute running bout at a speed corresponding to LTP with physiological and perceptual responses recorded throughout. These measurements were then repeated 24 and 48 h after muscle-damaging exercise (comprising 10 x 10 squats against a resistance of 80% of body mass). Two weeks later, when the symptoms associated with the initial bout of EIMD had dissipated, all procedures outlined at baseline were repeated. The differences across time and between bouts in the indirect markers of muscle damage and sub-maximal running performance were analysed via separate two-way [time x bout] repeated measures ANOVAs. Significant time by bout interactions indicated increases in perceived soreness and CK,
alongside reductions in force production of the knee extensors at 24 and 48 h following the initial bout of EIMD ($P < 0.05$). However, following the repeated bout, symptoms of EIMD were attenuated, with force production and CK unchanged ($P > 0.05$), and a smaller increase in perceived soreness ($P < 0.05$). Significant increases in $\dot{V}O_2$, minute ventilation ($V_E$), and RPE were observed during sub-maximal running at 24 and 48 h following the initial bout of EIMD ($P < 0.05$). However, following the repeated bout of EIMD the physiological and perceptual responses during sub-maximal running remained unchanged from baseline at all time points ($P > 0.05$). While an unaccustomed bout of resistance exercise resulted in symptoms of EIMD that altered the physiological and perceptual responses to sub-maximal running, skeletal muscle undergoes protective adaptation resulting in these alterations being attenuated following a second bout of resistance exercise performed two weeks later. These findings confirm that a single resistance session is sufficient for protecting skeletal muscle against the detrimental effects of EIMD on endurance exercise performance.

P15O

**A tyrosine and phenylalanine free amino acid mixture decreases exercise capacity in a warm environment.**

Tumilty, L., Davison, G., Beckmann, M., & Thatcher, R.

**Aberystwyth University**

Improvement in prolonged exercise tolerance in a warm environment has been linked to increased brain dopamine availability. Ingesting an amino acid mixture formulated to lower the availability of the dopamine precursors tyrosine and phenylalanine induces subjective, behavioural and neurohumoral changes indicative of reduced brain dopamine activity, however any effect on prolonged exercise in the heat is unknown. The present study explored whether acute supplementation of this mixture would decrease exercise capacity in a warm environment. Following prior ethical approval, eight healthy, regularly active male volunteers [age 24 ± 9 years; body mass 79.6 ± 13.0 kg, peak oxygen uptake ($O_2$peak) 4.1 ± 0.7 l·min$^{-1}$] unacclimated to exercise in the heat, performed two exercise trials in 30°C and 60% relative humidity separated by at least 7 d in a randomised, crossover design. Participants consumed either 500 ml of a flavoured sugar-free drink containing a balanced mixture of large neutral amino acids (isoleucine 15 g, leucine 22.5 g, lysine 17.5 g, methionine 5 g, valine 17.5 g, threonine 10 g, tryptophan 2.5 g; tyrosine 12.5 g; phenylalanine 12.5 g; BAL), or the same drink minus tyrosine and phenylalanine (TYR-FREE) in a double-blind manner 1 h before cycling to exhaustion at the same relative, constant exercise intensity in relation to a metabolic threshold (25% $\Delta$; power output at gas exchange threshold, plus 25% of the difference between gas exchange threshold and $O_2$peak), equivalent to 63 ± 5% $O_2$peak.

Exercise duration was shorter in TYR-FREE compared to BAL (59.8 ± 19.0 min vs. 66.2 ± 16.9 min; $P = 0.036$, paired Student’s t-test, $n = 8$). A two-factor (time × condition) ANOVA showed that tyrosine plus phenylalanine:large neutral amino acids (TYR ratio) was the same in both conditions pre-exercise ($P = 0.338$; $n = 7$), but administration of TYR-FREE caused a 25 ± 5% decrease ($P < 0.001$; $n = 7$) in TYR ratio pre-exercise, whereas BAL had no effect ($P = 0.061$; $n = 7$). Up until 30 min of exercise and at exhaustion, no difference existed between BAL and TYR-FREE in core temperature ($P = 0.116$), mean weighted skin temperature ($P = 0.958$) and heart rate ($P = 0.987$, ANOVA, $n = 8$ in all cases), or in ratings of perceived exertion and thermal sensation (both $P > 0.05$; Friedman’s test and Wilcoxon signed ranks test, $n = 8$) despite a longer exercise duration in BAL. Previous studies suggest that acutely administering an amino acid mixture lacking tyrosine and phenylalanine can reduce brain dopamine activity, and the present results extend these findings by showing a decrease in prolonged exercise capacity in the heat. These novel results suggest an important role of tyrosine and phenylalanine availability in man, during prolonged exercise capacity in a warm environment, and provide further indirect evidence for a role of brain dopamine under such conditions.
P160

The impact of cadence variations upon the sub-maximal prediction of VO\textsubscript{2-peak} using the YMCA test.

Quarterman, J., & Smith, P.
University of Wales Institute, Cardiff

The direct measurement of peak oxygen consumption (VO\textsubscript{2-peak}) is considered to be the gold standard measurement of aerobic fitness. However, due to its exhaustive nature this approach is not suitable for all populations; including the elderly or diseased (George et al., 2000: Journal of Physical Education and Exercise Science- A Modified Sub-maximal Cycle Ergometer Test Designed to Predict Treadmill VO\textsubscript{2-max}, 4, 229-243). Therefore, several sub-maximal protocols have been devised to attempt to predict VO\textsubscript{2-peak}, one such test, the YMCA test (Golding, et al., 1989: Y’s Way to Physical Fitness: The Complete Guide to Fitness and Instruction 3\textsuperscript{rd} Ed Champaign, IL: Human Kinetics) requires individuals to cycle at a cadence of 50 rev·min\textsuperscript{-1}. However, evidence suggests this cadence is too slow to permit a valid assessment of VO\textsubscript{2-peak} (Lepers, et al., 2002: Journal of Applied Physiology- Neuromuscular fatigue during a long duration cycling exercise, 92, 1487-1493). Therefore, the purpose of this study was to explore the validity of the YMCA sub-maximal VO\textsubscript{2} protocol, by investigating the impact three different cadences (50, 70 and 90 rev·min\textsuperscript{-1}) had upon the accuracy of the prediction of VO\textsubscript{2-peak}. Following ethical approval from the Cardiff School of Sport Ethics Committee, 9 healthy participants, 5 males and 4 females (means ± s, age years 21 ± 1, body mass 72.6 ± 7.2 kg, height 1.74 ± 1.08 m) volunteered to participate. Each participant was required to complete a graded VO\textsubscript{2-peak} test and three sub-maximal YMCA tests, at cadences of 50, 70 and 90 rev·min\textsuperscript{-1}, on a cycle ergometer (Lode, Groningen, Netherlands). Respiratory data during the VO\textsubscript{2-peak} test were collected using an on-line gas analysis system (Oxycon Pro, Jaeger at Viasys). Direct and predicted measurements of VO\textsubscript{2-peak}, work rate, ratings of perceived exertion and heart rate were recorded for analysis. A one-way repeated measures ANOVA revealed no significant difference (P > 0.05) between the directly measured and the three predicted values of VO\textsubscript{2-peak}. This was the case irrespective of whether an age predicted HR\textsubscript{max} of 220-age or 210-age was used. A significant correlation (P < 0.05) was found between the measured and predicted values of VO\textsubscript{2-peak} using 50 rev·min\textsuperscript{-1} with an estimated HR\textsubscript{max} of 220-age (r = 0.76) and 210-age (r = 0.71), 70 rev·min\textsuperscript{-1} with a HR\textsubscript{max} of 210-age (r = 0.71) and at 90 rev·min\textsuperscript{-1} (P < 0.01) with an estimated HR\textsubscript{max} of 220-age (r = 0.93) and 210-age (r = 0.96). The degree of error in the magnitude of estimates was found to range from 10-13% when using cadences of 50 and 70 rev·min\textsuperscript{-1}, but this was reduced to less than 6% when 90 rev·min\textsuperscript{-1} was used. The findings of the present study are in support of existing literature, and suggest that a cadence of 50 rev·min\textsuperscript{-1} does not permit an accurate sub-maximal estimation of VO\textsubscript{2-peak} compared to the use of 90 rev·min\textsuperscript{-1}.

P17P

The effect of isokinetic eccentric fatigue on angle specific functional hamstring to quadriceps ratio.

Tabrett, M.
University of Gloucestershire

The aim of the present study was to investigate whether eccentric fatiguing exercise caused a decrease in the functional ratio (Ham\textsubscript{ecc}/Quad\textsubscript{ecc}) of the knee at angle specific points of knee flexion (i.e. 10\degree, 20\degree & 30\degree of knee flexion with full extension being 0\degree). The aetiologial factor for the occurrence of Anterior Cruciate Ligament (ACL) injury is a failure of the stability systems during the performance of a decelerating manoeuvre. Decreased joint angle, increased velocity and the presence of fatigue have been suggested to increase the risk of ACL injury. This study investigated dynamic stability by examining the influence of an isokinetic action-specific protocol on the functional ratio at the final 30\degree of knee extension, where studies have suggested is the most at risk of injury motion in performance. Mechanical
studies, in which strain transducers were attached to the anteromedial fibres of the ligament, demonstrated that both isometric and isotonic quadriceps loads induced the greatest strain in the ligament between 0 degrees (full extension) and about 30 degrees of flexion of the knee. The character of the tibiofemoral insertion angles of both the patellar ligament and the anterior cruciate ligament causes contraction of the quadriceps to place maximum load on the anterior cruciate ligament between 0 and approximately 30 degrees of flexion of the knee (Draganich, Jaeger and Kralj,1989). Based on previous research it is suggested that functional ratio will decrease after eccentric fatiguing exercise. Twenty males performed a maximal voluntary eccentric fatiguing exercise, 50 repetitions of eccentric knee extension-flexion cycles (at 120 deg.s\(^{-1}\)) on a Cybex 6000 isokinetic dynamometer, with five concentric and five eccentric knee extension-flexion cycles (at 120 deg.s\(^{-1}\)) to test angle specific torque before and after fatigue. Data will be analysed using a two-way repeated measures ANOVA to determine any interaction effect of time and joint angle on functional ratio. It is hoped that the findings of the study will illustrate whether fatigue caused by eccentric muscle action has an effect on functional ratio and therefore increasing the likeliness of injury occurrence. The data analysis indicates that there is a significant interaction between Time and Angle of <0.05 and a significant main effect of Time of <0.05 and the main effect of Angle is 0.053. The interaction and main effects are due to a significant reduction in concentric strength of 50Nm ± 8Nm, whereas eccentric strength of hamstrings remains constant or drop slightly. In conclusion eccentric fatigue has the effect of reducing concentric strength post exercise and at specific angles, 10º, 20º and 30º from full extension. Therefore, having an effect on the functional ratio of the knee.

The relationship between recreational cycling and cardio-respiratory fitness in English school children.
Maher, M., Voss, C., Ogunleye, A., & Sandercock, G.
University of Essex

Cycling to work is positively associated with cardio-respiratory fitness (CRF) and can improve fitness in adults (Oja et al., 2007: Scandinavian Journal of Medicine and Science in Sports, 1, 151-157). Schoolchildren who cycle to school also have higher CRF than those who are driven or use public transport (Voss et al., 2010: Medicine and Science in Sports Exercise, 42, 281-287). Despite recreational cycling being more commonplace than commuter cycling in schoolchildren, it is less clear whether recreational cycling is positively associated with children's fitness. The purpose of the study was to determine whether there was a relationship between recreational cycling and CRF in English schoolchildren. The University of Essex ethics committee approved the study and parental consent was obtained. Participants were 5578 (53.4% boys) English school children (10-15.9 years) tested between 2008 and 2010 as part of the ongoing East of England Healthy Hearts Study. Anthropometric measurements (stature, body mass) were made during scheduled PE classes. Participants reported number of recreational cycling events as part of the PAQ-A; a validated 7-day recall Instrument (Kowalski et al., 2007: Medicine and Science in Sports Exercise, 42, 281-287.) The 1-5 response scale was collapsed to form three categories: ‘non-cyclists’= 0 times per week (35.4%); ‘occasional cyclists’ = 1-4 times per week (41.2%); ‘regular cyclists’ = 5+ times per week (23.4%). CRF was assessed using the 20 m shuttle-run test, converted to age and sex specific z-scores then classified as ‘fit’ or ‘unfit’ (Meredith & Welk, 2007: FITNESSGRAM/ACTIVITYGRAM Test Administration Manual. 3rd ed. Champaign: Human Kinetics). Logistic regression was used to determine the odd ratios (OR) for being classified as ‘fit’ in each cycling group using age as a covariate. Non-cyclists were used as the referent category in all analyses. Compared with non-cyclists, occasional cyclists were more likely to be fit (Boys: OR=1.30, 95%CI=1.07-1.59; Girls: OR=1.41, 95%CI=1.13-1.76). Frequent cyclists were also more likely to be fit (Boys: OR=1.58, 95%CI=1.29-1.95; and Girls: OR=1.55, 95%CI=1.09-2.20). This is the first study to demonstrate that recreational
cycling increases the likelihood of being fit in English school children. Current interventions to promote cycling appear only moderately effective (Yang et al., 2010: British Medical Journal, 341, c5293). Cycling to school is associated with several measures of health including higher CRF and lower BMI. Despite such benefits, cycling to school remains rare in many countries, especially the UK. It seems the focus of research on commuter cycling may have been at the expense of examining the more-common activity of recreational cycling. These findings suggest that recreational cycling may be a better target for interventions to increase PA. Further studies may benefit from a longitudinal approach to identify whether a causal relationship exists between recreational cycling and children’s fitness.

P19P
Comparison of Lactate Pro and Biosen C-line Lactate Analysers.
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Monitoring the kinetics of lactic acid is of great benefit to athletes, practitioners and clinicians. The accurate prescription and monitoring of training intensities based on lactate thresholds relies implicitly on the accuracy of measurement. The purpose of this study was to assess the accuracy of the Biosen C-Line Sport lactate analyser as compared to an established criterion analyser (Lactate Pro). Twelve subjects volunteered to take part in the study after being informed verbally and in writing as to the nature of the experiment. Subject’s characteristics were (mean ± SD): Age, 23.9 ± 3.7 yrs; height, 180.8 ± 8.9 cm; weight, 82.4 ± 16.7 kg, two of these were females with ten males. All subjects were recreationally active sports science students. Subjects were asked to refrain from exercise, alcohol and caffeine consumption 24h prior to testing. Each subject undertook a 5-stage incremental exercise test (3 min stages, 16W increments) followed by a maximal oxygen uptake test (VO\textsubscript{2max}). Both protocols were undertaken on a Monark Ergomedic 894E cycle ergometer (Monark, Sweden). Blood samples were taken at rest and at the end of each stage via earlobe capillary. The VO\textsubscript{2max} test started at 104W increasing 24W every minute until volitional exhaustion. Blood samples were taken pre and post VO\textsubscript{2max} test via the aforementioned protocol. All blood samples for both tests were taken in duplicate and simultaneously analysed using the Lactate Pro (LT1710, Arkray, Japan) and Biosen C-Line Sport (EKF Diagnostic, Germany) that were calibrated according to manufacturer’s guidelines. Relationships were investigated using Pearson’s product moment correlation coefficient, coefficient of variation and intra-class correlation coefficient. A two way repeated measures ANOVA was used to analyse differences across intensities. Resting data was analysed using a paired samples t test for differences. All data analysis was completed using SPSS 18 (Chicago, Illinois). A paired samples t test on the resting data highlighted a significant difference between analysers (p=0.000). Correlation analyses showed the analysers to be highly related across all intensities (r= 0.787-0.987, p<0.05). The repeated measures ANOVA with Greenhouse-Geisser correction highlighted significant differences across all 5 stages (F(1.0,11.0)=17.009, p=0.002), with the greatest differences occurring at 144 W and 160 W. A Bonferroni post hoc test highlighted significant differences (p=0.02) with a mean difference of 0.6 mmol across all 5 stages. The ramp data was also highly correlated (r= 0.803-0.986, p<0.05) but not significantly different (F(1.0,11.0) = 0.114, p = .742) with a mean difference of 0.082 mmol. In conclusion the results show a small but significant difference between analysers at resting lactate levels and during an incremental sub-maximal test, but no difference during a VO\textsubscript{2max} test. When means of absolute values are used, the Biosen provides readings consistently lower than the Lactate Pro. The largest differences are seen at lactate levels > 10 mmol, a level at which the Lactate Pro is known to over-estimate by ~12% compared to photofluorometry. Conversely when the highest Lactate Pro data are adjusted by 12%, the Biosen still reads lower. Like the Lactate Pro, the Biosen is an easy to use analyser, however further assessment of this device is needed.
Assessment of the Physiological Responses to Acute and Chronic BrushBoarding.

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Extreme Sport Zone Ltd. have created the new sport of BrushBoarding, best described as a multi board-sport, cross training activity combining the demands of surfing, snowboarding and skateboarding. Performed on a quarter-pipe, skateboard ramp with a moving surface of soft brushes, BrushBoarding aims to recreate the sensations experienced whilst surfing or snowboarding in a predictable, safe and controlled environment. The purpose of the current investigation was two-fold: 1) to characterise the physiological responses to an acute bout of BrushBoarding; and 2) to assess the effects of a six-week BrushBoard training programme on a number of physiological indices to provide insight into its potential use as a health and fitness aid and board-sport specific training tool. These indices included resting heart rate and blood pressure, thigh girth, waist girth and percent body fat. In addition to this, measurements of trunk flexibility, balance, core stability, aerobic and anaerobic capacity, countermovement jump height and isometric leg endurance were obtained. These parameters have been suggested to be key indicators of both health (American College of Sports Medicine, 1998: Medicine & Science in Sport & Exercise, 33, 2145-2156) and board-sport specific fitness (Mendez-Villuaneva & Bishop, 2005: Sports Medicine, 25, 55-70).

Following ethical approval, seventeen healthy subjects (10 male, 7 female, mean ± SD: age 22 ± 2 years, height 1.79 ± 0.09 m, body mass 77.3 ± 13.7 kg) completed a maximal incremental cycling test and a 10-minute acute bout of BrushBoarding, whilst measurements of $\dot{V}_O_2$, HR and blood lactate concentration were collected. A separate eight healthy subjects (3 male, 5 female, mean ± SD: age 20 ± 1 years, height 1.75 ± 0.07 m, body mass 68.2 ± 5.4 kg) completed a six-week training programme consisting of BrushBoard exercise. Prior to and following the training intervention, subjects completed a battery of physiological tests designed to reflect key fitness requirements in board-sport performance. Analyses revealed that a 10-minute bout of BrushBoarding resulted in mean $\dot{V}_O_2$ values of 1.83 l·min⁻¹ (56 ± 6% $\dot{V}_O_2$ peak), mean HR values of 157 ± 12 b·min⁻¹ (84 ± 5% HRpeak) and a blood lactate concentration of 6.0 ± 1.2 mM. Paired sample t-tests revealed that following the six-week training programme, peak power attained during maximal incremental cycling increased by 3% (Pre: 268 ± 62 W, Post: 276 ± 60 W; p < 0.05), counter-movement jump height was increased by 11% (Pre: 27.8 ± 6.9 cm, Post: 30.8 ± 9.3 cm; p < 0.05) and isometric leg endurance was increased by 122% (Pre: 81 ± 30 s, Post: 180 ± 90 s; p < 0.01). Additionally, Wingate test mean power output (Pre: 517 ± 161 W, Post: 580 ± 156 W; p < 0.05) and peak power output (Pre: 657 ± 192 W, Post: 836 ± 191 W; p < 0.001) were increased by 12% and 27%, respectively. However, $\dot{V}_O_2$ peak, resting HR, resting blood pressure, thigh girth, waist girth, percent body fat, trunk flexibility, balance and core stability were not significantly altered. In conclusion, BrushBoarding requires significant contributions from both the aerobic and anaerobic energy systems and may be considered an alternative exercise activity to promote several indices of fitness in healthy individuals. Furthermore, six-weeks of BrushBoarding resulted in improvements in several physiological variables likely to be important in board-sport performance. BrushBoarding might therefore be considered to be an effective board-sport specific training tool for board-riders during unfavourable sea or snow conditions.
Effect of 'recovery' intensity on exercise tolerance, oxygen uptake and iEMG during intermittent cycling.
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The hyperbolic power-time relationship for high-intensity exercise is defined by two parameters: an asymptote (critical power; CP) reflecting the highest sustainable rate of oxidative metabolism, and a curvature constant (W'), which indicates the fixed amount of work that can be completed above CP (W>CP). According to this model, the limit of tolerance (Tlim) for supra-CP exercise coincides with the complete depletion of W'; the W' can only be replenished when work rate falls below CP (Jones et al., 2010: Medicine and Science in Sports and Exercise, 42, 1876-1890). We hypothesized that when severe (>CP) exercise is performed intermittently with recovery exercise in progressively lower intensity domains (severe - heavy - moderate – 'light') that: 1) subjects will be able to recover a progressively greater portion of W' the lower the recovery intensity (<CP) and therefore will be able continue to exercise for longer; and 2) the overall \( \dot{V}O_2 \) and muscle activation (inferred from integrated electromyography; iEMG) response profiles for the heavy, moderate and light recovery conditions will be reflective of responses which normally characterize exercise below CP.

Following ethical approval, seven male subjects (mean ± SD: age 26 ± 5 years, stature 1.79 ± 0.06 m, body mass 81 ± 6 kg) completed a ramp incremental cycling test for the determination of \( \dot{V}O_2\text{peak} \) and gas exchange threshold (GET) and a 3-min all-out cycling test for the determination of CP and W'. Participants then completed, in a randomized order, a severe-intensity constant work rate trial to exhaustion (S-C) and, on separate occasions, four intermittent trials to exhaustion (work:recovery; 60:30 s) where the recovery work rate set as severe (>CP; S-S), heavy (<CP; S-H), moderate (<GET; S-M) and light (20 W; S-L).

The slopes of the \( \dot{V}O_2 \) and iEMG response profiles were determined using linear regression. Tlim was recorded to the nearest second and the W>CP was calculated as the power-time integral >CP in each trial. Data were analyzed using one-way repeated measures ANOVA. Compared to S-C (384 ± 48 s), the Tlim was ~15% smaller in S-S, ~100% greater in S-M and ~219% greater in S-L (\( P<0.05 \) in all cases). Similarly, the W>CP differed between conditions; compared to S-C (22.9 ± 7.4 kJ), the W>CP was 46, 98 and 220% greater in S-H, S-M and S-L, respectively (\( P<0.05 \) in all cases). However, the W>CP in the S-S (22.8 ± 5.0 kJ) was not different from the S-C trial (\( P>0.05 \)). The \( \dot{V}O_2 \) and iEMG response slopes became progressively smaller from the S-H to S-M and further to S-L trials. These data demonstrate that the improved severe exercise tolerance during intermittent protocols is commensurate with the degree of W' replenishment permitted in the recovery intervals. Furthermore, as recovery work rate is decreased, the \( \dot{V}O_2 \) and iEMG profiles during supra-CP intermittent exercise become characteristic of the responses which are usually observed during exercise below CP. Collectively, these data are consistent with the CP model and indicate that W' availability reflects the rate and extent of fatigue development during severe-intensity exercise. Moreover, W' availability appears to modulate muscle activation and the dynamics of O2, suggesting that ‘depletion’ of the W' and the development of the \( \dot{V}O_2 \) slow component might be intrinsically linked.

A new self-paced protocol to directly measure maximal oxygen uptake.
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The traditional VO2max (TMIE) protocol has recently come under criticism (Noakes, 2008: British Journal of Sports Medicine, 42, 551-555) for being a protocol that creates exercise which is ‘foreign’ to freely chosen exercise. Firstly, the unknown duration of the test creates a
closed loop form of exercise that prevents any form of anticipatory regulation of self-pacing. Secondly, the fixed incremental work rate enforced by the protocol prevents any intelligent form of self-pacing and non-monotonic fluctuations in power output, thus limiting the exerciser to a ‘stop or continue’ decision. The purpose of this investigation was to test a new, completely self-paced VO_{2max} protocol, allowing subjects to regulate their work rate using increments in RPE rather than fixed work rate. With ethical approval from the University of Bedfordshire ethics committee, seven trained male athletes and seven healthy male university students completed a traditional VO_{2max} protocol and a closed loop 5x2 minute RPE based incremental protocol (MSP). The MSP was performed on a non-motorised treadmill, where subjects could vary their speed according to incremental RPE-clamped stages (RPE 1.065, 5.324). No significant difference in VO_{2max} existed between the conditions (60.5 ml/kg/min vs. 61.4 ml/kg/min) (p>0.05), however, this may be due to the relatively large inter-subject variability in VO_{2max}. With a larger sample size differences in VO_{2max} may be expected to approach significance. There was also no difference in any other physiological variable (VE, HR, RER). The traditional incremental VO_{2max} test was an open loop (end point unknown) test which lasted approximately 10-12 minutes for each participant. The participant chose when to stop due to subjective feedback such as pain, increased effort and negative emotions. The RPE self-paced protocol was a closed loop (end point known) test where the participant had a set time of 10 minutes to completion. This test had a known endpoint which could have increased motivation in order to complete the test and also produced objective feedback such as a finite goal. Although the observation that a higher VO_{2max} can be achieved using a different protocol, similar results have been observed previously when the MSP has been used as a cycling based test. The results suggest that a closed-loop test design, where self-pacing is allowed, may allow the attainment of a higher measured VO_{2max}.

P23P

Can the Nintendo® wii fit plus improve the health of sedentary individuals?
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The Wii Fit Plus (Wii Fit Plus [WFP], Nintendo Inc, Kyoto, Japan) claims that it can help people improve their fitness and general health. Previous research has used a single session, to determine if the WFP can produce physiological responses great enough to improve the health of sedentary participants (Bonetti et al., 2009: Journal of Strength and Conditioning Research, 24, 1799 - 1803). Therefore the purpose of this study was to determine whether training using the WFP could improve the health of sedentary individuals over a period of 9 weeks. Eleven participants (5 Male 6 Female, \( \bar{X} \pm SD \) Age: 28.2 \pm 13.5 years, Stature: 155.2 \pm 52.1 cm, Mass: 70.4 \pm 9.6 kg) were recruited and were randomly allocated via a simple random allocation into either the Wii Fit Plus group (WiiG), or the control group (CONT). The WiiG performed a continuous 9-week intervention consisting of 3 sessions per week (37.0 \pm 0.3 min per session), on the WFP performing the most physically demanding exercises. All sessions were performed at 54.9 \pm 11.6 % predicted maximal heart rate. The participants were examined pre, midpoint and post intervention for body mass, systolic and diastolic blood pressure, mean arterial pressure (MAP), estimated % fat, estimated fat mass, sub-maximal oxygen consumption (YMCA ergometer sub-maximal test cycle) and muscular endurance (30 second chair stand). The data was analysed using a repeated measures ANOVA, and where appropriate, a Bonferroni post hoc test, using PASWS v. 18. The Health, Exercise and Sport Science ethics committee granted ethical clearance. No significant differences were observed between pre and post tests within either group for mass, systolic and diastolic blood pressure (all \( p > .05 \)), MAP - WiiG (\( F(2,8) = .005, p = .995, \eta^2 = .001 \)), CONT (\( F(1,10,5.324) = 1.472, p = .280, \eta^2 = .227 \)). YMCA ergometer sub-maximal cycle test, estimated % body fat, estimated fat mass, and 30-second chair stand - WiiG (\( F(2, 8) = .068, p = .935, \eta^2 = .017 \)) CONT (\( F(2,10) = .032, p = .968, \eta^2 = .006 \)). After a 9-week intervention the Wii...
Fit Plus did not significantly improve participants’ health. Even though the earliest health benefits of exercise are a reduction in resting and sub maximal heart rate (Ziembka et al., 2003: *Journal of Sports Medicine and Physical Fitness*, 43, 57 – 63) which can be found after nine weeks of training (McMurray et al, 1998: *Medicine and Science In Sports and Exercise*, 30, 1521 – 1529) these changes were not observed after using the WFP as the mode of exercise. Although there were no benefits for the WFP, these results may suggest the intervention requires additional time and/or greater intensity for the WFP to elicit significant health benefits commensurate to those observed in traditional modes of exercise.

**P24P**

**Neuromuscular electrical stimulation and its associated discomfort have an effect on the relationship between rate of perceived exertion and bodily physiological responses.**

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The use of neuromuscular electrical stimulation (NMES), as a therapeutic intervention, has previously received much attention, specifically in the promotion of muscle strength and tissue healing (Banerjee et al., 2005: *Journal of Applied Physiology*, 99, 2307-2311), and the provision of pain relief in the clinical setting. It has also been used in the management of urinary incontinence, spasticity, and spinal cord injuries (SCI) to improve aerobic capacity (Mutton et al., 1997: *Archives of Physical Medicine and Rehabilitation*, 78, 712-718). NMES has been used in the rehabilitation of sports injuries, mainly to re-educate muscles post injury, retard muscle atrophy caused by immobilisation or denervation, and to enhance strength. Previous studies demonstrate that NMES training can illustrate improvements of exercise capacities among pathological populations. However, factors such as comfort levels and pain tolerance may have an impact on reaching an optimal intensity that will bring about desired cardiovascular effects. This study focuses on relationships between healthy sporting participants’ perceived exertion, subjective feelings of pain and comfort, and their actual physiological response to NMES. Thus, this study investigates the relationship between increasing exercise intensities, using NMES, and perceptions of comfort and perceived exertion throughout. This study compares changes in physiological parameters (energy expenditure, heart rate, oxygen consumption), and individual perceptions of discomfort, at intensities corresponding to ratings of perceived exertion (RPE) for light (RPE 7-12), somewhat hard (RPE 13-14), and hard (RPE 15-16) in ten healthy adult female recreational athletes, using NMES. Approval for the study was obtained from the local university ethics board (UCD Human Ethics Committee). Three successive NMES tests were performed on the lower extremities in sitting at a randomised frequency of 4, 5, or 6 Hz. During each session, stimulation intensity increased over three minute stages in five milliamp increments. In the final thirty seconds of each stage participants rated their discomfort levels on a ten point visual analogue scale and their perceived exertion on a 15-point Borg RPE scale. Energy expenditure, oxygen saturation and consumption, and heart rate were also recorded using a gas analysis system and portable oximeter. Post-hoc repeated measures ANOVA (analysis of variance) revealed no significant differences across variables at a given RPE or frequency (p <0.05). NMES brought about feelings of discomfort in participants. These perceptions increased as levels of perceived exertion rose (RPE 7-12: VAS 4.72 ± 2.32 - 5.38 ± 2.10; RPE 13-14: VAS 7.31 ± 2.01 - 7.80 ± 1.53; RPE 15-16: VAS 8.33 ± 1.36 - 8.59 ± 0.98). Energy expenditure was consistent across all three frequencies at each RPE (Range: 998.92 ± 346.43 - 1391.96 ± 595.35 kJ/hr). Oxygen consumption and heart rate proportionately increased as exertion increases but there are no significant differences across the three frequencies. The principle finding of this investigation was that RPE is directly proportional to a range of comfort, NMES, and cardiovascular parameters. Levels of discomfort increase as levels of intensity and RPE increase. Similarly, levels of energy expenditure, heart rate and \( O_2 \) consumption increase as RPE increases. These patterns were consistent across all NMES frequencies used. NMES exercised our participants to approximately 30-55% of normal \( VO_2 \)
max for this age and gender, before they experienced undue discomfort whereby they felt they had to stop the test. To conclude, NMES can induce cardiovascular and respiratory responses in participants, but can also provoke feelings of discomfort among participants, particularly as perceptions of exertion increase. Because of this proportional relationship, individuals may not be able to reach an optimal intensity that will bring about the desired effects of neuromuscular electrical stimulation.

P25O

The effects of chronic supplementation of beta-alanine on a competition specific protocol in amateur boxers.

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Amateur boxing is an intermittent sport requiring athletes to perform short duration, high intensity bursts of activity, producing elevated levels of lactate that may lead to premature fatigue. Being able to delay these effects can be the difference between winning and losing. It has been suggested that chronic (4 weeks) beta-alanine supplementation can increase intramuscular carnosine levels which result in the buffering of hydrogen ions, so enhancing boxing performance. Following ethical approval sixteen amateur boxers (Mean ±SD) height = 174.4 ±7.0cm; weight = 78.4 ±7.6kg; age = 24.3 ±3.9 years; experience = 6.0 ±1.0 years) performed 3 trials in a matched pairs, placebo-controlled, single-blind study. The subjects initially performed a familiarisation trial from which they were matched based on punch performance and all allocated to either the control or experimental groups. One week following the familiarisation the subjects performed the baseline trial and started consuming 6g of beta-alanine or maltodextrin placebo. The beta-alanine was supplied in capsules and divided into 4 equal portions. These were consumed throughout the day with at least 2 hour intervals for 28 days. Each boxing trial consisted of 3x3 minute rounds of 2 minutes 50 seconds on a punch bag and performed a standardised combination every 12 seconds. The subject then performed a final 10 seconds of maximal output punching, a standardised jab, cross combination (punch combinations were based on an analysis of elite boxers from the 2010 Commonwealth games finals). Heart rate was recorded at the end of each round and lactate measured immediately following the final round. Punch force and the number of punches were recorded during the last 10 seconds of each round using a force transducer attached to a restrained punch bag. A two way repeated measures ANOVA was used to identify changes in physiological and performance parameters. Significant (p < 0.001) improvements were found in accumulative punch force (mean (±SD) beta-alanine 4582 ±515 kg: placebo 3100 ±864kg; total number of punches (beta-alanine 60 ±2; placebo 53 ± 4; p < 0.001) and lactate levels (beta-alanine 12.6 ±0.5 mmol⁻¹: placebo 7.0 ±2.7 mmol⁻¹; p < 0.001) following chronic ingestion of beta-alanine. No significant differences occurred in mean punch force (mean (±SD) beta-alanine 82kg (11): placebo 59kg (15); p = 0.067) and heart rate (β-alanine 190 ±10 bpm⁻¹: placebo 187 ±8 bpm⁻¹; p < 0.001).

Chronic ingestion (28 days) of beta-alanine resulted in significant improvements in delaying fatigue and improving punch performance (short term high intensity exercise). Subjects were able to perform at a similar maximum heart rate, and an increase was recorded in both force and number of punches. This was reflected in the increased levels of lactate production. In conclusion beta-alanine may delay the effects of fatigue for longer and enhance a boxer's punch force and number which may be beneficial to amateur boxers. Research in supplementation and boxing is sparse, further studies are required in this area.
The physiological and performance effects of even and positive pacing strategies on 1km pursuit ergometer cycling in physically trained athletes.

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The distribution of effort during the 1-km time trial for elite athletes is consistent in its inconstancy. Athletes prefer an all out effort at the start with the times, from the 2nd lap onwards, getting gradually slower. This pattern of effort results in changes in energy contribution which impact on fatigue and ultimately performance. An even distribution of effort may elicit a more efficient production of energy that results in a faster overall time. The purpose of this experiment was to identify the aerobic demand and relative performance during an even paced (EP) and a positive pacing (PP) strategy during a 1-km time trial in order to identify a more effective race plan.

Following ethical approval, five male athletes (mean age 36 ±0.14 years; stature 181 ±5 cm; body mass 85 ±9 kg; VO2max 4.25 ±0.285 l·min⁻¹), on separate days performed two familiarisation 1-km time trials. Following a further 48 h rest each subject performed an incremental step test to volitional exhaustion (VO2max) with 25 W increments on a Wattbike cycle ergometer. During the step test heart rate and breath-by-breath oxygen consumption (VO2) were measured. The athletes then randomly performed two 1-km maximal time trials, an even passed or positive pacing strategy with 48 h rest between. During the PP trial the subjects modified their output every 250 m to match those of the World Championship 1-km time trial medallists (2007-9). In the last 200 m of both trials they were required to maximise their output regardless of the chosen strategy. During the trials power output (Watts.pedal revolution⁻¹) and VO2 (breath-by-breath) were measured. Immediately following each trial heart rate and finger prick blood lactate samples were taken. Overall means and standard deviations in even pacing and positive pacing strategies were then compared and a student’s paired t-test was performed for each variable.

All subjects’ times were faster using an even pacing strategy (70.57 ± 2.13 s) compared to the positive pacing strategy (71.95 ± 3.19 s, P=0.06). Oxygen consumption per second was higher for the EP strategy (51.7 ± 6.14 ml.s⁻¹) compared to PP (48.9 ± 6.14 ml.s⁻¹, P=0.57). There was no significant difference in HR (EP 166 ± 8.0 bpm v PP 170 ± 17.0 bpm; P=0.56) or blood lactate (EP 7.8 mmol.l⁻¹ ± 1.2 v PP 7.6 mmol.l⁻¹ ± 1.7; P=0.85).

Although there was no significant difference in the measured variables all athletes went faster with the EP strategy.

The effects of pacing strategies on physiological responses and performance in 400 m freestyle swimming.

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Pacing and racing strategy are often misunderstood and frequently neglected in many training programmes. One of the most important decisions that swimmers make is how to distribute their effort during a race. There are a variety of pacing strategies many coaches and researchers have observed in swimming. These include negative pace (NP, slow-fast), positive (PP, fast-slow) and even (EP, same pace), although the most commonly used strategy is PP. The aim of the study is to determine which pacing strategy is most effective for swimming 400m freestyle event and to examine the physiological responses for each pace. Ten club level male swimmers (Mean±SD; 400m freestyle seasons best time 308.17±16.68s) completed three 400m time trials from a dive start performing a PP, NP or EP strategy in a Latin square design, with one week between each trial. Training and nutrition were kept
consistent and the athletes rested for 24h prior to each trail. The percentage time for the PP and NP trials were calculated using the 2009 FINA World Championships 400m men’s freestyle final (percentage of mean speed = 0-25m - 132.94%; 25-200m - 98.75%; 200-350m - 101.25%). The PP being the reverse of the NP times from 25-350m. Each swimmer apportioned their effort based on their season’s best time. The time was kept consistent for each length by verbal and hand signals. The final 50m was completed as a performance trial and the time recorded using a hand held stopwatch. Post trial lactate, heart rate and RPE (to 350m) were recorded for each time trial. A significant difference was found in RPE between PP and EP (Mean±SD; PP, 17.00±1.79; EP, 15.10±1.51: P=0.013), and PP and NP (NP, 14.20±0.87: P=0.001). There was also a significant difference in last 50m time between the PP and EP strategies (PP, 38.54±2.47s; EP, 35.12±2.19s: P=0.013) and between PP and NP (NP, 35.68±2.56s: P=0.031). There was a significant difference between the PP and EP strategies for blood lactate (PP, 8.92±1.51mmol.l⁻¹: EP, 7.01±1.57mmol.l⁻¹: P=0.007), Heart Rate (PP, 184.4 ±11.11bpm; NP, 167.9 ±8.36 bpm⁻¹: P=0.007). It appears that the PP strategy is the least effective and there is little difference between the EP and NP strategies in terms of physiological parameters and performance.

P29P
Cadence in Competitive Cyclists: VO₂ Kinetics and Efficiency.
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It has been observed that when adopting a freely chosen cadence (FCC) cyclists adopt higher cadences (92-95 rpm) than non-cyclists (72-80 rpm). Lucia et al., (2002: Med. Sci. Sports Exerc., 34, 320-325) reported that in elite cyclists higher cadence (100 rpm), show an increased efficiency and exhibit a smaller end gain in VO₂ when compared to lower cadences (60-80 rpm). It may be suggested that highly trained amateur cyclists assume a demographic between that of trained non cyclists and professional cyclists, who differ greatly in terms of training status and experience. Therefore, the purpose of this study was to examine the effects of varying cadences on gross efficiency (GE) and the VO₂ response during square exercise in both the moderate (MOD) and heavy (HEY) exercise domains in this population group. Following local institution ethical approval 7 highly trained amateur cyclists (mean ± SD); age 27.3yrs ± 2, mass 72.2kg ± 8.0, stature 181.1cm ± 9.5, VO₂max 66.09 ± 8.24 ml·min⁻¹·kg⁻¹, volunteered and agreed to participate. All participants were either 1st or 2nd British Cycling Federation category racing licence holders with at least two seasons of racing and training experience. Initially each participant completed a ramp test starting at 100W with an increase of 1W·2s⁻¹ to volitional exhaustion for determination of both VO₂max and ventilatory threshold (VT). FCC was established during a 10 minute self-selected warm up prior to the VO₂max test. The following four visits involved 3 square wave transitions from baseline unloaded (BL) pedalling (4min @ 15W), followed by two MOD (6 min @ Δ75% BL – VT) and one HEY (6min @ 50% ΔVT - VO₂max) each separated by a period of 6min @ 15W. For each square wave visit cadence was systematically assigned. All participants completed each test at 100% FCC, which equated to (98.2 ± 3.8 rpm), 85% FCC (85 ± 3.2 rpm) and 115% FCC (113 ± 4.3 rpm). VO₂ was recorded on a breath-basis. The phases of VO₂ kinetics were computed using a 3 component model. Data was statically analysed using repeated measures analysis of variance (ANOVA) to examine changes in VO₂ kinetics and GE. Results of this study show non-significant differences in GE for MOD and HEY between all cadences, (p>0.05). However, parabolic relationships were found between GE and cadence for both MOD (R²=1) and HEY (R²=1) workloads predicting an optimally efficient cadence of 64rpm for MOD and 75rpm for HEY. Phase 2 VO₂ gain (P₂) in MOD showed a non-significant (p>0.05) linear increase (R² = 0.93) with cadence (1634 ±242ml·min⁻¹–1797±349 ml·min⁻¹). HEY P₂ showed a non significant (p> 0.05) linear decrease (R² = 0.97) with increase in cadence (2867±269 ml·min⁻¹–2520±798 ml·min⁻¹). MOD Phase 3 VO₂ gain (P₃) had a maximum value (190 ± 112ml·min⁻¹) at FCC with non-significant differences between all
cadences. HEY \( P_3 \) was increased linearly (\( R^2 = 0.70 \)) with increase in cadence (416±145 ml·min\(^{-1}\)– 473±162 ml·min\(^{-1}\)). It is contended that cadence related effects on \( P_2 \), \( P_3 \), and EG for MOD and HEY are related to fibre type composition and optimal contractile efficiency ranges. It is apparent that the principle contributor to the observed increase in EG within MOD domain is the increase in \( P_2 \), with the rise in \( P_2 \) is due to a shift from optimal contractile frequency range of Type I fibres recruited for relatively low force production. \( P_3 \). The decline in rise in \( P_2 \), in HEY for the higher cadences, may be as a result of recruitment of a greater proportion of less oxidative Type II fibres yielding ATP through a greater percentage of anaerobic metabolism at the transition from baseline. The greater rise in \( P_3 \) in HEY may be attributed to an increased recruitment of Type II fibres and shift from the Type I optimal frequency thereby reducing contractile efficiency. In conclusion it may be advisable for competitive cyclists to adopt higher cadences (>FCC) at the onset of HEY exercise to reduce \( VO_2 \). Furthermore it observed that adoption of FCC is more relative to \( VO_2 \) economy than GE. Whether FCC choice is related to muscle physiology or training adaption is not clear.

P30P
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It is widely reported that elite cyclists adopt freely chosen, self-selected cadences (FCC) of between 85-100 rpm, well above that which is considered most energetically efficient (50-80 rpm). Pedal force data indicates that an increase in cadence leads to reduced peak crank torque values and lower joint moments within the leg. It has also been reported that neuromuscular fatigue in certain major prime movers of the leg when measured using electromyography (EMG), forms a parabolic relationship with cadence suggesting optimal cadence at the nadir. However, little data has included a range of leg muscles, peak EMG, and linked both to crank torque data at varied cadences. Therefore, the purpose of this study was to examine the effects of cadence manipulation on net pedal force, neuromuscular fatigue, and muscle activation in a group of highly trained cyclists. Following local institution ethical approval 8 highly trained road cyclists (Mean ± SD); aged 27.3 ± 2 yrs, body mass 72.2 ± 8 kg, stature 181.1 ± 9.5 cm, \( VO_{2\text{max}} \) 66.09 ml·kg\(^{-1}\)·min\(^{-1}\) ± 8.24 ml·kg\(^{-1}\)·min\(^{-1}\), volunteered to participate. All participants held either a 2nd or 1st category licence and had a minimum of 2 seasons of racing experience. Participants completed an initial incremental cycle test at a self-selected FCC, starting at 100 W, then increasing at 1 W·2 s\(^{-1}\) to determine \( VO_{2\text{max}} \) and ventilatory threshold (VT). FCC was determined during a 10-minute self-selected warm up prior to testing. Participants returned for three subsequent visits, during which they performed two, 6-min moderate (MOD) (75% ΔBase Line - VT) and one heavy (HEY), 6-min (50% ΔVT – \( VO_{2\text{max}} \)) square wave transition from base line pedalling at 15 W.. A period of rest followed each square wave trial of 6-min. Each visit required the participant to cycle at one of three assigned cadences which equated to FCC (98 ± 3.8 rpm), 85% FCC (85 ± 3.2 rpm) and 115% FCC (113 ± 4.3 rpm). EMG of the rectus femoris (RF), vastus lateralis (VL), bicep femoris (BF), lateral gastrocnemius (LG) and medial gastrocnemius (MG) were recorded for a 10 s period 330 s into each trial, at 1000 Hz and a root mean square was applied to rectify the signal.. Crank torque (Nm) was also recorded during this time period at every 2° of crank rotation. RMS EMG for all muscles were time aligned with crank torque. EMG data was normalised (%) to the peak value recorded for each muscle group for each trial. Results indicate a parabolic trend for peak EMG although this was shown to be non-significant across all three cadences and muscles groups (p> 0.05). A similar parabolic relationship was evident when examining iEMG of the BF, MOD 85%-FCC 50.9 ± 12.2%, FCC 47.3 ± 11.1%, 115%-FCC 57.1 ± 12.5%, although again non-significant (p> 0.05) and no cadence effect was found in either extensor muscles. However iEMG of the LG and MG
was significantly higher at 115%-FCC for both MOD (82.1 ± 15.1% and HEY (95.3 ± 11.7%) when compared to both FCC and 85%-FCC (p< 0.05). In agreement with past research, effective torque index (ETI) decreased significantly as cadence increased (p<0.05) and was significantly higher in the heavy domain than the moderate (p< 0.05). Results do not support the notion that minimal neural activation occurs at FCC, although adopting an excessively high cadence may increase fatigue in the plantar-flexors, possibly as the muscle strives to control pedalling technique. A parabolic trend in peak EMG values may be linked to FCC and although research with a larger population group is required to confirm this, reducing peak activation could lower the contribution of less efficient type II muscle fibres.

P31P
Central blood pressure versus peripheral blood pressure at rest, incremental exercise and recovery in a young female and male cohort.
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In 2007 cardiovascular disease caused 34% of deaths in the UK, killing over 193,000 people (British Heart Foundation, 2009: Coronary Heart Disease Statistics 2010, Retrieved from: http://www.heartstats.org). Arterial stiffening is the principal cause of increasing systolic pressure and it predominantly affects pressure in the central arteries though peripheral arteries are affected also (O’Rourke et al., 1990: Journal of Hypertension, 15, 339-347). The measurement of central blood pressure (CBP) may provide more useful information than peripheral blood pressure (PBP) as a marker of hypertension. However, there is limited research on CBP versus PBP measurements as markers of hypertension (McEniery et al., 2008: Hypertension, 51, 1476-1482). Therefore, the purpose of this study was to determine CBP versus PBP in a young, female and male cohort at rest, incremental exercise and recovery. Ethics approval was obtained for, ten white Caucasian, females (age 20.1 ± 0.6, height 167.8 ± 5.5 cm, body mass 66.2 ± 12.4 kg) and ten white Caucasian males (age 20.4 ± 1.9, height 179.9 ± 5.6 cm, weight 72.9 ± 9.2 kg) performed an incremental VO$_{2peak}$ on a cycle ergometer with CBP, PBP and augmentation index (Aix) measured at rest, during incremental exercise, exhaustion and an hour of recovery. A SphygmoCor® device was used to determine CBP to identify differences in the compliance of the arteries by the measures of Aix and pulse wave velocity (PWV). The measurement of PBP was obtained by a brachial sphygmomanometer. A paired sample t-test will analyse the difference between CBP and PBP to determine the accuracy of CBP or PBP as a measurement of blood pressure and arterial compliance during rest, exercise and one hour post exercise. One-way ANOVA will be used to determine changes in CBP and PBP from rest, incremental exercise and recovery. It is envisaged that results from this study will support the work by McEniery et al. (2008: Hypertension, 51, 1476-1482) that CBP is a more useful marker of hypertension than PBP when healthy subjects are put under the effects of stress from exercise.

P32O
The Effects 8 Weeks Inspiratory Muscle Training on a Self-Paced Six Minute Stepper Task in Chronic Obstructive Pulmonary Disease Patients.
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Research has demonstrated that Chronic Obstructive Pulmonary Disease (COPD) patients often have weakness in the inspiratory muscles from physiological consequences of the disease, which, as a result can limit exercise performance (Spruit and Wouters, 2007: Sports Medicine, 37, 501-519). A six minute walk test, is often used as a field test to measure exercise capacity in COPD patients and Inspiratory Muscle Training (IMT) has been shown to improve the distance walked (Hill et al., 2006: European Respiratory Journal, 27, 119-
More recently the six minute stepper test has been highlighted to be a valid field measure of COPD patients (Borel et al., 2010: Clinical Rehabilitation, 24, 82-94) but it is unknown if IMT has any affects on stepping exercise performance. The purpose of the study was to investigate the influence of IMT on performance in a six minute stepper task in COPD patients. With ethical approval from the HESS committee at Southampton Solent University, eight volunteer (male=5, female=3) COPD patients (age 66.2±5.3 yr, stature 1.59 ±0.10 m, body mass 66.26±11.9 kg, maximal inspiratory pressure 47.6±17 cmH₂O, mean ± SD) took part in the study. Spirometry values (FEV₁, FVC, PImax) were recorded, and then participants were instructed to complete as many steps as possible during a self paced six minute stepper task. Peak dyspnoea scores were recorded on the CR-10 Borg scale every min of the test. Participants were randomly allocated to a treatment (n=4) and a control group (n=4). The treatment group performed, thirty breaths twice a day, for 8 wks using a spring loaded threshold loading device (POWERbreathe, Medic, Warwickshire) at >30% of maximal inspiratory pressure. The participants also completed the COPD specific version of the St. Georges Respiratory Questionnaire (SGRQ-C), pre and post intervention to determine health status. Data was statistically analysed using paired sample t-tests with Bonferroni correction to determine any effect of IMT on performance in a six minute stepper task. Independent samples t-tests were completed to determine significance between groups. Statistical significance was set at P<0.05. There was a statistically significant increase in maximum number of steps in the IMT group (200±93.9 vs. 278±76.08; t(3)=−4.384, P=0.022) but there was no significant improvement in the control group (251±59.57 vs. 249±63.09; t(3)=1.96, P=.857). There was no statistical significance between the groups post testing scores (t(5)=0.546, P=.605). Although PImax increased by 28% this wasn’t statistically significant for the IMT group (52.5±23.93 vs. 67.5±32cmH₂O; t(3)=−2.762, P=.07) or for the control group (42.75±10.73 vs. 51.25±15.85cmH₂O; t(3)=−2.35, P=1.00). Between groups, there was no significant difference for PImax (t(6)=−862, P=.431). Peak Dyspnoea scores and SGRQ-C scores remained unchanged from pre to post testing with no difference between the groups.

The study concludes that in patients with COPD, there is an increase in stepping exercise capacity following an intervention of IMT. The findings from this study support those of Hill et al. (2006: European Respiratory Journal, 27, 119-128) that IMT improves exercise tolerance in COPD patients.

P33O
The effects of exercise-induced muscle damage on endurance performance during arm-crank ergometry.
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Exercise-induced muscle damage (EIMD) occurs following unaccustomed, eccentric-biased exercise, the effects of which typically peak between 24 and 48 hours after the initial insult. EIMD is known to elicit key physiological, metabolic and perceptual changes that have been shown to impose a detrimental effect on lower body endurance performance (Twist & Eston, 2009: European Journal of Applied Physiology, 105, 559-567). However, despite elbow flexors and extensors being more susceptible to eccentric exercise than the lower limbs (Chen et al., 2011: European Journal of Applied Physiology, 111, 211-223), the effects of EIMD on upper body endurance performance are unknown. Therefore, the purpose of this study was to examine the effects of EIMD on the physiological, metabolic and perceptual responses during upper body arm-cranking exercise. Following ethical approval, 9 physically active male participants were recruited for the study (mean age 21.8 ± 1.7 y, body mass 80.9 ± 10.3 kg, stature 1.82 ± 0.09 cm, upper body $\dot{V}O_{2\text{max}}$ 30.1 ± 3.6 ml·kg⁻¹·min⁻¹), during which all participants completed both the treatment and control condition in a counterbalanced, cross over design, with 7-10 days washout period between conditions. Participants initially performed an incremental test to exhaustion on an arm-crank ergometer to determine $VO_{2\text{max}}$ and ventilatory threshold (VT). Participants then performed either bench pressing exercise
consisting of 10 sets of six repetitions against a load corresponding to 70% of their previously established 1-RM (treatment condition), or rested for 20 min (control condition). This was followed 48 h later by a 6 min exercise bout of arm-cranking at a workload corresponding to VT (moderate intensity), followed by a time to exhaustion trial performed at 80% of the difference between VT and VO\textsubscript{2max} (high intensity). Oxygen consumption (VO\textsubscript{2}), minute ventilation (V\textsubscript{E}), heart rate (HR), blood lactate concentration ([La]) and RPE responses were also measured during moderate and high intensity trials. Accompanying measurements of creatine kinase, muscle soreness and isokinetic force of elbow flexors and extensors were also measured at baseline and then 24 and 48 h following the treatment and control conditions. Additionally, a motivation questionnaire was administered at baseline and 48 h following the treatment and control condition. A repeated measures ANOVA revealed an interaction effect for time and condition on peak isokinetic extension (P<0.05), flexion (P<0.05) and muscle soreness (P<0.05), indicating that muscle damage was present at 24 and 48 h following the treatment condition. During the moderate intensity exercise, only RPE was significantly higher at 48 h in the treatment compared to the control condition (14.4 ± 1.0 cf. 12.5 ± 1.1; P<0.05), while VO\textsubscript{2}, V\textsubscript{E}, HR and [La] remained unchanged (P>0.05). During the high intensity trial, time to fatigue was significantly reduced in the treatment compared to the control condition (207.2 ± 91.9 cf. 293.4 ± 75.6 s; P<0.05), as were end VO\textsubscript{2} (29.32 ± 2.36 cf. 33.8 ± 4.18 ml·kg\textsuperscript{-1}·min\textsuperscript{-1}; P<0.05) and [La] at 0 (7.5 ± 1.3 cf. 8.7 ± 1.1 mmol·l\textsuperscript{-1}; P<0.05), 5 (7.6 ± 1.6 cf. 8.4 ± 1.2 mmol·l\textsuperscript{-1}; P<0.05) and 10 min post exercise (5.9 ± 1.9 cf. 7.1 ± 1.7 mmol·l\textsuperscript{-1}; P<0.05). During the high intensity trial, V\textsubscript{E}, HR, RPE and motivation scores remained unchanged between conditions (P>0.05). These findings confirm that following EIMD of the upper body there is an increased sense of effort for the same relative workload during moderate intensity arm-cranking exercise. However, despite the same effort and no change in motivation, exercise tolerance at a high intensity was reduced and would appear to be explained by locomotor muscular fatigue related to a lower end VO\textsubscript{2} and reduced blood lactate production.

P34P
The effect of pacing strategy on energetics during a 62 second cycling test.
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A major dilemma faced by elite track cyclists is identifying the best pacing strategy for competition, as this enables them to efficiently use all available physical resources and optimise performance. Previous studies have drawn inferences regarding optimal strategies during short duration events (< 2 min), yet it is inconclusive as to which allows the cyclist to tax each energy system fully (Hettinga et al., 2007: Medicine and Science in Sports and Exercise, 39, 2212-2218). The purpose of this study was to investigate the effect of pacing strategy on anaerobic and aerobic energy output during different 62 s pacing profiles, mimicking an elite sprint cycling event. Following ethical approval, 9 male university level sport players [mean ± SD, age 20.4 ± 1.0 years, stature 180.7 ± 6.8 cm, body mass 77.1 ± 12.3 kg] performed an incremental test to exhaustion on a cycle ergometer to determine peak aerobic power (PAP) and VO\textsubscript{2max}. After a minimum of 48 h, the participants then undertook three different 62 s cycling pacing profiles scaled to their individual PAP on separate occasions: a) a typical sprint with a very hard start and decreasing power until finishing, b) a softer start with a subsequent decrease in power towards a constant power throughout, requiring a 13 % higher average power to achieve the same theoretical race distance, and c) a power profile similar to b with an average power identical to a) resulting in a loss of approximately 4.5 % cycling distance. Contribution of different energy systems in terms of anaerobic alactic, lactic and aerobic metabolism were calculated from the fast component of the kinetics of post-exercise oxygen uptake, net lactate production and oxygen uptake during exercise. The result of the repeated measures ANOVA showed that anaerobic
lactic energy output was higher (P < 0.05) during profile b (95 ± 15.4 kJ) than in profile a (88.3 ± 15 kJ), yet no difference was found for profile c (90.9 ± 20.1 kJ). Similarly no difference (P > 0.05) was found for either the aerobic or anaerobic alactic energy system contribution between the three profiles. The contribution of the different energy systems within each profile was consistent throughout, with both the aerobic and anaerobic lactic system contributing more energy (P < 0.05) than the anaerobic alactic system. Additionally the anaerobic lactic system consistently provided a greater amount of energy (P < 0.05) in comparison to the aerobic energy system. Therefore the idea that an ‘all-out’ pacing strategy is optimal during a 1 km time-trial can still be accepted, as the increase in anaerobic energy contribution during profile b was the result of an increased mechanical power required at the start of the race.

P35P

**Relationship between digit ratio (2D:4D), physiological performance and competitiveness in physically active males.**

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Research indicates that a low second to fourth digit ratio (2D:4D) (a marker of high prenatal androgen exposure) is linked to performance in sport, however much of the research has examined the links between 2D:4D and sporting achievement rather than specific physiological measures. Therefore the purpose of this study was to examine the relationship between 2D:4D, competitiveness and a number of key physiological variables. With institutional ethics approval, 13 physically active but untrained male volunteers (age 23.8 ± 6.3 years; stature 1.77 ± 0.05m; body mass 80.1 ± 5.2 kg) performed a series of physiological tests. 2D:4D was determined in the right hand according to Honekopp et al. (2006: Hormones and Behaviour, 49, 545-549). Skinfold measurements were obtained from 7 sites to determine percentage body fat (%BF). Lung function measures were also recorded (forced vital capacity [FVC], forced expiratory volume [FEV₁], and peak expiratory flow [PEF]). Strength and power was assessed using the Concept 2 dynamometer (bench press, a leg press, and a lateral pull). During a 15 min rest period the subjects completed a 25 item sport orientation questionnaire (Gill and Deeter, 1988: Journal of Sport and Exercise Psychology, 10, 139-150) which provided a measure of competitiveness. The subjects then completed an incremental treadmill test to exhaustion to determine $\bar{V}O_{2\text{max}}$. Data was analysed using Pearson’s correlation (r) to assess the relationship between 2D:4D, competitiveness, and the physiological measures. Results indicate there is no significant correlations ($p > 0.05$) between 2D:4D and any of the explored variables (FVC $r = -.136$; FEV₁ $r = .076$; PEF $r = -.296$; bench press strength $r = .364$; $p > 0.05$; bench press power $r = .254$; leg press strength $r = .148$; leg press power $r = .236$; lateral pull strength $r = .154$; lateral pull power $r = .367$; absolute $\bar{V}O_{2\text{max}}$ $r = -.025$; relative $\bar{V}O_{2\text{max}}$ $r = .071$; % BF $r = -.397$; win orientation $r = .589$; goal orientation $r = .367$) which fails to reflect the work of Manning et al. (2007: American Journal of Human Biology, 19, 416-421) and Fink et al. (2006: American Journal of Human Biology, 18, 776-782) who have previously established relationships between 2D:4D, endurance running and hand grip strength. However there was a significant correlation observed between 2D:4D and competitiveness ($r = .589$; $p > 0.05$). The differences observed in the results may be due to the different samples used by the researchers (trained versus untrained, boys versus males) and the ethnicity of the subjects, as well as the implementation of differing methods of measuring 2D:4D. Future studies should aim to include a bigger sample size to increase statistical power, and examine the difference between subjects with high and low 2D:4D.
Overweight and obesity is a global problem and has reached epidemic proportions in the UK, resulting in 30,000 deaths a year and annual costs to the UK economy of £3.5bn (Haslam et al., 2006: British Medical Journal, 23, 640-642). Being obese or overweight increases risk for cardiovascular disease, Type 2 diabetes (Despres et al., 2004: Nature, 444, 881-887) and mortality (Deckelbaum et al., 2001: Obesity Research, 9, 239-243). Increased BMI during late adolescence and young adulthood is a major risk factor for overweight and obesity in adulthood (Guo et al., 2002: American Journal of Clinical Nutrition, 76, 653-658). Weight regulation in adolescents and young adults is therefore imperative. Physical activity is recommended as an important part of weight management largely since it promotes energy expenditure (Goran et al., 1992: American Journal of Physiology, 263, 950-957), but another possible benefit relates to previous evidence that an acute bout of exercise can elevate fat oxidation for 2 hours post-exercise (Binezm et al., 2002: Medicine & Science in Sport & Exercise, 33, 932-938). However, the optimal mode of exercise for promoting post-exercise fat oxidation remains unclear and is under-researched. The purpose of this study was thus to compare fat oxidation rates following an acute bout of aerobic and resistance exercise. Following ethical approval, 10 healthy (males = 5, females = 5, body mass index 24.37 ± 2.61 kg/m²) 18-19 year-olds volunteered to take part in the study. Following completion of a 10-repetition maximum (10RM) test, participants returned to complete 2 exercise sessions, each followed by a 1-hour resting period. Session 1 consisted of performing 2 sets of 7 exercises (bench press, squats, triceps extensions, bicep curls, calf raises, shoulder press and single arm rows) at an intensity of 10RM. Session 2 consisted of cycling at 55-60% of heart rate reserve until calorie expenditure (kcal) corresponded to that observed during Session 1. Each exercise session was separated by a minimum of 2 days. Fat oxidation (grams per hour, g/h) and caloric expenditure were analysed using a MetaMax 3B portable online breath-by-breath gas analyser. A 2x4 repeated measures ANOVA (Exercise x Time) revealed an increase (P < 0.001) in fat oxidation from 15 to 30 minutes post-exercise (6.08 ± 3.29 to 8.64 ± 4.53 and 4.69 ± 3.39 to 6.40 ± 3.66 g/h following resistance and aerobic exercise, respectively). Fat oxidation rates remained elevated for at least the next 30 minutes (P < 0.001). There was a main effect of exercise type (P < 0.05) but no Exercise x Time interaction effect (P > 0.05) on post-exercise fat oxidation rates. The results of this study demonstrate that resistance exercise promotes post-exercise fat oxidation to a greater degree compared to aerobic exercise in 18-19 year-olds. These findings contradict previous research that has found no significant change in fat oxidation compared to pre-exercise resting levels during the 24 hours after either a single session of aerobic or resistance exercise (Melanson et al., 2002: Medicine & Science in Sport & Exercise, 34, 1793-1800). However, other researchers have reported an increase in post-exercise fat oxidation following a single session of resistance exercise (Binezm et al., 2002: Medicine & Science in Sport & Exercise, 33, 932-938), and more following aerobic exercise (Hansen et al., 2005: Sports Medicine, 35, 363-373). In conclusion, the findings of the present study suggest that an acute bout of resistance exercise increases post-exercise fat oxidation to a greater degree in comparison to aerobic exercise. Resistance exercise may thus be more effective for weight regulation in this age group to aid in the prevention of overweight and obesity in later life, and this warrants further attention.
The potential influence of the ACTN3 gene on athletic performance has received much attention in the scientific literature. A common nonsense polymorphism (577XX) within the ACTN3 gene results in a total deficiency of the AA3 protein (North et al., 1999) and has been purported to influence muscle performance capabilities during activities involving rapid production of high force (MacArthur et al., 2004: Bioessays, 26, 786-795). Studies have shown the detrimental consequences of AA3 absence on post fatigue neuromuscular performance (MacArthur et al., 2008: Human Molecular Genetics, 17, 1076-1086) in animal models, however, no studies to date have investigated fatigue-related neuromuscular performance in human populations in relation to ACTN3 polymorphisms. Thirty six recreationally active European Caucasian males participated in the study. Retrospective genotyping of whole blood via PCR and electrophoresis techniques confirmed that 27 participants possessed the R allele (expression of AA3 protein) and 9 participants were homozygotic for the X allele (AA3 deficient). Estimates of knee extensor volitional static peak force (PF), peak twitch force (PTF), rate of force development and twitch half relaxation time (THalf) were obtained prior to and following i) a fatigue intervention consisting of 4 bouts of 3 x 10 second maximal isometric contractions (45° knee flexion) separated by 5 seconds and ii) a control condition of equivalent duration consisting of no exercise. The control condition was performed first to minimise any carry over effects. Analysis of baseline performance revealed significant slower twitch half relaxation time in the AA3 deficient group (P<0.05) vs. AA3 expression group. Mixed-model repeated measures ANOVA revealed a significant exercise-related impairment in PF of a similar amount in both genotype groups (~18% vs. baseline, F[1, 34] = 33.9, P<0.001) No impairments to other indices of performance were observed following the fatiguing exercise. THalf appears to be lengthened in AA3 deficient individuals. This may support the tenet that AA3 deficiency is associated with fast twitch muscle fibres (Vincent et al. 2007: Physiological Genomics, 32, 58-63). However, the lack of differential change in performance throughout the fatigue protocol between the two groups might suggest that more research into AA3 deficiency is needed with larger cohorts to explore further the issues of fatigue-related muscular performance and ACTN3 genotype.

Polycystic ovarian syndrome (PCOS) is associated with abdominal obesity, insulin resistance and elevated hepatic fat. This adverse cardiovascular disease (CVD) risk profile is associated with ~2 fold increased risk of coronary artery disease (De Groot et al., 2011: Human Reproduction Update, Epub ahead of print). Limited research exists regarding the cardiometabolic effects of exercise in PCOS, and its impact on endothelial function, an early indicator of CVD risk, has not been explored. We hypothesised that PCOS patients would exhibit decreased endothelial function when compared to matched healthy controls and that an exercise intervention would improve endothelial function in PCOS. Following ethical approval, PCOS (n = 9, age 27 ± 2 yrs, BMI 30 ± 2 kg/m²) and healthy control (n = 9, age 27 ± 2 yrs, BMI 29 ± 2 kg/m²) subjects were matched for age and BMI. Brachial artery endothelial function was assessed using flow mediated dilation (FMD). Anthropometric data and cardiorespiratory fitness was also assessed. All PCOS women then completed a 16-week
supervised exercise program (93% exercise compliance), after which all assessments were repeated. Differences between PCOS and controls, and changes with exercise in the PCOS group were analysed using t-tests. Data are presented as mean ± SE. FMD was impaired in PCOS compared to the healthy controls (7.1 ± 1.1 vs. 11.8 ± 1.1%; P=0.02) at baseline. FMD improved following exercise training in PCOS women (7.1 ± 1.1 vs. 10.3 ± 0.8%; P=0.04). Cardiorespiratory fitness improved by 4.7 ml.kg⁻¹.min⁻¹ (P=0.01) and waist circumference tended towards a reduction (98.2 ± 4.5 vs. 94.1 ± 5.5 cm; P=0.09). Favourable effects were observed in BMI and body mass; however these reductions were not statistically significant. The novel finding of this study is that impaired endothelial function in PCOS patients can be improved by 45% with an exercise intervention. These data suggest that the utilisation of exercise as a non-pharmacological management strategy has therapeutic effects on CVD risk in this high risk patient group.

P41O
An echocardiographic cross-sectional investigation into the relationship between left ventricular morphology and VO2max performance of untrained sedentary males and trained male cyclists.
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It is generally accepted that the untrained population are at a greater risk of pathology. Cardiovascular disease is one of the largest epidemics sweeping worldwide, being one of the largest killers and causes of morbidity in the western world. The heart of an athlete represents the sum of left ventricular (LV) structural and functional changes in response to long-term, intensive repetitive bouts of training. Trained individuals show greater oxygen transport with physiological left ventricular hypertrophy (LVH) and overwhelming evidence exists suggesting that the heart of an athlete may differ from that of a non-athlete (Fagard et al., 1984: The British Heart Journal, 52, 124-129). There has been much debate concerning pathological and physiological hearts and LVH in apparently healthy people has generated considerable interest. A particular concern is the nature of LVH of athleticism; is this simply a physiological adaptation to volume loading or has this enlargement been due a diseased state? The diagnosis issues in the past have proven to be fatal. Morganroth et al’s (Morganroth et al., 1975: Annals of Internal Medicine, 82, 521-525) ‘Athletes Heart Hypothesis’ emerged stating that aerobic exercise causes an increase in left ventricular diameter (LVD) but no change in wall thickness. Much of the literature in this broad area was appraised by Naylor (Naylor et al., 2008: Journal of Sports Medicine, 38, 69-90). The purpose of the current study was to examine a potentially linear relationship between VO2max values and cardiac dimensions using echocardiogram m-mode images and a modified Astrand protocol. Following ethical approval, 20 subjects were recruited (untrained inactive males as controls n = 10 aged 25 ± 6.5 years, trained road and time trial cyclists as the experimental group n = 10 aged 26 ± 8 years). Subjects performed a maximal modified Astrand protocol on a Lode bike to determine direct VO2max. Left ventricular m-mode images were taken (Left ventricular diameter LVD, intraventricular septum IVS, posterior wall thickness PW) with calculations made to obtain LV mass. Two methods of body composition were administered to predict % body fat and fat free mass (FFM). All data were analysed at the end of testing and echocardiogram images interpreted blind in a random order by one observer. Data will be analysed using a multiple regression analysis to determine any relationship between predictor and criterion variables. It is anticipated that the findings of this study will reiterate those of Morganroth et al. (1975: Annals of Internal Medicine, 82, 521-525). This research is hoped to build on and provide more evidence for the ‘athlete’s heart’ and provide some normalisation values as reference in the future.
Running the extra mile: Factors relating to increased running economy in distance runners.
Park, O.
MMU Cheshire

Performance in distance running has long been an area of interest for researchers, however empirical evidence relating arm position to performance, that can be applied to achieve a significant improvement in race times, is sparse. The purpose of this study was to provide tangible evidence to improve distance running performance by examining arm position and flexibility on running economy (RE) in 16 recreational distance runners (age 34.4 ± 13.2 years, stature 1.77 ± 0.78m, body mass 73.1 ± 7.9kg). Following Manchester Metropolitan University ethics approval, Oxygen up-take ($\dot{V}O_2$) was recorded during 3 minutes of treadmill running at 3 different speeds. The three running speeds were selected on recent distance race performance and ranged from 8-16km/h. Two digital video cameras were used to record arm position (anterior and lateral views) following identification of key anatomical landmarks (acromion process, olecranon and distal radius), to enable 2D video data analysis. A sit-and-reach test was completed by each participant to measure lower body flexibility. A one way within group ANOVA will be used to analyse differences between $\dot{V}O_2$ and running speeds. A one way between groups ANOVA will be used to analyse differences between all participants $\dot{V}O_2$ and the 3 speeds completed. Pearson’s product moment correlation coefficient will analyse the relationship between RE and lower limb flexibility, findings are expected to be similar to that of Jones (2002: International Journal of Sports Medicine, 23, 40-43). Pearson’s correlation coefficient will also identify relations between $\dot{V}O_2$ and other variables: stature, body mass, BMI, years ran, humeral radial angle range, radial internal displacement, linear arm displacement.

Cardiac Dimensions, Anthropometric and Cardio Respiratory Measures in trained Footballers and Healthy Sedentary Subjects.
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Athletic training is associated with significant increases in cardiac dimensions compared to sedentary individuals (Rawlins et al., 2009: European Journal of Echocardiography, 10, 350-356). However exercise and training causes morphological and physiological changes in left ventricular dimensions, particularly left ventricular mass (LVM), which stem from divergent cardiac adaptations. This has been termed as the ‘athletes heart’ by Morganroth et al., (1975: Annals of Internal Medicine, 82, 521-524) who distinguished two forms of the athletes heart: endurance and a strength trained heart. However this hypothesis has remained controversial within the literature and ambiguity exists around the cardiac morphological adaptations to exercise in athletes (Naylor et al., 2008: Sports Medicine, 38, 69-90). The purpose of this study was to examine the relationships between left ventricular size, anthropometric and cardio-respiratory measures in order to verify the controversial data on the ‘athletes heart’. Further the aim was to determine the importance of scaling cardiac dimensions and its validity through echocardiography scaling practice. Following ethical approval 18 male volunteers (aged 18-24) were selected at random and then divided into two groups. Nine university amateur footballers and 9 healthy sedentary. Subjects underwent a maximal multistage fitness test to assess predicted $\dot{V}O_{2\text{MAX}}$ and static lung volume testing using a microspirometer. Fat free mass (FFM) was assessed by air displacement plethysmyography. Body surface area (BSA) was calculated using the Dubois and Dubois formula (1916). M-mode echocardiography recorded cardiac dimensions in a paresternal long axis view. Left ventricular mass (LVM) was derived from the following calculation proposed by Devereux et
(1984) \[ LVM = 0.8[1.04(\text{SWT+LVID+PWT})^3 - (\text{LVID})^3] + 0.6 \text{ g}. \]

Full data analysis for only 12 subjects, 6 footballers and 6 sedentary subjects has been analysed as remaining data is in progress. Multiple regression analysis revealed no significant correlations from the coefficients as the predictor variables VO\textsubscript{2max}, FFM, BSA, height and lung volume were all greater than the adopted alpha value \( p<0.1 \) due to a backward regression method employed. However the predictor values that remained in the regression equation as the most significant predictors of LVM were lung volume at 0.345 and FFM at 0.121. Overall the inconsistent results showed poor linear relationships between left ventricular size, body size dimensions and cardio-respiratory variables. However this is likely to be a result of the small sample size. It is hoped that the findings of this study will verify the controversial literature on the athlete’s heart and determine the importance of cardiac scaling.

An investigation into the effects that UnderArmour HeatGear and the Fusion Sport UK Triathlon Ice Top has on performance and core temperature while cycling 10 miles in hot conditions.

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Adding a skin tight garment such as HeatGear (HG) and the Fusion Triathlon Ice Top (FIT) to a cyclist increases the amount of conduction that takes place and may reduce the amount of convective heat loss. Conduction occurs when the atoms in an area of high heat, vibrate against the atoms in an area of low heat in an attempt to reach equilibrium. Convection occurs in a similar way amongst fluids; in physical activity convection would occur when sweating. Sweat on the surface of the skin causes convection between the skin and the sweat, evaporation then results in heat being removed from the body as a process of thermoregulation. The HG may reduce evaporation of sweat as Gavin (2003) suggests that the rate of sweat evaporation from the skin is proportional to wind speed. The HG and FIT reduce the amount of air flow against the skin therefore reducing convection. The aim of this study was to determine whether the increase in conductive heat loss outweighs the decrease in convective heat loss in terms of increasing performance and reducing core temperature (Tc), when wearing HG or FIT. HG is designed to ‘wick’ away sweat quickly and remove heat from the body. HG also boasts a compression fit to increase circulation and therefore increase performance by increasing the oxygen supply to the muscles. The manufacturer states that FIT is designed to regulate Tc using ice packs which are strategically placed over the subclavian vein and artery to reduce the temperature of the blood by conduction. There is currently a lack of research which focuses specifically on during exercise cooling in cycling. Drust \textit{et al.} (2004) found that elevated core temperature and muscle temperature negatively affect performance, therefore HG and FIT have the potential to improve performance. Seven recreationally active subjects (age 19.67 \( \pm \) 1.18 years, mass 78.17 \( \pm \) 5.61 kg, stature 181 \( \pm \) 10.47 cm) were used in a repeated measures design, randomised in terms of order for which the three conditions were tested; a normal cycling jersey (C), HG and the FIT. A ten mile time trial (TT) was performed at 36\(^\circ\)C and 30\% humidity (to replicate stage 8 of the Tour de France 2010), with a minimum of seven days between each condition. Performance (time) was measured, and Tc, heart rate (HR), and rating of perceived exertion (RPE) were measured every three minutes throughout the TT. The results are expected to show that Tc is reduced in HG and even more so in FIT in comparison to C. It is also expected that HG and FIT increase performance in comparison to C, in this case Tc may not be reduced due to an increase in performance causing an increase in Tc.
P45O
Effect of acute dietary nitrate supplementation on long distance cycling time-trial performance.
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It has recently been shown that dietary nitrate supplementation improves short-distance cycling time trial performance (Lansley et al: 2011, Medicine and Science in Sport and Exercise, in press). Acute ingestion (2.5-hours prior to exercise) of nitrate-rich beetroot juice (BRJ) resulted in an improvement in 4 and 16.1 km TT performance by 2.8 and 2.7% respectively. The purpose of this study was to determine the effect of acute BRJ ingestion on 50 mile TT performance. With local ethics approval, 7 trained male cyclists reported to the laboratory on four occasions. The first visit was for the completion of a ramp incremental test on an electronically braked cycle ergometer, at a ramp rate of 30W·min^{-1}. Subjects returned to the laboratory on three more occasions to complete the following conditions: 1) a familiarisation TT (10 miles) with no supplementation; 2) a 50 mile TT following ingestion of nitrate depleted-BRJ; 3) a 50 mile TT following ingestion of nitrate-rich BRJ. The second and third visits were presented in a counterbalanced order. Power output and HR were measured throughout all tests. Pulmonary gas exchange was measured throughout the ramp incremental test and 10 mile TT, and every 0-10, 15-20, 25-30, 35-40 and 45-50 miles in the 50 mile TT. Blood [lactate] was determined via a fingertip capillary blood sample every 10-miles. Data will be analysed using a two-way (supplement by time) ANOVA with Bonferroni correction. It is expected that 50-mile TT performance will be improved following acute supplementation of nitrate-rich BRJ, and this will be underpinned by an improvement in the power output:VO_{2} ratio.

P46O
The physiological effects of six sessions of sprint-interval training in a trained cyclist.
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Sprint interval training (SIT) has recently been shown to be as good, if not more effective, at inducing aerobic training adaptations when compared to more conventional, low-intensity ‘endurance’ training, in previously untrained males. Briefly, both VO_{2peak} and time to exhaustion have been shown to increase following just six sessions of SIT (Bailey et al., 2009: Journal of Applied Physiology, 106, 1875–1887; Burgomaster et al., 2005: Journal of Applied Physiology, 98, 1985–1990). Due to the nature of SIT, training sessions are short (~ 20 – 30 min) enabling them to be more easily incorporated into a busy work/life schedule. As such, SIT could prove itself to be a valuable training modality for non-professional or time-restricted athletes. The purpose of this intervention case study was to establish the physiological response of a trained masters cyclist to a two-week period of SIT. Based on the available literate, it was hypothesised that SIT may increase both the VO_{2max} and ‘Critical Power’ (CP) of the athlete whilst speeding the VO_{2} kinetics of moderate-intensity exercise.

Prior to, and following two weeks (six sessions) of SIT the athlete (Age: 45 yrs; Stature: 1.81 m; Mass: 72.5 kg) completed an incremental ramp test (30 W·min^{-1}) to determine VO_{2max}; a moderate-intensity cycling bout at a work rate equating to 80 % Lactate Threshold (LT) and a 3-min all-out cycling test to estimate Critical Power and W’ (a measure of anaerobic work potential). SIT training consisted of 30 s of maximal sprinting, interspersed by 4.5 min of active recovery. Sprints were performed on the athletes own bicycle affixed to a Computrainer ergometer. Resistance on the rear wheel was calibrated and standardised across sessions and power output was recorded throughout each session. The number of 30 s sprints performed per session progressed from 4 to 6 over the two-week period. Typical work completed during two weeks of habitual training for this athlete in the weeks prior to the intervention totalled ~ 9000 kJ. Total work completed over the two-week SIT period totalled
1170 kJ, 13% of his ‘normal’ training volume. Peak power output (PPO) of sprints across the SIT sessions remained reasonably consistent; being highest in session 1 (650 W), lowest in session 5 (623 W) and finishing at 642 W in session 6. \( \text{VO}_{2\text{max}} \) was unaffected by the SIT intervention (pre: 4.28 vs. post: 4.30 L·min\(^{-1}\)). The mean response time of the overall VO\( 2 \) kinetics was unchanged (pre: 13.4 vs. post: 13.2 s), as was as was end power (~ CP) from the 3-min all-out cycling test (pre: 312 W, post: 315 W). W’ also remained unchanged (pre: 10.1 vs. post: 10.0 kJ) but 3-min test PPO increased (pre: 606 vs. post: 635 W) without the time to attain PPO changing (Pre: 8 vs. Post: 8 s). Interestingly VO\( 2 \) at 80 % LT appears to have been reduced following SIT (pre: 2.83 vs. post: 2.73 L·min\(^{-1}\), \( P = 0.00 \)).

Despite a lack of obvious physiological progression in most parameters investigated, there was no retardation in any variable despite an 87 % reduction in training volume. The reduced oxygen cost at the same absolute and relative exercise intensity pre and post SIT should be considered carefully due to the single work transition completed pre and post and the relatively high signal to noise ratio of breath-by-breath online analysis systems. Previous literature suggests SIT may increase CP in untrained individuals. Here, no change in CP was observed in an already trained individual. While a short period of SIT may not obviously prove physiologically beneficial for a trained cyclist, it may provide a viable method of maintaining physiological adaptations when training time is limited. It could also provide a change of training stimulus following, or prior to, a training block; and furthermore, could be an effective method in attempting to ‘fool’ an athlete into adhering to a ‘recovery’ or ‘rest’ period (greatly reduced training volume), without them perceiving the period to necessarily be ‘recovery’ or ‘rest’.

**P47P**

**Effects of 9 weeks resistance training on left ventricular structure.**

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Morganroth *et al.* (1975: *Annals of Internal Medicine*, 82, 521-4) suggested that cardiac hypertrophy, particularly left ventricular mass (LVM) is a result of training through prolonged repetitive volume overload. Strength training is thought to result in increased LVM and left ventricular (LV) wall thickness as a result of the high cardiac afterload associated with this form of training (Morganroth *et al.*, 1975). It is now suggested that with strength training, cardiac hypertrophy is closely associated to fat free mass (FFM), with a positive correlation between body size and cardiac hypertrophy (Naylor *et al.* 2008: *Sports Medicine*, 38 (1), 69-90). The initial adaptations to strength training in previously sedentary individuals are increases in strength through neuromuscular adaptations without hypertrophy occurring (Wilmore *et al.*, 2008: *Physiology of Sport and Exercise*. 4th ed. Champaign, IL: Human Kinetics). This study aimed to see the effects of cardiac afterload without simultaneous increases in FFM on cardiac morphology. 14 untrained male participants (age 18-20 years; height 179.58 ± 7.66 cm; body mass 76.04 ± 17.06 kg) were recruited via opportunity sampling and participated in 9 weeks of progressive resistance training. Intraventricular septal wall thickness (IVS), LV internal dimension (LVD) and posterior wall (PW) measurements were taken throughout the study (weeks 0, 3, 6, 9) via M-mode echocardiography (Vivid 7 GE Healthcare, Fairfield, CT, USA). FFM measurements were taken via Air Displacement Plethysmography (‘BodPod’ – Life Measurements Instruments, Concord, CA, USA). Resting Heart Rate and Blood pressure were assessed via standard techniques (MI-5, Omron). \( \text{VO}_{2\text{max}} \) was assessed using a cortex metaalyzer on a Woodway treadmill at weeks 0, 5 and 9 to ensure improved aerobic capacity was not contributing to cardiac adaptations. Strength was also assessed weekly via bench press and squat one rep max predictions. 7 participants completed the full 9 weeks of training. It is expected that FFM and \( \text{VO}_{2\text{max}} \) will not increase over 9 weeks. Strength in the bench press and squat exercises is expected to increase. Increases are expected in PW and IVS but are not expected in LVD. 9 weeks of resistance training is expected to increase strength but not FFM, this is likely to be
attributed to neuromuscular adaptations (Wilmore et al., 2008). Only changes in PW and IVS are expected, meaning cardiac afterload is ineffective in LVD. Cardiac afterload may not stimulate cardiac adaptations, disagreeing with the work of Morganroth et al. (1975).

P490
A physiological case study of a double amputee marathon runner.
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This case study describes the physiological profile of a runner who has now become World record holder for the lower-limb amputee marathon, at the age of 32 years. The purpose of the study was to examine the physiological adaptations over a two year period and investigate the relationship between selected physiological variables and marathon performance. Following University ethical approval and informed consent, the participant took part in four physiological testing sessions at 6 month intervals during 2009-2011. Anthropometric measures included height and body mass, whilst the physiological measures included running economy, blood lactate threshold, blood lactate turn-point and \( \dot{V}O_2 \) \(_{\text{max}} \). The sub-maximal treadmill exercise consisted of a 5-7 stage incremental speed based protocol at a 0% gradient. Treadmill speeds ranged from 6 – 11 mph (9.7 – 17.7 km·h\(^{-1}\)) and increased by 0.5 or 1 mph (0.8 – 1.6 km·h\(^{-1}\)) each stage. Each stage lasted 4 minutes and expired air was collected in the final minute of each stage using the Douglas bag technique (visit 1-3) and the Cortex Metalyzer 3b (Cranlea, Birmingham, UK) (visit 4). Heart rate was monitored continuously using radio telemetry (PE4000 Polar Sport Tester, Kempele, Finland). A small capillary blood sample was obtained from the finger, at the start of the test and within the 1-minute break between stages, for determination of blood lactate using the YSI 1500 Sport (Yellow Springs, USA). Lactate threshold was defined as the exercise stage the participant completed before the first increase in blood lactate. Lactate turn-point was defined as the exercise stage the participant completed before a steep rise in lactate concentration. Both thresholds were determined visually by two observers independently. The relationship between individual physiological variables and marathon performance over the two year period was described. The results showed that, over the two year period, the participant improved his marathon time from 02:56:45 to 02:42:52 (hh:mm:ss), corresponding to an 8% improvement. During the months leading up to his best marathon performance, the participant increased his body weight by 4.1 kg (which corresponds to an increase of 6%). Absolute \( \dot{V}O_2 \) \(_{\text{max}} \) improved from 3.78 L·min\(^{-1}\) in Feb 09 to 4.27 L·min\(^{-1}\) in Feb 10. This translates to a change in relative \( \dot{V}O_2 \) \(_{\text{peak}} \) of 6.4 mL·kg\(^{-1}\)·min\(^{-1}\) after accounting for the weight of his prostheses. Performance time tended to improve with increases in \( \dot{V}O_2 \) \(_{\text{max}} \). Over the 2 year period there was an improvement in lactate threshold with the treadmill speed at which this occurred increasing from 7 – 9 mph (11.3 - 14.5 km·h\(^{-1}\)). Lactate turn-point was also enhanced over the two year period with the treadmill speed at which the turn-point occurred increasing from 9 – 10.5 mph (14.5 – 16.9 km·h\(^{-1}\)). The increase in lactate threshold and turn-point was associated with an improvement in marathon performance. Running economy at 10 mph (16.1 km·h\(^{-1}\)) improved from Feb 09 (45.6 mL·kg\(^{-1}\)·min\(^{-1}\)) to July 09 (45.1 mL·kg\(^{-1}\)·min\(^{-1}\)) and then decreased slightly in Feb 10 (45.9 mL·kg\(^{-1}\)·min\(^{-1}\)). The slight decline in running economy suggests this variable was not associated with an improved marathon completion time. We conclude that, although running economy has been shown to correlate well with endurance performance in previously published work (Jones, 1998: British Journal of Sports Medicine, 32, 39-43), the physiological variables that appear to be most favourably related with marathon performance in the participant studied in this case were lactate threshold and lactate turn-point.
Six month follow up study of a community based exercise and lifestyle programme for cancer patients post treatment.
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In the UK approximately 280,000 people are diagnosed with cancer each year and current estimates suggest that there are over 2 million people living with cancer in this country (http://www.cancerresearchuk.org/). Higher levels of survivorship are due to better detection methods and more effective treatments. However, intensive treatments can have an impact on physical health and general well being and many people living with cancer experience long term difficulties in readjusting to life after treatment (Ness, 2006: Annals of Epidemiology, 16, 197-205). The aim of this study was to investigate whether a community-based group exercise intervention had long term effects on quality of life (QoL), aerobic and muscular fitness, self efficacy and levels of active daily living. The intervention was a 45 minute circuit session that combined aerobic and resistance exercises and the programme ran for 12 weeks. Participants with different types of cancer who had completed treatment were invited to attend this programme weekly. The exercise each week was followed by a lecture on different topics related to improving lifestyle after cancer. Outcome measures were QoL using the FACT-G, fatigue with FACT-F, lower body strength (tested with sit-to-stand-test), cardiovascular exercise (12min-walk test), 7-day recall of physical activity (using IPAQ), barriers to exercise with the Barrier Self-efficacy questionnaire, task self-efficacy and anxiety and depression with the HADS scale. Tests were done at baseline, 12 weeks and 6 months post intervention. The mean age of participants was 60 years (range 44-70) and adherence to the intervention was 68.2%. Physical activity was significantly increased at 12 weeks (+9602, P= 0.02) but was not maintained at 6 months (-6801MET-minutes, P= 0.049). Lower body strength also improved at 12 weeks and was maintained at 6 months follow-up (+25, P= <0.01). Quality of Life after 12 weeks only showed significant improvement in emotional well-being (+2.5, P= <0.01). After 6 months physical and functional aspects of QoL were significantly increased compared to baseline (+2.8, P=0.006; +4.5, P=0.005) and emotional well-being was borderline significant (+2.2, P=0.005). Qualitative data suggests that the group exercise programme was very motivating and encouraging. Data obtained in the follow up shows that cancer survivors who participate in a lifestyle rehabilitation programme are able to make changes towards a healthier lifestyle and increase physical and psychological functions. However, the study suggests that lifestyle changes at 6 months were not maintained in regards to amount of physical activity per week and this is comparable to other long-term studies (Demark-Wahnefried, 2006: Journal of Clinical Oncoly, 24, 3465-3473).

Assessment of neuromuscular recovery and fatigue following a simulated rugby league match and its affect on a subsequent performance.
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In European elite rugby league, the Easter weekend is a very demanding period of fixtures, where players are expected to play two games with only 72 h recovery in between. There have been growing concerns recently over the impact this intense schedule has on the players’ wellbeing. Therefore the purpose of this study was to assess the neuromuscular recovery and fatigue following a simulated rugby league protocol and its affect on a second simulation trial after a 72 h recovery, designed to mimic the Easter weekend period. Eight university level team sports trained males (21.4 ± 2.2 y, 180.8 ± 6.1 cm, 81.2 ± 8.8 kg, predicted VO2max
46.03 ± 2.03 ml/kg/min) were recruited to take part in the single group, repeated measures design. Following ethical approval, measurements of muscle soreness, isokinetic peak torque of the knee flexors and extensors, squat jump and countermovement jump heights, creatine kinase (CK) activity, and a general well being questionnaire, were recorded at baseline immediately following the first game simulation (0 h), 24 h, 48 h, 72 h, and finally following the second game simulation. Each game simulation lasted 50.5 minutes to replicate the average game time experienced by forwards during a rugby league game. During the two simulated games, average heart rate (HR) and average peak sprint velocity (PSV) were recorded throughout and rating of perceived exertion (RPE) was recorded every quarter of the simulation. Participants reported a lower general muscle soreness following the second simulation (P = 0.003), and an increase in CK. at 0 h (P = 0.003) following the first simulation trial. However, isokinetic peak torque of the knee extensors and flexors and vertical jump performance remained unchanged at all time points (P > 0.05). During the two simulation trials, there was no significant difference in RPE and HR (both P < 0.05); however there was a significant decrease in PSV in the second trial compared to the first (P < 0.05). Despite minimal changes in muscle function, increased perceptual fatigue in the days following the first simulation trial potentially explains the reduction in sprint performance in the second trial. However, the absence of a true physical contact situation in the simulation trial suggests that the movement demands alone of forwards during a rugby league match do not impose fatigue of a magnitude to impair performance in the days following.

P52O
The effects of prior running on cycling performance.
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Prior swimming has been shown to reduce cycling performance (Krieder et al., 1988: Medicine and Science in Sports and Exercise, 20, 385-390) and gross cycling efficiency (Delextrat et al., 2005: Canadian Journal of Applied Physiology, 30, 329-403). Higher pedal cadences during a prior 30 min cycling time trial (TT) has been shown to improve subsequent 3.2 km running performance when compared to low cadences (Gottscha & Palmer, 2002: Medicine and Science in Sport and Exercise, 21, 1518-1522). However the effects of prior running on cycling performance is an area that has received little or no research. The purpose of this study was therefore to investigate the effects of a prior 5 km ventilatory threshold (VT) run and cycling cadence on subsequent 20 km cycling TT performance. With institutional ethics approval, six male recreational athlete volunteers (age 26 ± 5.5 years, stature 183.7 ± 9.3 cm, body mass 82.2 ± 7.8 kg, \( \dot{V}O_2 \)max 62.3 ± 6.7 ml·kg\(^{-1}\)·min\(^{-1}\)) performed an incremental test to exhaustion on a treadmill to determine VT calculated using the ventilatory equivalent method. Following a minimum of 48 h, participants performed a control measure of 20 km laboratory based cycling TT performance on a Kingcycle ergometer. In random order and with at least 48 h separating each trial, participants performed both a 5 km treadmill run at VT followed immediately by a laboratory based 20 km cycling TT at their freely chosen cadence (FCC) on a Kingcycle ergometer and a 5 km treadmill run at VT followed immediately by a laboratory based 20 km cycling TT at 100-110% of their FCC on a Kingcycle ergometer. Measurements of \( \dot{V}O_2 \), \( \dot{V}E \), HR, RER were taken continuously during the cycling TT using a portable metabolic system and RPE was recorded at 4 min intervals. Cycling performance time was reduced by 6% and 4% in prior run FCC and 100-110% FCC cycling conditions, respectively, however this was not significant (P > 0.05). A one-way analysis of variance (ANOVA) for repeated measures with post hoc paired-samples t-tests with bonferroni correction revealed significantly (P < 0.02) reduced power and increased mean RPE in prior running cycling conditions, but no differences were found between prior run conditions. In addition, RER and cadence were significantly (P < 0.02) higher in the prior run 100-110% FCC compared to prior run FCC cycling condition. A two-way ANOVA for repeated
measures with post hoc paired-samples *t*-tests with Bonferroni correction revealed significantly (*P* < 0.02) increased HR at 10 min during the prior run FCC cycling condition when compared to control. The findings of this study suggest that prior running exercise has a detrimental effect on subsequent cycling performance while significantly increasing the perceived effort of exercise. Results of this study show increasing cycling cadence above FCC can reduce performance decrements, albeit not significantly, resulting from performing a prior bout of running. These results suggest similar mechanisms may effect cycling performance following running as effect running performance following cycling (Gottschall & Palmer, 2002). While the mechanisms for a reduction in cycling performance following running remain inconclusive, these results support the notion that residual effects of prior exercise may increase the physiological demands of performing subsequent disciplines and further research is needed (Peeling *et al*., 2005; *British Journal of Sports Medicine*, 39, 960-964).

P53O

Sedentary activities and the prevalence of overweight and obesity.
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There is a popular conception that sedentary activities such as television (TV) and video game (VG) use are causally linked to the increasing prevalence of obesity and decreasing levels of fitness in children. The aim of this study was to investigate the effects of sedentary activities on the increasing prevalence of obesity and decreasing fitness levels in schoolchildren. Children aged 9-10 (*n*=299; 150 boys and 149 girls) participated in the study. A previously validated questionnaire was completed by participants which included information related to the amount of time spent participating in sedentary activities (watching TV, playing VG, internet). Aerobic fitness was assessed using the 20 m multi-stage fitness test (MSFT). BMI status was classified as normal and overweight (Cole *et al*., 2000: *British Medical Journal*, 320, 1-6). Participants classed as obese and morbidly obese were grouped with the overweight individuals. Categories for the sedentary activities were <1 h, 1-2 h and >2 h per day. Results from BMI measurements indicated that 36% of children (35% of boys and 34% of girls) were overweight. There was no association between BMI status and VG duration in boys (*P*=0.797) or girls (*P*=0.684), and watching TV (duration) in boys (*P*=0.247) and girls (*P*=0.582), and BMI status and length of internet use in boys (*P*=0.991) and girls (*P*=0.799). There was a significant (*P*<0.001) difference between BMI classifications and MSFT score. The results of the present study demonstrate that overweight children have lower MSFT scores compared to normal weight children. Studies have indicated that watching TV has no impact on obesity, whereas video game use is strongly related to weight status (Vandewater *et al*., 2004: *Journal of Adolescence*, 27, 71-85). However, the results of the present study indicate that duration of sedentary activities including VG use have no impact on childhood obesity. It is possible that the impact on obesity of sedentary activities only occurs at the highest levels of use (20+ h per week). However, sedentary activity is hard to capture accurately using questionnaires. Future studies should explore the links between sedentary activities and obesity using accelerometer data.

P54P

Deception of precooling temperature and cardiovascular strain upon self-paced 5K running performance in the heat.
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Endurance performance is known to be decreased in the presence of heat stress (Galloway and Maughan, 1997: *Medicine and Science in Sports and Exercise*, 29, 1240-1249). During
self-paced exercise, this has been evidenced by the self-selection of a slower pace to reduce physiological strain and to ensure an end goal is reached. The Central Governor Model has been proposed to alter pacing strategies in the heat through a process of anticipatory regulation during exercise to prevent cellular damage and maintain a physiological reserve (St. Clair Gibson and Noakes 2004: *British Journal of Sports Medicine, 38*, 797-806). With the conscious perception of effort thought to influence exercise performance, but also able to be manipulated by deception (Baden et al., 2005: *British Journal of Sports Medicine, 39*, 742-746), the purpose of this study was to identify whether deception of precooling temperature and cardiovascular strain altered pacing strategy during 5K running in hot conditions. With University ethics approval, six physically active males (age mean 20.3 ± 0.8 years; stature mean 175.5 ± 6.6 cm; body mass mean 75.6 ± 10.3 kg; VO$_{2}$peak mean 53.0 ± 7.3 ml·kg$^{-1}$·min$^{-1}$), each undertook precooling for 20 minutes in temperatures they believed to be 11°C, 14°C and 17°C (actual temperature in all conditions was 14 ± 0.3°C) in a randomised order. During the 11°C trials, participants received feedback that heart rate (HR) was 10 beats per minute (BPM) lower than it actually was, and in the 17°C trial, 10 BPM higher than it actually was. Pre-cooling was immediately followed by a 5K self-paced run on a motorized treadmill in the heat (35.2 ± 0.9°C; 53.2 ± 3.2% relative humidity). Cumulative running times, rectal temperatures, heart rate and subjective scales of ratings of perceived exertion (RPE) and thermal comfort were recorded throughout the 5K-time trial at 1K intervals. Cumulative running times were faster in the 11°C trial compared with the 14°C (2K, 8.3%, P=0.03; 3K, 2.6%, P=0.04) and 17°C (2K, 9.2%, P=0.02; 3K, 3.2%, P=0.02) trial. Heart rate increased significantly with distance in all conditions (P<0.05) and was significantly higher in the 11°C trial compared with the 17°C trial at 2K (3.5%, P = 0.03) and 3K (3.8%, P=0.04). Core temperature, RPE and thermal comfort increased significantly during the 5K-time trial in all conditions (P<0.05), but no differences were found between conditions. Deception of precooling temperature and cardiovascular strain using a lower temperature and heart rate positively altered the pacing strategy during the first 3K of a 5K time trial compared to when a higher precooling temperature and heart rate was perceived.

P560

**Perceived hydration status versus actual hydration status in university rugby league players.**

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It is well established that physiological functions are affected by an individual’s hydration status (Montain et al., 1998: *International Journal of Sports Medicine, 19*, 87-91). In terms of sporting performance, incorrect hydration status has been shown to have detrimental effects (Buono & Wall, 2000: *European Journal of Physiology, 440*, 476-480). A cross sectional study on 12 sports found 79% of athletes to be dehydrated during sporting activity (Volpe et al., 2009: *Journal of Athletic Training, 44*, 624-629). In terms of rugby league specific research, it has been shown that on average players lose 1.3% of body mass during match play, and on some occasions arrive dehydrated (O’Hara et al., 2010: *Applied physiology, Nutrition and Metabolism, 35*, 790-796). To date there is only one study that has combined hydration status with perceived hydration (Decher et al., 2008: *International Journal of Sports Physiology and Performance, 3*, 262-278). A correlation was observed, however this was conducted on youths at sports camps and so was not sport specific. Therefore the purpose of the study was to attempt to fill the void within this area of research and compare perceived hydration status versus actual hydration status of rugby league players. With full institutional ethical approval from Leeds Metropolitan University, 12 male university rugby league players (age 21.4 ± 3.8 years, weight 90.7 ± 11.8 kg) volunteered via a self selected sample, after receiving information sheets and giving fully informed consent to complete the testing over a 5 day period. Participants will complete a hydration knowledge survey 1-day prior to testing. Participants will then have urine osmolality (mOsm/kg) (Osmomat 030-D,
Gonotec, Germany) and body mass measured (SECA 875, Germany) simultaneously, at three time points throughout the day, over a 5 day period. Body mass will be measured to indicate euhydrated body mass. Collection points include first morning samples to indicate total body water (Shirreffs & Maughan, 1998: *Medicine and Science in Sport and Exercise*, 30, 1598-1602) and pre and post-training. Data will be analysed using a correlation analysis in SPSS to evaluate the relationship between perceived hydration status and actual hydration status. It is hoped that this research will identify how accurate personal hydration status knowledge is, which can subsequently be used to provide feedback to the participants.

**P59P**

The influence of lumbar strength on one-repetition maximum squat performance.

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The lumbar muscles are used to keep the pelvis stable during a squat; however, these muscles can be naturally weak (Graves *et al.*, 1994: *Archives of Physical Medicine and Rehabilitation*, 75, 210-215) resulting in excessive trunk lean when using maximal loads. This can cause excessive shearing forces on the spine (Orloff *et al.*, 1997: *International Society of Biomechanics in Sports*, 223-229), potentially increasing the chance of injury (Lawrence *et al.*, 2006: *Journal of American Academy of Orthopaedic surgeons*, 14, 726-735). Therefore the purpose of this study was to investigate the influence of lumbar strength on a 1RM (repetition maximum) free standing back squat. With programme ethics approval 20 male volunteers (age 20.2 ± 3.0 years, stature 177 ± 5.7 cm, body mass 76.6 ± 8.3 kg) familiar with the squat were randomly allocated to a control group (CG) (n=10) or training group (TG) (n=10). All participants completed pre testing of a squat 1RM and MedX (MedX, Ocala, FL) lumbar extension strength test. The TG performed an 8 week strength training intervention using the MedX lumbar extension machine (MedX, Ocala, FL) while the CT performed no squating or lumbar strength training for the same period. Both groups then performed post-test of a 1RM squat and MedX lumbar extension strength test. Data will be analysed using a Kolmogorov-Smirnov test, two way ANOVA and dependant and independent t tests with Bonferroni correction (PASWS Version 18). It is hoped that any strength increases will be similar to those of Carpenter *et al.*, (1991: *Physical Therapy*, 17, 580-588) ranging from 16.4 - 91.6% in lumbar torque at full flexion, and in turn influence squat performance resulting in an improved 1RM. Full data analysis will be undertaken imminently.

**P60O**

Is habitual vigorous physical activity is a more accurate predictor of cardio-respiratory fitness than moderate physical activity?

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Physical activity possesses the potential to have life-changing impacts upon the individuals who partake in at least 30 minutes of moderate intensity physical activity five times per week, by reducing the risks of developing chronic diseases including coronary heart disease, stroke and type 2 diabetes by up to 50% (Department of Health, 2004: *At Least Five a Week*, London: DH). It has been demonstrated that, in England in 2006, just 30% of women and 40% of men met the recommended of physical activity (Information Centre, 2008: *Statistics on Obesity, Physical Activity and Diet: England January 2008*. London: Information Centre). As a validated objective measure of physical activity, accelerometers are an appropriate method of assessing levels of physical activity. One application of accelerometry is to determine how the habitual physical activity patterns of an individual relate to guideline amounts. It is important to know whether achieving the government’s target of 30 minutes of physical activity, five times per week, is more effective at promoting cardio-respiratory
fitness if undertaken at a moderate or more vigorous intensity. The purpose of this study was to determine whether vigorous physical activity predicts cardio-respiratory fitness better than moderate physical activity. Following ethical approval, 8 male volunteers (age 19.1±1.3 years, height 1.64±0.1 m, body mass 66.3±9.6 kg, VO$_{\text{2max}}$ 53.3±17 ml.kg$^{-1}.\text{min}^{-1}$) completed a maximal aerobic fitness test. Participants cycled at 50-70 revolutions per minute (rpm) on an electronically braked Monark cycle ergometer. The workload was increased at three minute intervals according to the participant’s sex. The participant was instructed to continue until exhaustion. An exhaustive effort was considered to be when the participant reached a heart rate of > 185 beats per minute and when the researcher observed they could no longer continue (Hansen et al., 1989: European Journal of Applied Physiology and Occupational Physiology, 58, 618-624). Participants wore an online breath-by-breath indirect calorimetry device (MetaMax3B) during the test to determine maximal oxygen consumption. To determine levels of habitual physical activity, participants were asked to wear an RT3tri-axial accelerometer for seven consecutive days. The activity levels were split into four categories according to the number of counts recorded by the accelerometer per minute; sedentary <288, light 288-959, moderate 970-2332 (≥3 ≤6 METs), and vigorous >2333 (≥6 METs) (Rowlands et al., 2004: Medicine and Science in Sports and Exercise, 36, 518-524.). All data were analyzed using SPSS Version 17.1 software and the statistical test employed was a Multi-Variate Regression analysis. The results revealed that neither habitual vigorous physical activity ($R^2 = 0.11 \ (1,5) \ p <0.05$) or moderate physical activity ($R^2 = 0.15 \ (1,6) \ p <0.05$) was significantly correlated with cardio-respiratory fitness. These results suggest that whilst there is no significant relationship between habitual physical activity and cardio-respiratory fitness, vigorous intensity physical activity is a stronger predictor of cardio-respiratory fitness than moderate activity. Previous studies such as Gutin et al. (2005: American Journal of Clinical Nutrition, 81, 746-750) have demonstrated that vigorous physical activity is a better predictor of cardio-respiratory fitness in adolescents. Future studies should incorporate a larger sample size, using both sexes. It is evident that this area requires more detailed study and the concept of repeated vigorous physical activity sessions related to cardio-respiratory fitness should form the basis of further examination.

P61P
A comparison of time in health enhancing physical activity intensities during a school day assessed using two methods in 11 to 16 year old children.
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Evidence suggests that physical inactivity in adolescence is a strong indicator that can predict total abdominal obesity in young adulthood (Pietiläinen et al., 2008: Obesity, 16, 409-414). Recommendations now state that children should accumulate at least 60 minutes of MVPA daily (WHO, 2010: Global Recommendations on Physical Activity for Health. Geneva: Switzerland). There are many methods that are used to measure the amount of physical activity in a field setting. Accelerometers offer an accurate and feasible method of gathering physical activity in free-living individuals and are becoming easier to use and buy, thus prompting an increased use in research. Due to advances in technology, measuring heart rate has become easier and is therefore also becoming a popular method to gain insight into physical activity intensity in a free-living environment (Achten & Jeukendrup, 2003: Sports Medicine, 33, 517-538). The purpose therefore was to compare time spent in health enhancing physical activity intensities and achievement of method-specific physical activity guidelines assessed using heart rate monitoring and accelerometry in 11 to 16 year old school children. Following ethical approval, 42 children (Male=20, Female= 22; Age 13.4±1.7yrs; height 156.9±8.7cm; weight 59.7±15.4kg) completed the study. The accelerometers and heart rate monitors were fitted before school worn throughout the school day. Time spent with accelerometer counts above the health enhancing physical activity threshold of 58 count per 5
The purpose of this study was to assess the validity and reliability of a treadmill graded exercise test (PRET) using the 6-20 Ratings of Perceived Exertion Scale (RPE; Borg, 1998: Borg’s Perceived Exertion and Pain Scales. Champaign Il: Human Kinetics). However, the validity and reliability of PRET during treadmill-based exercise in sedentary compared to active participants is yet to be confirmed.

The purpose of this study was to assess the validity and reliability of a treadmill-based PRET to predict $\dot{V}_O2max$ in active and sedentary participants. The accuracy of predicting $\dot{V}_O2max$ from PRET was also compared to $\dot{V}_O2max$ values predicted from submaximal $\dot{V}_O2$ RPE and HR relationships during submaximal stages of the graded exercise test (GXT). Seventy-five
participants (40.0±13.8y) were grouped as either active (n=49) or sedentary (n=26), depending on whether or not they met current physical activity guidelines (≥30 mins moderate-intensity exercise on ≥3 days per week). With informed consent and institutional ethical approval, participants completed two PRETs on a treadmill. Each PRET required participants to change the treadmill speed or incline to correspond to RPEs of 9, 11, 13 and 15. A GXT was also performed to allow the direct measurement (DM) of \( \dot{V}O_2\max \). To predict \( \dot{V}O_2\max \) from both PRET trials, average \( \dot{V}O_2 \) from the last 30 s of each intensity (RPE 9, 11, 13, 15) were extrapolated to RPE 19 and 20 using regression analysis. \( \dot{V}O_2\max \) was also predicted by extrapolating the \( \dot{V}O_2 \) and corresponding HR between RPE 9 and RPE 15 to the age-predicted maximal HR (HR\( \max_{\text{pred}} \)) during the GXT. A two-factor ANOVA (group (2) x method (4)) revealed no significant interaction of group x method on \( \dot{V}O_2\max \) (F(1,73)= .355, P>0.05). The expected difference (F(1,73)=106.90, P<0.001) in \( \dot{V}O_2\max \) between active (53.9±7.6 ml/kg/min) and sedentary (34.4±7.0 ml/kg/min) participants was observed. However, there was no difference (F(10,89,26,1)=416) in \( \dot{V}O_2\max \) between assessment methods (DM, PRET 1, PRET 2, HR\( \max_{\text{pred}} \)) for the active (53.9±7.5; 54.3±7.4; 52.9±8.1; 53.3±10.0 ml/kg/min, respectively) and sedentary participants (34.4±7.0; 34.1±10.2; 34.2±9.6; 34.1±9.0, ml/kg/min, respectively). These results confirm i) the PRET protocol is a valid method of predicting \( \dot{V}O_2\max \) in both active and sedentary individuals during treadmill exercise, ii) the PRET protocol offers an accurate and practical alternative to the HR\( \max_{\text{pred}} \) method for predicting \( \dot{V}O_2\max \).

P63P
Assessment of the efficiency of two strategies for high-altitude trekking: Slow plod vs. rush and rest.
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Exercise at high-altitude has been linked with an increased risk of acute mountain sickness (AMS) (Roach et al., 2000; Journal of Applied Physiology, 88, 581-585) and is performed intermittently whenever the intensity is high or when working capacity is reduced e.g. at high-altitude (Pugh, 1958: Journal of Physiology, 141, 233-261). Work efficiency (total oxygen cost (\( \dot{V}O_2 \)) of work) is lower in intermittent compared with continuous exercise (Edwards et al., 1973, Journal of Physiology, 234, 481-497), however to-date this has not been documented at altitude. Our study assessed the efficiency of two high-altitude trekking strategies; 1) a slow, steady continuous walk (SS), and 2) an intermittent high-speed walk (rush) and rest (RR). Ten high-altitude naive volunteers (age 21 ± 1.4 years; height 171 ± 12 cm; body mass 70.1 ± 15.2 kg; peak walking speed (Wpeak) 7.4 ± 0.6 km h\(^{-1}\)) completed two experimental sessions on a powered treadmill, following a crossover design, in a normobaric hypoxic chamber at a simulated altitude of 3,500 m (O\(_2\) 13.5%; CO\(_2\) 0.04%; N\(_2\) balance; ambient temperature 10°C; relative humidity 20%). Conditions; 1) SS: a 30 min walk at 50% Wpeak; 2) RR: a timed walk to complete SS distance, at Wpeak, with participants resting as required. Breath-by-breath \( \dot{V}O_2 \) was measured and RPE and breathlessness ratings taken during exercise and whole blood lactate 3-min post. Data were analysed with paired t-tests and Wilcoxon signed-rank tests as appropriate. There was no significant difference in the time to complete the 30-min distance between conditions (1714.84 ± 285.59 s). Total \( \dot{V}O_2 \) was greater for the RR condition (RR: 5012.9 ± 1748.6 L; SS: 3327.5 ± 1625.3 L; P = 0.017) as were RPE and breathlessness (RPE: RR: 16.7 ± 1.1; SS: 10 ± 1; breathlessness: RR: 5.6 ± 0.9; SS: 1.7 ± 0.7; P = 0.012). Lactate concentrations were higher for the RR condition (RR: 7.20 ± 1.20 mmol·L\(^{-1}\); SS: 1.21 ± 0.50 mmol·L\(^{-1}\); P < 0.001). The decreased RR efficiency and greater RPE compared to the SS condition in hypoxia agrees with those data reported in normoxia, and suggests that the latter strategy is a more efficient approach when high-altitude trekking that may reduce the risk of AMS.
P64O
Time course change to endothelial-dependent, nitric-oxide independent vascular function and capacity following an 8-week exercise program with shear rate modulation in one limb.
Digby Bratton, N., Birk, Gurpreet., Dawson, E., Cable, N., Thijssen, D., & Green, D.
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The impact that exercise training has on vascular function and capacity has been widely researched over the last number of years. This interest in vascular function and structure is due to the links between the non-invasive assessment of vascular function and clinically predicting cardiovascular events. Previous studies demonstrated that a measure of endothelium-dependent dilation of conduit arteries, but also the peak blood flow response, provides valuable prognostic information for the development of future cardiovascular diseases. Although shear stress is hypothesised to mediate vascular adaptations to exercise, cycling exercise also mediates systemic effects that may contribute to vascular adaptations to exercise. The purpose of this study was to examine bilateral brachial artery diameter and blood flow response to 5-minutes ischemic exercise, before during and after an eight week cycle exercise programme. To examine the role of shear stress during cycling training, we will unilaterally manipulate the shear stress response during each exercise session. With ethical approval granted by Liverpool John Moores ethics committee, 9 healthy males (age 22±1.4 years, body mass 75±16.0 kg, height 1.77±0.1) took part in an 8-week exercise programme consisting of 30-minutes on a cycle ergometer working at 80% Heart Rate Maximum(HRM) (208-0.7 x AGE, Tanaka et al(Journal of the American College of Cardiology, 7(l), 15) 3 times a week. Measurement of peak diameter and blood flow responses were performed at weeks 2, 4, 6 and 8. A cuff was placed around one forearm and inflated to 60 mm Hg during the exercise protocol to reduce mean Shear Rate (SR) in the cuff arm. This provides a within subject comparison and allows for assessment of the effect of exercise training on vascular adaption as well as the role of shear stress for these adaptations. Peak diameter and blood flow responses are assessed by examining the brachial artery using duplex ultrasound before and for 3 minutes after a 5-min period of ischaemic exercise. Data will analysed using a two-way repeated measures ANOVA to examine the effect of time and group (cuff or uncuffed) on Flow Mediated Dilation plus ischaemic exercise (FMD+IX) and also the interactions between time group and FMD+IX. Findings from the study hope to show that exercise induces functional and structural improvement in vasculature and indicate that shear stress is the principle hemodynamic stimulus that determines adaptations in vasculature.

P65O
Is raised intracranial pressure the cause of acute mountain sickness?
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Acute mountain sickness (AMS) is a common ailment amongst unacclimatized lowlanders who ascend to high altitude. Common symptoms include headache, nausea & vomiting and gastrointestinal upset; however its exact aetiology is not entirely understood. Acetazolamide (AZ) is a drug used to prevent AMS. Its primary mechanism is thought to be the reduction of intracranial pressure (ICP) and therefore attenuation of high altitude headache via stimulation of hyperventilation. Ocular ultrasonography of optic nerve sheath diameter (ONSD) is a surrogate marker of ICP. Using AZ as an experimental manipulation the present study aimed to establish the effect of altitude on ONSD, and determine whether this predicted AMS. Thirteen healthy, active non-acclimatised adults (M=9, F=4; mean age 24.3 ± 3.9 yrs), had sea-level ONSD and AMS measured. 250 mg/bid AZ was prescribed to the treatment group (N=7) and all participants were then exposed to five days of intermittent hypoxia. ONSD and AMS (Lake Louise Scale; LLS) were measured again at 3,730 m. ONSD increased with
altitude (5.0 mm to 5.9 mm; $F_{1,11}=12.59$, $P=0.05$), but there was no interaction between AZ and altitude ($F=1.54$, $P=0.240$). No one developed AMS (max daily mean = 0.75) and thus there was no effect of altitude on AMS ($F_{1,12}=2.48$, $p=0.144$). LLS headache scores alone also failed to predict ONSD. Minimal evidence was presented that raised ICP causes AMS or high altitude headache. The main limitation is that AZ did not manipulate AMS or headache. This may be due to a lack of power however, recent data suggests that while ICP increases with altitude, it does not differentiate between those with AMS or headache and those without. In conclusion, no evidence was presented that ICP causes high altitude headache.

P66O
The effect of altitude acclimatisation on the thermoregulatory response to a cold and hypoxic environment.
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Acute hypoxic exposure has been shown to alter thermoregulation to the cold which may increase the predisposition to cold injuries, such as hypothermia and frostbite. This is most evident where core temperature is shown to decline more quickly in combined hypoxia and cold stress, compared with cold alone (Cipriano and Goldman, 1975: *Journal of Applied Physiology*, 39, 796-800). Additionally acute hypoxia has been shown to alter thermal sensation which may also increase predisposition to cold injury (Golgi et al., 2004: *International Archives of Occupational and Environmental Health*, 65, 147-155). Sea level cold exposure, following altitude acclimatization, indicates hypoxic adaptations alter thermoregulation (Blatteis and Luther, 1976: *Journal of Applied Physiology*, 41, 848-858). Presently it is unclear what the effect of acclimatisation to hypoxia on thermoregulation and sensation is, in a combined cold, hypoxic environment. The aim of the present study is to determine the effect of acclimatization to hypoxia upon the thermoregulatory system during a cold hypoxic exposure. Seven healthy males completed a cold air test (CAT) in a normobaric environmental chamber, set at 0ºC (±0.7ºC) and 12.4% oxygen (±0.2%: simulation ~ 4000 m), for 2 hours. The CAT was undertaken pre (preE) and post (postE) a 17 day mountaineering expedition to the French and Italian Alps, reaching a maximum height of 4559 m. Throughout the CAT, rectal temperature ($T_{rec}$), skin temperature ($T_{sk}$), thermal sensation, oxygen consumption ($V_{O2}$), oxygen saturation, heart rate and shivering intensity were measured. Haemoglobin was assessed pre and post-expedition. Post expedition haemoglobin (preE 14.3 ± 2.1, postE 15.9 ± 2.1 mmHg; $P = 0.002$) and oxygen saturation during the CAT (preE 86 ± 9, postE 90 ± 7 %; $P = 0.034$) were indicative of altitude acclimatization. Two-way repeated measures ANOVA were conducted for each of the following variables. Thermal sensation indicated participant’s sensitivity to the cold hypoxic environment was altered during the beginning of the CAT (preE 1.45 ± 0.31, postE 1.51 ± 0.32; $P = 0.00$). Core temperature decreased throughout the cold exposure ($P = 0.00$) with no significant effect of acclimatisation (preE 36.73 ± 1.84, postE 36.62 ± 0.46; $P > 0.05$). However, $T_{sk}$ was significantly lower postE (preE 27.67 ± 0.98, postE 26.90 ± 1.12; $P = 0.011$) which may indicate reduced blood flow and reduced heat loss. Compared to preE, $V_{O2}$, as an indication of metabolic heat production, was significantly increased ($P = 0.018$), whereas shivering intensity was reduced postE (preE 2.07 ± 0.29, postE 1.70 ± 0.40; $P = 0.001$). This may indicate an increased reliance on non-shivering thermogenesis (NST). In conclusion, following a 17 day mountaineering expedition altitude acclimatization altered thermal sensation, reduced skin temperature and indicated an increased reliance on non-shivering thermogenesis, due to a reduction in shivering intensity and the maintenance of core temperature.
P67O
Impact of 8-week cycling exercise training and shear modulation on forearm microvascular nitric oxide dependent vasodilation in humans.
Atkinson, C., Birk, G., Dawson, E., Cable, N., Thijssen, D., & Green, D.
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Exercise training is associated with a beneficial cardioprotective effect, which may relate to the direct effects of exercise on vascular function. For example, exercise training leads to an improvement in microvascular function. Recent evidence suggests that the mechanism explaining these improvements may relate to repeated increases in shear stress. Shear stress up-regulates NO release from the vascular endothelium and induces smooth muscle cell relaxation. This in turn increases vasodilation thus increasing forearm blood flow. Green et al. (2010: Journal of Physiology, 588, 1571-1577) observed an improvement in NO-dependant response as a result of repeated elevations in shear stress, through exposure to forearm heating. Therefore the purpose of the current study was to determine the effect of exercise training on forearm microvascular endothelial function and whether these adaptations are associated with the episodic increases in shear stress during training. Following ethical approval, nine healthy young men were exposed to 8 week exercise training, which consisted of 30 min cycling bouts, 3 times per week at 80% maximum heart rate. During exercise, a blood pressure cuff around one forearm was inflated to 60 mmHg to unilaterally attenuate the shear rate pattern. Bilateral forearm NO-dependent vasodilation was examined at 0, 4 and 8 weeks of exercise training. Forearm microvascular NO-dependent vasodilation was examined using laser Doppler probes to record red blood cell flux in response to heating. Heater disks were used to incrementally heat the skin from 33 °C to 42 °C with step of 0.5 °C per 2 min 30 s. Blood pressure data was used to calculate the cutaneous vascular conductance. Data was analysed using a two-way ANOVA to examine the effects of exercise training on forearm skin blood flow responses to heating and whether these changes differed between the cuffed and non-cuffed arm. A two-way repeated measures ANOVA revealed no significant main effects across the 8 week training period (P = 0.13) nor between the cuffed and the uncuffed arm (P = 0.62). Similarly, there was no significant cuff*time interaction effect (P = 0.66). However, relevant post-hoc analysis revealed a significant decrease in CVC in the uncuffed arm (P = 0.03) but not in the cuffed arm (P = 0.49). Similarly, ANOVA results on one-minute averaged CVC data during the 70 min heating stimulus revealed a decreased CVC-response to local heating after 8 weeks training in the uncuffed arm (P = 0.00), whilst such change was not observed in the cuffed arm (P = 0.98). Using this information, results indicated that training induced an attenuated increase in the skin blood flow response to local heating. These changes in skin blood flow may be as a result of a more efficient blood flow response to the same heating response over a training period. Moreover, these adaptations in CVC responses to local heating did not occur when the shear stress stimulus was attenuated by cuff inflation on the contra-lateral arm. This suggests that shear stress has an important role in the adaptations that can be observed in the skin blood flow responses to local heating after exercise training in healthy individuals.

P68O
Impact of repetitive same day prolonged exercise bouts on cardiac function and markers of cardiac damage.
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Prolonged strenuous exercise has been associated with a decline in cardiac function and the appearance of biomarkers of cardiac cell damage during recovery. No study to our knowledge has assessed the impact of repeated bouts of prolonged exercise during a 24 hour period, and the cumulative effect of functional changes and appearance of biomarkers of damage. With limited recovery time any changes are unlikely to return to baseline, resulting in an
accumulation of biomarkers of cardiac damage, and a progressive increase in functional alterations. This information is important for athletes and military personnel training multiple times throughout a day. Seven endurance trained athletes (Mean ± SD; age 21.1 ± 1.9 years, stature 179.3 ± 8.7 cm, body mass 82.4 ± 15.6 kg) completed three one hour cycle exercise bouts at an exercise intensity of 90% of their ventilatory threshold within a 24 hour period after ethical approval being obtained from the local (LJMU) ethics committee. There was a 3 hour recovery time between each bout. Echocardiographic scans of cardiac function, and venous blood samples for cardiac biomarkers were obtained prior to and immediately after each exercise bout as well as 3 hr after the final bout. Echocardiograms were analysed to determine peak septal, peak left ventricular (LV) free wall and peak right ventricular (RV) free wall tissue velocities as well as peak filling velocities during early (E) and atrial (A) diastole. Venous blood samples were analysed for concentration of cardiac troponin T (cTnT). Variables were analysed using a two way repeated measures ANOVA, and cTnT analysed descriptively. We hypothesise that successive exercise bouts will result in an accumulation of cTnT and further reductions in LV and RV wall velocities as well as greater perturbations in E and A flow velocities.

P69O
Artery remodelling in elite athletes and spinal cord injury patients: Insights into localised and systemic adaptation.
Rowley, N.J., Thijssen, D., Dawson, E., George, K., Whyte, G., & Green, D.J. Liverpool John Moores University

The effects of exercise on conduit artery structure are directly relevant to explaining the cardiovascular benefits of exercise. However, the impact of training on arterial remodelling in humans has not been fully characterised. The purpose of this study was to examine localised versus systemic effects of chronic exercise training on arterial wall thickness (WT) and diameter. We recruited distinct groups of elite athlete including lower limb endurance athletes (LL, n=13), upper limb canoe paddlers (UL, n=12) and matched healthy inactive controls (C, n=16). We also included spinal cord injured patients (SCI, n=9) with no motor/sensory innervations of the lower limbs (i.e. thoracic lesion), but full control of the upper limbs. Carotid, brachial and superficial femoral artery characteristics (baseline and peak diameter and wall thickness) were assessed in all groups using high resolution duplex ultrasound. Body composition was assessed using DXA. Brachial diameters were significantly larger in UL compared to C (4.9±0.8, 4.1±0.4, respectively P<0.01). In response to a maximal dilator stimulus UL responses were significantly different to C (5.6±0.9 versus 4.8±0.6, P<0.05). In the superficial femoral artery, baseline diameter in SCI was significantly smaller compared to UL, LL and C (4.6±0.9 vs 6.8±0.7, 7.1±0.6, 6.6±0.5, P<0.01). Athletic groups (UL-LL) demonstrated a lower wall thickness than C and SCI subjects across carotid (UL 542±59, LL 524±38µm versus SCI 657±67µm, C: 618±74µm, all P<0.05) and brachial (CP 346±96, LL 280±92 versus SCI 488±69, C 516±101, all P<0.05) arteries. The superficial femoral artery wall thickness was also greater in athletes than controls (UL 475±64, LL 498±57 vs. C 634±155, all P<0.05). Wall-to-lumen-ratios were lower in both athletes groups in all arteries compared to SCI and C. This is the first study in humans to attempt to uncouple localised and systemic effects of shear and pressure signals on artery size and wall thickness in response to exercise. These findings suggest that remodelling of the arterial wall occurs systemically in response to exercise training, unrelated to exercise type, in humans whereas localised effects are evident in arterial diameter of the predominately trained or used limb. These findings have implications for our understanding of the anti-atherogenic effects of exercise training in humans and the haemodynamic mechanisms involved.
Impact of disrupted sleep on cutaneous thermal hyperaemia assessed by laser Doppler flowmetry in healthy young males.

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Disrupted sleep has been associated with an increased incidence of adverse cardiovascular and metabolic disorders in humans. A possible mechanism for this increased risk is endothelial dysfunction, caused by impaired nitric oxide (NO) availability. Despite this, relatively few studies have examined the effects of acute sleep disruption (SDIS) upon vascular function. The primary objective of the present study was to assess the impact of 72 hours of disrupted sleep on skin microvascular reactivity in response to a localized heating (42°C) challenge. SDIS was hypothesised to reduce microvascular function in comparison to normal sleep (CON). Cutaneous thermal hyperaemia was assessed on the forearm in 11 healthy young males (age ± SD) (20.5 ± 1.5) using an integrating-probe LDF (Periflux 5000). The test was performed on two occasions, separated by 7 days in a randomised cross over design. On one occasion the test was performed following 3 nights of SDIS (2 inconsecutive hr/night). On the other, the test followed three nights of CON (8 hr/night). Energy, fluid provision and daily physical activity were consistent between the trials. The baseline, initial peak (IP) and plateau phases (PP) of the data traces were identified. Measurements of skin blood flow were divided by mean arterial pressure to calculate cutaneous vascular conductance (CVC) in APU mmHg⁻¹. Endothelium-dependent (PP) and -independent (IP) CVC were normalized to baseline (%CVCBL): [(CVC minus baseline CVC/baseline CVC) x 100]. Following SDIS; baseline CVC was elevated compared to CON (0.19 ± 0.08 vs. 0.13 ± 0.04 respectively; mean ± SD; p <0.05, paired t test); IP was lower at 1254 ± 443 %CVCBL vs. 1546 ± 625 %CVCBL (NS); PP was lower at 1157 ± 443 %CVCBL vs. 1613 ± 646 %CVCBL (p <0.05). The present observation that acute exposure to 3 nights of disrupted sleep significantly reduced the endothelium-dependent response has important implications for persons with disrupted sleeping patterns. Endothelial dysfunction is considered to be an early and major promoter for atherosclerosis and thrombosis and consequential cardiovascular diseases.

Effect of Exercise Induced Stress on leukocyte hsp72, GRP78, hsp90α and GRP94 mRNA expression.

Muscle Cellular and Molecular Physiology Research Group and Applied Sport and Exercise Physiology Research Group, ISPAR Bedford

Heat shock proteins (HSPs) are a group of proteins which are ubiquitously expressed within leukocytes and which have a key function in both the immune and inflammatory response to exercise. They function to prevent a loss of protein activity caused by various physiological stressors such as exercise, heat and oxidative stress (Noble et al., 2008: Applied Physiology Nutrition and Metabolism, 33, 1050-1065). Leukocyte expression of HSPs is important for maintaining leukocyte homeostasis and function during the immune and inflammatory response however there is little information regarding the effect of mechanical stress (exercise induced muscle damage) on expression across the whole range of HSPs. The aim of this study was therefore to determine whether metabolic stress, mechanical stress, heat stress or heat plus mechanical stress altered leukocyte HSP gene expression. With university ethical approval 16 physically active students (mean ± SD; age 19.86±2.53 y, body mass 71.33±8.66 kg, VO2max 55.49±5.94 ml.kg⁻¹.min⁻¹) participated. Using an independent groups design, participants were randomly allocated to either a temperate (20°C, 50% RH) or heat group (30°C, 50% RH). In a random order participants in the temperate group completed 30 min
running (1% gradient) at lactate threshold (LT; metabolic stress/control condition) and 30 min downhill running (-10% gradient) at LT (mechanical stress). Participants in the heat group completed the same protocols in the heat (heat stress and heat plus mechanical stress). Core temperature, oxygen consumption, heart rate and subjective RPE & ratings of thermal sensation (TS) were measured continuously during exercise. Venous whole blood samples were obtained for determination of HSP gene expression along with measurements of muscle soreness (pressure sensitivity and subjective ratings) immediately before, immediately after, 3hrs after and 24 hrs after exercise. RNA was extracted via the Trizol method and gene expression was determined using Quantitative RT-PCR. Initial results from N = 4 in each condition indicate that heat stress and heat plus mechanical stress induced an upregulation of cytoplasmic HSP72 (334.7±217% and 371±128%, respectively), HSP90α (222±102% and 344±183%, respectively), endoplasmic GRP78 (218±153% and 239±17%, respectively) and GRP94 (184±89.5 and 602±126.6%). The elevated core temperature in the heat plus mechanical stress (38.82±0.2°C Vs 39.27±0.32°C) condition may have contributed to the increased HSP gene expression.

P73O  
The Effects of Up-regulating or Down-regulating the Cardiac Transcription Factor, GATA-4 on Endogenous Cardiac Stem Cell Biology and Regenerative Potential.  
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Since the identification of a resident population of stem cells within the mammalian heart (Beltrami et al., 2003: Cell, 114, 763-776) the biology and regenerative capacity of the adult heart has been questioned, opening a new exciting field for cardiovascular basic science and medical applications. c-kit is the stem cell growth factor receptor and is expressed on the surface of several stem cells. Exercise training increases cardiac IGF-1 expression, endogenous c-kit positive (c-kitpos) cardiac stem cell (eCSC) number, differentiation and new cardiomyocyte formation. eCSCs expressing high levels of the cardiac transcription factor GATA-4, exert a pro-survival 'paracrine' effect on adult cardiomyocytes through induction of the IGF-1R-dependent signalling pathway (Kawaguchi et al., 2010: PLoS ONE, 5, e14297). Moreover, eCSCs with increased GATA-4 expression show enhanced differentiation into cardiomyocytes, suggesting that this eCSC subset has a potent cardiac regenerative potential (Miyamoto et al., 2010: Stem Cells and Development, 19, 105-116). These data identify a specific eCSC type for potential use in cardiac repair and regenerative therapies. The purpose of this study was to genetically manipulate the expression of GATA-4 in c-kitpos CSCs and establish two stable cell lines which were either high or low for GATA-4 expression. These CSC lines could then be used to test for a cause-effect relationship among GATA-4 expression, regenerative potential, IGF-1 secretion and the paracrine protective effects of c-kitpos eCSCs on adult cardiomyocytes. To this aim, c-kitpos eCSCs were isolated from the adult rat heart through retrograde enzymatic perfusion and cultured in complete medium (DMEM, 10% ESQ-FBS, 10 ng/mL LIF, 5 U/L EPO, 1% penicillin-streptomycin, fungizone and gentamicin) at 37°C in 5% CO2 incubator. A clonal c-kitpos eCSC line was generated from the parental line by seeding a single cell into wells of 96 well plates. This eCSC clonal line (named C5 c-kitpos CSCs) was characterised for stem cell properties, GATA-4 expression and differentiation potential. GATA-4 expression in C5 c-kitpos CSCs were genetically manipulated to produce over-expressing GATA-4 CSCs or under-expressing (knock down) GATA-4 CSCs. These GATA-4 manipulated CSC lines were evaluated for their GATA-4 expression through Western blot, immunocytochemistry and qRT-PCR. The GATA-4 manipulated CSC lines were characterised over culture time for the principle properties of stem cells: clonogenicity, self-renewal and multipotency. The phenotypic and genomic stability of each CSC line was also assessed. C5 c-kitpos CSCs that underwent GATA-4 knock-down (GATA-4-kd) showed decreased GATA-4 expression at the gene and protein level, compared to C5 c-kitpos CSCs that underwent GATA-4 over-expression (GATA-4-oe)
and the non-transfected parental C5 c-kit<sup>pos</sup> CSCs. On the other hand, GATA-4<sup>−ve</sup> showed increased GATA-4 expression at the gene and protein level, compared to GATA-4<sup>−ve</sup> and the non-transfected parental C5 c-kit<sup>pos</sup> CSCs. GATA-4<sup>−ve</sup> and GATA-4<sup>+ve</sup> CSC lines showed significant differences in stem cell properties, while respectively maintained a stable genomic and phenotypic character over culture time. In differentiation medium, GATA-4<sup>−ve</sup> CSCs showed enhanced differentiation into cardiomyocytes compared to GATA-4<sup>−ve</sup>CSCs. In conclusion, manipulating the expression of the cardiac transcription factor, GATA-4 in c-kit<sup>pos</sup> CSCs alters their cardiomyocyte differentiation potential and suggests GATA-4 as a key factor in defining the optimal cell type for use in cardiomyocyte regenerative therapy. Ongoing work is investigating the cause-effect relationship between GATA-4 expression, IGF-1 and the pro-survival effects of c-kit<sup>−ve</sup> eCSCs on adult cardiomyocytes.

P74O
The effect of three different pacing strategies (power profiles) on oxygen uptake kinetics (VO<sub>2</sub>) during 62 s cycle sprints.

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An initial all-out start increases VO<sub>2</sub> response kinetics, important in delaying premature fatigue by 'sparing' the anaerobic systems for the penultimate sprint finish in middle distance events (Jones et al., 2008: Scandinavian Journal of Medicine and Science in Sports, 18, 615–626). Faster VO<sub>2</sub> kinetics are also reported by de Koning et al. (1999: Journal of Science and Medicine in Sport, 2, 266-277) in long sprint simulations. However, all-out starts also include the risk of premature fatigue, which is detrimental to performance towards the end of a race. The aim was to inspect the effects of three different power profile distributions on VO<sub>2</sub>. Profile 1 involved a progressing decrease in power following an all-out start. Profiles 2 and 3 required a depressed yet demanding initial power, with an almost steady power during the final phase. Following ethical approval, nine active males (mean ± SD): age 20.4 ± 1.0 years; body mass 77.1 ± 12.3 kg; height 1.81 ± 0.7 m; VO<sub>2peak</sub> 3853.6 ± 528.2 ml.kg<sup>−1</sup>.min<sup>−1</sup>; peak aerobic power (PAP) 279.2 ± 51.2 W, performed an incremental test to exhaustion to determine power output at VO<sub>2peak</sub>. Following at least 48 h rest between tests, each participant performed all three randomly allocated profiles, requiring on average 150% (profile 1 and 3) or 170% (profile 2) of PAP over 62 s. The pulmonary breath-by-breath VO<sub>2</sub> kinetics were analysed in two ways. Either with the free parameter of the amplitude, Model I: VO<sub>2pred</sub> = A*(1 - e<sup>−τ/τ</sup>), or using a pre-determined amplitude, Model II: VO<sub>2pred</sub> = VO<sub>2peak</sub> * (1 - e<sup>−τ/τ</sup>), where A and τ represent amplitude and time constant, respectively. Using a within subjects ANOVA, the average amplitude results for profiles 1, 2 and 3 were 3425.0 ± 454.46, 3535.89 ± 686.08 and 3463.73 ± 474.04 ml.kg<sup>−1</sup>.min<sup>−1</sup>, respectively (P > 0.05). Also, these (amplitudes) were not different from the average VO<sub>2net_peak</sub> achieved during the incremental test; 3506.65 ± 472.85 ml.kg<sup>−1</sup>.min<sup>−1</sup> (P > 0.05). The τ, using Model I were: 15.30 ± 2.5, 18.22 ± 7.15 and 17.23 ± 3.46 for profiles 1, 2 and 3, respectively (P > 0.05). The τ, when using Model II, were: 15.62 ± 3.74, 17.08 ± 4.36 and 17.02 ± 2.62 for each profile respectively, (P > 0.05). The τ between Model I and Model II was not different (P > 0.05). In conclusion, different power profiles had no effect on the amplitude and time constant during 62 s of cycle sprint. There were no differences in the time constant between the two methods of calculating VO<sub>2</sub> kinetics.
P76O

The thermoregulatory responses to wearing a compression garment when exercising in the cold.
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The thermoregulatory responses to wearing a compression garment when exercising in the cold. It is becoming increasingly evident professional sports men and women are wearing base layer clothing under sporting attire during training and competitive matches. Compression based garments have been used in a medical setting for decades known as ‘compression therapy’, to aid recovery of oedema and vascular diseases. As compression garments has now become a multi-million pound industry the evidence to support their usage is rather weak. There has been no previous study, which has investigated the effect of compression garments in a temperature lower than 10°C and no study, which has done so at 0°C. A full speed-lactate profile was obtained before testing conditions (compression vs non-compression) commenced. 11 male sport and exercise students with varying fitness levels performed two 30-minute treadmill based run at 1k.h\(^{-1}\) slower than lactate threshold agreed from a speed lactate graph. Each participant would complete the exercise protocol once wearing a long sleeved t-shirt and knee length shorts (Umbro, Manchester, England) under sporting attire (Nike, Washington County, Oregon, USA) and once wearing similar non-compression based under garment (Primark, Dublin, Ireland & Umbro) under sporting attire (Nike). Participants would be performing the exercise protocol in an environmental chamber (Design Environmental, UK) at 0°C and 30% humidity. Core temperature, skin temperature (4 site – chest, back, upper arm and thigh), heart rate, VO\(_2\), blood lactate concentration and rating of perceived thermal stress (RPTS) would be measure at 5-minute intervals during the exercise protocol, nude body weight was measured pre and post test, and morning hydration status was measured. No significant difference will be found in core temperature, sweat rate, heart rate, VO\(_2\), blood lactate concentration and RPTS hydration status when comparing compression vs. non-compression conditions. A significant difference will be found within skin temperature as found in many other studies.

P77O

Physiological demands of running and dribbling a ball in soccer.
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It has previously been identified that the physiological demands differ when dribbling a ball in soccer compared to running at the same given speed (Reilly & Ball, 1984: Research Quarterly for Exercise & Sport, 55, 267 – 271). However, this study was conducted in a laboratory using a treadmill-based protocol, even though soccer is a field-based activity. Technological advances, such as portable gas analysers, have now allowed field-based research to be accurately measured (Duffield et al, 2004: Journal of Science and Medicine in Sport, 7, 11 -22). Therefore, the purpose of this study was to investigate the physiological differences between running and dribbling in a field environment. Eleven male competitive soccer players (mean ± SD age: 20.8 ± 0.6 y; height: 177.2± 5.3 cm, mass: 72.4 ± 5.9 kg) completed two trials in a counterbalanced order which involved either dribbling a soccer ball or just running. Each trial comprised four bouts of five min exercise at increasing speeds of 9, 11, 12.5 and 14 km·h\(^{-1}\) interspersed with 5 min passive recovery. Speeds were dictated by auditory signals and validated using a Global Positioning System (GPS) (catapult Minimax, Australia). Continuous measurements of oxygen uptake (\(\dot{VO}_2\)) and respiratory exchange ratio (RER) were obtained during the trials utilising a portable gas analyser (Metamax, UK) to enable the calculation of energy expenditure (EE). Heart rate (HR) was also continuously recorded (Polar system, Finland) and the mean values for each minute of exercise were calculated for each variable. Rating of perceived exertion (RPE) was taken after each five min
exercise bout. Data were analysed using factorial (trial x speed x time) within-subjects general linear models. Data are described as mean ± SD. Averaged across all speeds, $\dot{VO}_2$ ($P=0.023$) and EE ($P=0.014$) was significantly higher when dribbling a ball than running. There was also a speed and time mediated increase in $\dot{VO}_2$ and EE ($P<0.005$). HR was also significantly higher ($P=0.003$) whilst dribbling (173 ± 6 beat·min$^{-1}$) compared to running (167 ± 6 beat·min$^{-1}$) and was increased with speed and time ($P<0.005$). RPE was greater whilst dribbling the ball across all four speeds (9 ± 1 to 19 ± 1) compared to running (8±1 to 17±1). These findings indicate that the physiological cost of dribbling a ball is higher than running at the same speed. These findings support those previously established in the laboratory (Reilly & Ball, 1984: Research Quarterly for Exercise & Sport, 55, 267 – 271), suggesting that the mechanical changes involved in dribbling pose an additional physiological load. These findings, however, suggest that although the added metabolic cost of dribbling does not on its own add substantially to the metabolic load imposed during a soccer game due to the small amount of time actually spent dribbling, the proportinate increase in energy expenditure over various running speeds should be considered when devising training sessions.

P79P

Effect of unloaded treadmill running on accelerometer derived player load in young soccer players.
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Gravity correction treadmills use differential air pressure to provide an upward lift for users, which has the effect of reducing body mass. These devices have been reported to reduce ground reaction forces (Grabowski & Kram, 2008: Journal of Applied Biomechanics, 24, 288-297) whilst reducing muscle activity and yet maintain muscle firing patterns, thus providing an ideal environment for rehabilitation and recovery purposes. The recent development of microelectromechanical (MEMS) systems containing GPS and accelerometry technologies has allowed sports professionals to quantify training and match play activities in a variety of field based team sports. Montgomery et al (2010: International Journal of Sports Physiology and Performance, 5, 75-88) have demonstrated ‘Player Load’, the accumulation of the instantaneous change in rate of acceleration in three axes (x, y and z), derived from MEMS devices, to be a key discriminate measure in quantifying the demands of exercise. Player Load has been proposed as an appropriate measure of effort during sporting activity, due to its capacity to quantify whole body movement, independent of body mass. The purpose of this study was to investigate the effect of reducing effective body mass using a gravity correction treadmill on Player Load at 2 different running velocities. Six male elite youth soccer players from an English Premier League Under-18’s squad (Mass 73.4±3.5 kg, Height 1.785±0.045 m, Body Fat 6.7±1.3%) and their parents gave written informed consent to participate in the study. Following a 5-min self selected warm-up, each player completed five minutes of treadmill running at five body mass equivalents (BME; 100, 95, 90, 85 and 75% of individual body mass), and at two treadmill speeds (11 and 12.5 km/h). All sessions were performed at the same time of day, and order of trials was randomised. Players were monitored using a 100 Hz 3D accelerometer as part of a MEMS tracking system (Minimax S4, Catapult innovations, Scoresby, Australia). Player Load was derived for each subject and each condition using proprietary software (Logan Plus, Catapult Innovations, Scoresby, Australia). Differences in Player Load between levels of BME for each running velocity were explored using one-way repeated measures analysis of variance. For all comparisons, the level of significance was set at $P < 0.05$. At a running velocity of 12.5 km/h, Player Load reduced from 117.5± 25.3 units at 100% BME to 93.7± 23.5 units at 75% BME. At 11 km/h, Player Load reduced from 114.2 ± 14.4 units at 100% BME to 86.3 ± 10.7 units at 75% BME. For both treadmill speeds, Player Load at 75% BME was different to all other conditions ($P < 0.05$). The large variance in results for each level of each condition emphasises that Player Load has between subject discriminate properties, even for a relatively uniform activity such
as treadmill running. Our results would suggest that offloading body mass to 75% BME is effective in reducing Player Load in subjects. This information may be useful in informing rehabilitation and recovery practises.

**P80P**

**Skeletal muscle GLUT4 content and localisation in response to 6 weeks of endurance or high intensity interval training in previously sedentary males.**


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Upregulation of GLUT4, the skeletal muscle-specific glucose transporter, has the potential to enhance skeletal muscle glucose uptake and improve insulin sensitivity. Many research studies show an increase in GLUT4 content in response to exercise training (e.g. Little *et al.*, 2010: *The Journal of Physiology*, 588, 1011-1022; Burgomaster *et al.*, 2007: *American Journal of Physiology. Regulatory, Integrative and Comparative Physiology*, 292, 1970-1976), however no studies have looked at the localisation of GLUT4 following training or the effect of different exercise modes. Therefore, the purpose of this study was to compare changes in GLUT4 content and localisation following high intensity interval training (HIT) and traditional endurance training (ET). Following ethical approval and participant consent, 16 healthy untrained male participants were randomly allocated to one of two training groups: HIT (n=8; age 22 ± 1 years; BMI 24.8 ± 0.8 kg/m²; VO₂ max 3.13 ± 0.15 L/min) or ET (n=8; age 21 ± 1 years; BMI 22.6 ± 1.6 kg/m²; VO₂ max 2.93 ± 0.30 L/min). All participants trained for a period of 6 weeks. HIT involved 3 exercise sessions per week and comprised repeated Wingate tests of 30 seconds ‘all out’ cycling interspersed with 4.5 minutes active recovery. The number of Wingate tests performed per session was progressively increased over the training period. ET involved 5 exercise sessions per week during which participants cycled at 65% VO₂ max. The exercise duration of each session was progressively increased to 1 hour during the course of the training period. The pre- and post-training testing followed an identical protocol. Diet was controlled for the 24 hours prior to testing and subjects arrived at the laboratory following an overnight fast where a muscle biopsy was taken from the vastus lateralis using the percutaneous needle technique. Immunofluorescence staining of muscle sections for GLUT4, myosin heavy chain type 1 (for staining of type 1 muscle fibres) and the plasma membrane was conducted followed by image capture with fluorescence microscopy and image analysis. A factorial ANOVA was performed to analyse the main effects of training and exercise mode on GLUT4 content, as well as the interaction of these variables. Statistical significance was set at the level of P < 0.05. We hypothesise that GLUT4 content will increase in response to both training modes. It is currently unknown whether changes in subcellular localisation will occur or whether fibre type specific changes will be observed.

**P81P**

**Physiological profile of the under 16 years old Portuguese national team of Judo: Relationship between assessments and correlation with competitive results.**

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The objective of this study was to determine the fitness level of the Juvenile national Judo team of Portugal. 53 national level athletes were tested (36 males [age 14.62±0.72 years; height 169.31±9.65 cm; weight 63.04±14.50 kg] and 17 females [age 14.62±0.72 years; height 162.00±5.34 cm; weight 56.24±9.26 kg]). The ethical committee of the Portuguese Judo federation approved the study and obtained the necessary consent for the data collection. The assessment took place in a national training camp just after the national championships
and it used a battery test consisting of % of body fat, hand-grip strength, “sit&reach”, push-ups, timed sit-ups, chin-ups, squat jump, counter movement jump, back/leg strength (a maximal isometric pull, performed on a back dynamometer, with the subject placed in a comfortable position of slightly flexed knees and their back bent forward at roughly 30 degrees). The battery test also consists of the special judo fitness test (created by Sterkowicz (1995: Antropomotorika, 12/13, 29-44) which consists of 3 bouts: A-15sec; B-30sec and C-30sec with 10sec rest between each. The subject is placed 3 meters away from each of the two helpers who are going to be projected. In each bout the subject is asked to perform the maximal number of throws that he/she is able and this number is recorded. Heart rate (HR) is measured at the end of the test and 1 minute after). The results show that the national team preformed above the reference values in % of body fat (males 10.54±4.53 %; females 15.69±4.08 %), “sit&reach” (males 49.00±6.15 cm; females 56.18±6.24 cm) and special judo fitness test (males 13.14±1.38; females 12.44±2.48), and had a poor performance on the chin-ups (males 10.24±5.44; females 6.10±3.87) when comparing with similar studies. A significant difference between genders was found on leg power (p<0.05), % of body fat (p<0.01), hand-grip strength (p<0.01), back/leg strength (p<0.01), chin ups (p<0.05) and “sit&reach” (p<0.01). Surprisingly, the results from push-ups and timed sit-ups, relating to local muscular resistance, showed no correlation with gender.

P82P
The effect of fitness test protocol on maximal heart rate.
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Maximal heart rate values (HR\text{max}) are frequently used in the prescription of exercise intensity (Gellish et al., 2008: Medicine and Science in Sport and Exercise, 39, 822 – 829). However, recent research has reported that laboratory- and field-based protocols can produce significantly different HR\text{max} values, (Semin et al., 2008: Journal of Sports Science and Medicine, 7, 455 – 460). With this in mind the aim of the present study was to determine the effect of three different, but commonly used, fitness test protocols on the assessment of HR\text{max}.

Eight healthy male participants (21.7 ± 1.8 years; weight 76.4 ± 6.4 kg) underwent three different fitness test protocols to volitional exhaustion, within a two month period. These protocols were, 1) a laboratory-based maximal treadmill run (Woodway, ELG, Woodway Germany ) with a constant running speed of 11 km•h^{-1} and an increased gradient of 1% each minute (TR), 2) the multi-stage fitness test (MSFT) (Ramsbottom et al.,1988: British Journal of Sports Medicine, 22 141 – 144), and 3) the Yo-Yo intermittent recovery test (level 1) (YOYO) (Bangsbo, 1994: Fitness Training in Football: A Scientific Approach. Denmark: HO+Storm). Heart rate was recorded at 1 s intervals throughout the duration of each protocol (Polar RS400). HR\text{max} was defined as the peak value obtained for each protocol (Gellish et al., 2008). To quantify physical exertion on each protocol breath by breath gas analysis was collected using a mobile gas analyser (Cosmed Kb4^2, Cosmed Srl, Italy). Blood lactate (YSI 2300, LYsi UK) and ratings of perceived exertion were also collected upon test termination.

A multivariate analysis of variance was used to determine differences in all dependent measures between test protocols. Where a significant F value was found the LSD post-hoc test was applied.

Multivariate analysis of variance revealed no main effect for test protocol on HR\text{max} values (TR: 198 ± 5; MSFT 195 ± 8; YOYO 190 ± 7 b•min^{-1}, F_{2,21} = 2.702, P = 0.090). However, pairwise comparisons revealed a difference between TR and YOYO (P = 0.031). This difference occurred in the absence of a main protocol effect for VO\text{2max} (TR 52.7 ± 6.3; MSFT 52.7 ± 6; YOYO 50.6 ± 5.2 mL•kg^{-1}•min^{-1}, F_{2,21} = 0.360, P = 0.702), RER (TR 1.20 ± 0.04; MSFT: 1.21 ± 0.04, F_{2,21} = 0.250, P = 0.781) or blood lactate (TR 7.0 ± 0.9; MSFT 6.9 ± 1.7; YOYO 7.2 ± 1.3 mmol/L, F_{2,21} = 0.080, P = 0.923). There was a significant effect for protocol on RPE (TR: 17.1 ± 1.3; MSFT 18.9 ± 0.4; YOYO 19.5 ± 0.5,
F_{2,21} = 18.518, P < 0.001). Specifically, RPE was lower after TR when compared to both MSFT (P < 0.001) and YOYO (P < 0.001).

The main finding of the present study was HR_{max} was higher on a laboratory-based treadmill protocol when compared to a field-based protocol. As such, a practical implication is that coaches and sports scientists should be aware that different protocols can impact upon HR_{max} values. Therefore, a test should be picked specifically for the athletes sporting activity.

P83O

**Effect of dietary nitrate supplementation on maximal and heavy intensity cycle exercise in humans.**

L. Wylie

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Dietary nitrate supplementation has been reported to have a relatively dissimilar effect on oxygen uptake (\(\dot{V}O_2\)) kinetics during moderate and severe intensity exercise (Bailey et al., 2009: *Journal of Applied Physiology*, 107, 1144-1155). Additionally, nitrates effects on maximal exercise are inconclusive (Bailey et al., 2009: *Journal of Applied Physiology*, 107, 1144-1155; Larsen et al., 2010: *Free Radical Biology and Medicine*, 48, 342-347). We aimed to investigate the effect of dietary nitrate in the form of beetroot juice (BR) on heavy intensity exercise \(\dot{V}O_2\) kinetics and maximal exercise parameters. We hypothesised a reduction in \(\dot{V}O_{2\text{max}}\) and increased exercise tolerance following BR ingestion. In a placebo controlled, crossover study, nine well trained male cyclists (mean ± SD, age 30 ± 7 yr, height 175 ± 9 cm, body mass 78 ± 16 kg; \(\dot{V}O_{2\text{max}}\) 55 ± 6 ml·kg\(^{-1}\)·min\(^{-1}\)) consumed 500 ml/day of either BR or a placebo of cordial juice (PL), for 6 consecutive days. On day 3 of supplementation, subjects completed an incremental cycle test to exhaustion followed by a “step” heavy intensity exercise test on day 6. Blood pressure was recorded to evaluate the presence of elevated nitric oxide (NO) concentration in the body. On days 3-6, systolic blood pressure was significantly reduced following BR ingestion (PL: 133 ± 11 vs. BR: 128 ± 8 mmHg (P<0.05) indicating elevated NO. During heavy intensity exercise BR supplementation resulted in a reduced \(\dot{V}O_2\) primary amplitude (PL: 2.06 ± 1.94 vs. BR: 1.94 ± 0.31 l·min\(^{-1}\)) (P<0.05) and a reduced \(\dot{V}O_2\) primary “gain” (PL: 9.7 ± 1.6 vs. BR: 9.1 ± 2.1 ml·min\(^{-1}\)·W\(^{-1}\)) (P<0.05). During maximal exercise BR reduced \(\dot{V}O_{2\text{max}}\) from 4.43 ± 0.63 to 4.19 ± 0.64 l·min\(^{-1}\) (P<0.05) with no affect on time to exhaustion (P>0.05). In conclusion, a natural dietary source of nitrate can increase efficiency during heavy intensity exercise and reduce \(\dot{V}O_{2\text{max}}\) with no effect on performance during maximal exercise, presumably by direct effects on oxidative phosphorylation itself.
Performance Analysis

PA1P
Pacing Strategies Associated with Superior Duathlon Performance.
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University of Worcester

Pacing strategies involving a slow start and fast finish have been associated with superior performances in endurance running and cycling events (St Clair Gibson et al., 2006: Sports Medicine, 36, 705-722). However, little research has examined optimal pacing strategies during multi-sport events that necessitate the completion of several sequential stages. The aim of this study was to analyse differences in run and cycle performance during the fastest and slowest of two competitive duathlons (run 3.2 km, cycle 16 km, run 3.2 km) performed by individual athletes during the course of 6 race series. Following receipt of Institutional ethics Committee approval, performance data was analysed for 31 participants (29 male, 2 female) who competed in at least two races. Participants were all active members of specialist athletic or triathlon clubs, and competed in the full range of age categories (2 Junior, 19 Senior, 10 Masters). Chip timing was used to record both total and individual stage times. Transition times were subsequently removed. Total times were divided into fastest (FAST) and slowest (SLOW) individual performances, and T-tests for repeated measures were used to assess differences on each individual stage. Of the 31 participants, 18 (58%) achieved their fastest overall performance in Race 1 (2981 ± 237s) and 13 (42%) achieved their fastest in Race 2 (2990 ± 239s). Comparison of Race 1 with Race 2 also revealed no significant differences in performance, or relative percentage of total time spent on any individual stage. Comparison of FAST and SLOW revealed no significant differences in performance on Run 1 (FAST 719 ± 69s, SLOW 724 ± 62s) or Run 2 (FAST 724 ± 62s, SLOW 758 ± 62s). However, performance was significantly faster ($P<0.01$) on the cycle stage during FAST (FAST 1463 ± 101s, SLOW 1546 ± 149s). The results suggest performance on the cycle stage of a competitive duathlon was largely responsible for variations in individual performance. In the present study, 58% of participants achieved their fastest overall performance in Race 1 and 42% in Race 2, suggesting differences between fast and slow performances were not simply the result of familiarisation or environmental conditions. The mechanisms for these observations are unclear. If overall pacing was based on a telioanticipatory strategy (Ulmer, 1996: Experentia, 52, 416-420), then a faster first run would be anticipated during the fastest overall race as the pacing regulatory centre in the brain would have allowed a higher muscular work rate based on a peripheral physiological status more conducive to the forthcoming exercise bout. Alternatively, if work rate in run 1 was too high during the slowest overall races due to inappropriate performance goals, then a comparatively greater performance decrement would be expected during run 2. Further research is warranted in order to identify the reasons underpinning the apparent independence of run and cycle performance during a competitive duathlon.

PA2O
Predicting timing gate speed from a 5 Hz Global Positioning System.
Waldron, M., Worsfold, P., Twist, C., & Lamb, K.
University of Chester

The measurement of over-ground speed via global positioning systems (GPS) has numerous sporting applications, yet their validity is uncertain and recent studies have reported the widely used 5 Hz systems to underestimate speed determined by infra-red timing gates. Therefore, the purpose of this study was to examine whether a regression model of sufficient accuracy could be developed to provide a more accurate representation of over-ground speed. Sixty elite team sport participants (age: 14.2 ± 0.67 years; stature: 171.6 ± 9.8 cm; body mass:
66.1 ± 12.9 kg) performed one maximal sprint over a 30 m distance and were concurrently measured using a 5 Hz GPS device and infra-red timing gates. Analysis demonstrated a significant correlation ($r = 0.85$) between the measures, but a systematic underestimation ($P<0.05$) by GPS mean speed ($20.89 \text{ km} \cdot \text{h}^{-1}$) of that from the timing gates ($22.85 \text{ km} \cdot \text{h}^{-1}$). Nonetheless, multiple regression analysis revealed that the prediction of timing gate speed (TGS) from mean GPS speed was within $0.65 \text{ km} \cdot \text{h}^{-1}$ for 68% of the sample. When peak GPS speed was added to the model, the predictive accuracy was improved to $0.50 \text{ km} \cdot \text{h}^{-1}$, and reflected in the equation; $TGS = 2.869 + [(0.246 \times \text{mean GPS speed}) + (0.497 \times \text{peak GPS speed})]$. On this basis, it is suggested that amongst sportsmen such as these, either of the current GPS prediction models may provide a valid alternative to timing gates in the assessment of sprint performance over 30 m and the determination of sprinting categories for match analysis purposes.

**PA3P**

Do children perform a more effective and quicker reaction movement, to a more familiar audio sound at the start of a sprint race within athletics?

Baker, G.

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Even though the most effective start within track athletics does not guarantee that winning performance, it does give athletes an early physical and psychological advantage, which could influence the race result (Collet, 1999: *Percept Motor Skills*, 88, 65-75; Stevenson, 1997: *Coach and Athletic Director*, 66, 18-20). It has been suggested that a reaction to a familiar stimulus (for example a starting gun) can be enhanced by experience, commonly referred to as repetition priming (Tulving and Schacter, 1990: *Science*, 247, 301–303) and can also enhance the response of an unfamiliar stimuli, when using imagery (Henson et al., 2000: *Science*, 287, 1269–1272). Previous research however has been unable to confirm whether or not a more familiar audio sound produces a more effective reaction movement. The purpose of this study is to identify whether there is any correlation between a familiar audio sound, resulting in a more effective and quicker reaction movement at the start of a sprint race amongst young athletes. With institutional ethics approval, 20 (age 10.11 ± 0.4 y, stature 1.44 ± 0.1 m, body mass 36 ± 5.7 kg) healthy primary school children performed three consecutive sprint starts, each time reacting to a different audio starting cue. The three randomised pre-recorded audio sounds used, were a verbal “GO”, the firing of a starting pistol and the sound of a whistle being blown. All of the sprint starts were recorded using a Casio Exilim EX-FH20 camera at 210Hz, positioned adjacent to the starting line. This recorded footage was analysed using Kinovea 0.8.7 software, to measure the subject’s reaction time and to identify the first initial reaction movement of either foot, for each of the three audio starting sounds. After concluding the last sprint start the subjects completed a post experiment questionnaire, this data was then analysed using Statistical Package for the Social Sciences 16 software, to identify how familiar and often they hear each of the audio sounds. The results from this study firstly indicated a weak correlation between the subject’s initial reaction movement and the familiarity of the audio sound with 70% of the subjects demonstrating an identical movement for all three sounds. However, when analysing the subject’s reaction time to each of the audio starting sounds, the results identified that 60% of the subjects produced their fastest reaction start ($0.879 \pm 0.120$ seconds) to the whistle, which was highlighted by the subjects in the experiment questionnaire as the most familiar audio sound. The results also identified that 55% of the subjects produced their slowest reaction start ($1.027 \pm 0.083$ seconds) to the starting pistol, which was highlighted by the subjects in the experiment questionnaire as the least familiar audio sound. This strong correlation between a more familiar audio sound producing a quicker reaction movement at the start of a sprint race amongst young athletes, indicates that there is need to familiarise young sprint athletes with the audio starting sound relative to their sport, in this case the firing of a starting
pistol would be used during training to assist towards performance enhancement within competition.

PA4O

**Positional demands of elite rugby union players.**

Cahill, N., Worsfold, P., & Lamb, K.

*University of Chester*

Many researchers and applied practitioners have used time motion analysis techniques to gain a greater understanding of the physical demands of elite rugby players (Duthie *et al*. 2003: *Sports Medicine, 33*, 973-991; Roberts *et al*. 2008: *Journal of Sports Sciences, 26*, 825-833). However, detailed assessments of the movement characteristics of contemporary elite rugby union players are still lacking and an understanding of the physical demands of a rugby union match is essential in order to train players optimally. Therefore, the purpose of this investigation was to quantify the movement characteristics of elite rugby union players during competitive play and identify whether significant position-related differences exist.

Following ethical approval from the University of Chester, 69 elite rugby union players from 8 English Premiership Clubs were tracked using GPS SPI Pro 5 Hz units during 34 competitive premiership matches during the 2010/2011 premiership season. 153 GPS data files were collected continuously throughout each match and later downloaded to a PC and analysed with GPSports Team AMS software. The following dependent variables were extracted for each player: total distance covered (m), metres covered per minute, maximum speed, distance covered at high intensity running (HIR) and low intensity running (LIR) and percentage of total distance covered at HIR and LIR. Data was analysed by forwards and backs positions and by six positional groups (Front Row (FR), Second Row (SR), Back Row (BR), Scrum Half (SH), Inside Backs (IB), Outside Backs (OB)) using non parametric Kruskal-Wallis tests and where appropriate, Mann-Whitney tests to identify differences between specific positions. The results yielded significant differences ($P<0.05$) between forwards and backs in all the measured variables excluding percentage of total distance covered at LIR. Greater total distances were covered by the backs (median 6579.70 ± 863.12 m; mean 6506.04 ± 94.17 m) than the forwards (median 5969.25 ± 722.14 m; mean 5990.45 ± 102 m) and the backs travelled further at HIR (median 611.50 ± 204.28 m; mean 635.43 ± 22.29 m) than forwards (median 287.78 ± 262.78 m; mean 359.32 ± 37.16 m). Positional group differences ($P<0.05$) were observed for numerous variables; group SH covered the greatest total distance during a match (median 7263.7 ± 646.69 m) and differed significantly from all other groups aside from IB. The SR group covered the lowest distance (median 5774 ± 503.96 m). The forward groups (FR, SR and BR) differed in maximum speed compared to the back positional groups (SH, IB and OB). Additionally, notable differences were observed between the FR and BR and IB and OB groups. The highest maximum speeds were achieved by the OB (median 31.7 ± 2.2 km·h$^{-1}$). FR and SR covered the smallest amounts of distance in HIR (median 205.1 ± 118.2 m & 160.1 ± 86.1 m, respectively) and the IB the greatest (median 638.6 ± 140.6 m). These findings highlight clear differences in the positional demands of elite rugby union players during competitive matches and reinforce the case for utilising a position-specific approach to training programmes.

PA5P

**Global positioning system (GPS) analysis of rugby tackles in professional rugby union.**

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The game of Rugby Union involves intermittent bouts of low to medium intensity activity punctuated by periods of maximal or high intensity exercise e.g. tackling. However, large
variations in exercise intensity levels exist between different player positions within a team, and therefore, their physiological demands and skill prerequisites. The tackle is one of the most frequent body contact skills in the game of Rugby Union and results in the highest incidence of injury (Fuller et al., 2010: *British Journal of Sports Medicine*, 44, 159–167, McIntosh et al., 2010: *Journal of Sports Medicine*, 44, 188–193). A number of recent studies have investigated the physiological demands placed upon professional rugby union players using global positioning system (GPS) technology at both international (Coughlan et al, 2011, In Review) and club level (Cunniffe et al., 2009: *Journal of Strength and Conditioning Research*, 23, 1195-1203). The aim of this study was to investigate the levels of bodyload sustained by seven professional club players during tackles in a competitive game in order to evaluate the use of this data for injury prevention and rehabilitation. Seven players, two forwards and five backs were selected for analysis. Each of the players wore a GPS device which recorded their positional and bodyload data in a Magners League game. These players were chosen in order to compare the bodyload between and within forwards and backs units. Bodyload data was classified in terms of gravitational (G) forces. Light (e.g. hard acceleration/deceleration/change of direction) (5 - 6G), light to moderate (player collision/contact with the ground) (6 – 6.5G), moderate to heavy (tackle) (6.5 – 7G), heavy (tackle) (7 – 8G), very heavy (scrum engagement/tackle) (8 – 10G) and severe (tackle/collision) (10+G). Ethical approval was obtained from UCD Ethics Committee and each player gave written consent to participate in the study. All seven players experienced the majority of tackle bodyloads at either the very heavy (8-10G) or severe (10+G) levels. With the exception of the full back, all of the backs had a higher total number of tackles compared to the forwards. The inside centre had the highest total bodyload for any player at 142.2G (tackles against). The loosehead prop had the highest average bodyload at 11.3G (tackles made). The scrum-half had the highest single bodyload for any player at 13.1G (tackle against). The primary findings of this investigation were that there were differences in the number of tackles and levels of bodyload experienced by professional club rugby union players in a range of positions. While studies such as (Eaton and George, 2006: *Physical Therapy Sport*, 7, 22-29) found that forwards were involved in higher intensity activity, backs were shown to experience higher bodyloads and a greater number of tackles. Our results indicate that the majority of backs experienced higher total bodyloads than the forwards, with the exception of the full back. (Coughlan et al., 2011: In Review) discusses the potential for GPS bodyload data to be used for tactical and educational purposes to help deal with the injury risks associated with the specific tackling demands of individual players. It could also be used as a ‘Red Flag’ to injury for clinicians during and following a match. Many studies also allude to the potential of creating individualised rehabilitation and recovery programmes based on a player’s specific game demands, as indicated by bodyload data. Future studies should monitor players over longer periods of time such as a whole season to increase the applicability of the data collected and its potential utilisation. In conclusion, this investigation has shown that GPS data is a potential beneficial addition to professional rugby union, providing specific individualised data regarding the loads experienced by players during tackling. It also highlights the differing demands and specificity of each position.

PA6P

**Goal scoring patterns over the course of a match and season: An analysis of the 2009-2010 English Premier League (no winter break) and German Bundesliga (winter break) seasons.**

Haines, M.

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Previous research suggests that a relationship between time and goal scoring frequency (GSF) exists, with GSF highest in the second half (46-90+ min) of matches and peaking in the last 15 minutes (76-90+ min). However to our knowledge no research appears to have investigated whether such a pattern is present in the English Premier League (EPL) and
German Bundesliga (DBL), or whether GSF is consistent throughout a season. The purpose of this study was to investigate whether the same pattern of GSF was observed in the EPL and DBL and whether the inclusion of a winter break has an effect on GSF. Following institutional ethical approval the time of all 1919 goals from the 686 matches of the 2009-2010 season of the EPL and DBL were recorded according to the time indicated by the EPL results page of the British Broadcasting Corporation’s Sport (BBC) website and the official website of the DBL. The data was put into a Microsoft Excel spreadsheet to create frequency counts for each minute of play from 1 to 90+ min. Chi-square analysis was used to determine any statistically significant differences in goal scoring frequency per 45 minute period, per 15 minute period, and between the last 15 minutes of play per half season for each league. Chi-square analysis was also used to look for statistically significant differences in GSF during the last 15 minutes of matches in the second half of the season between the two leagues, for an effect of league, time of season and a league x time interaction. The level of significance in all cases was set at p ≤ 0.05. Chi-square analysis revealed GSF was significantly greater in the second half of matches (EPL: 56% v 44%, p < 0.001; DBL: 56% v 44%, p < 0.001) and greatest in the last 15 minute period (76-90+ min) of matches compared to all other 15 minute periods in both the EPL and DBL (EPL: 24%, all at p < 0.05; DBL: 22%, all at p < 0.05). Although non-significant, GSF during the last 15 minutes of matches in the EPL was greater in the second half of the season compared to the first (27% v 21%, p = 0.227). Conversely GSF during the last 15 minutes of matches in the DBL was less in the second half of the season compared to the first, although again this difference was not significant (21% v 24%, p = 0.613). No significant difference in GSF in the last 15 minutes of play in the second half of the season was observed between the EPL and DBL (27% v 21%, p = 0.384). The league x time interaction was not significant (p = 0.240) although a main effect for league on GSF during the last 15 minutes of play was found (p = 0.010). By showing its existence in two previously unstudied leagues the results provide further support for a relationship between time and GSF which may be explained by deterioration in physical conditioning, tactical play and lapses in concentration. The study further adds to existing knowledge with the observation that GSF in the last 15 minute period of play in the second half of the season increased by 6% in the EPL and decreased by 3% in the DBL. This 9% swing between EPL and DBL suggests a rest factor may be involved in GSF when considered over the course of a season. The results suggest that most goals are scored during the second half of matches and specifically during the last 15 minute period of play in both the EPL and DBL. They also suggest that a winter break may reduce GSF in the last 15 minutes of play in the second half of the season compared to the first, and the lack of a winter break may increase GSF in the last 15 minutes of play in the second half of the season compared to the first, although further investigations are required and should compare leagues with the same number of matches in order to increase statistical power.

PA7P

Systematic variation in power output during a simulated hilly time-trial.

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When conditions are constant, varying power output during a flat cycle time-trial (TT) leads to an increase in completion time (Swain, 1997: Medicine and Science in Sports and Exercise, 29, 1104-1108). Mathematical modelling has indicated this performance decrement to be 0.26 – 0.58% over a flat 40km TT when power was varied by 15% in 5km periods (Atkinson et al., 2007: Journal of Sports Science, 25, 1001 - 1009, Swain, 1997: Medicine and Science in Sports and Exercise, 29, 1104-1108). The purpose of the present study was to model the effect of power variation on performance during a hilly TT with periods of power variation both shorter and longer than the length of the hill. To enhance the ecological validity of the analysis, the effects of acceleration and deceleration as power varied were also modelled. Using a previously validated equation of motion and forward integration (2 Hz) to account for
acceleration and deceleration (Martin et al., 2006: *Medicine and Science in Sports and Exercise, 38*, 592-597) and assuming starting velocity to be 1 m·s\(^{-1}\), the time to complete a hilly, windless, 40-km time trial was calculated. The course consisted of eight equal 2.5 km sections of uphill and downhill resulting in no net elevation change; hill gradients of 1, 3 and 6% were examined. A hypothetical rider (mass 70 kg, bicycle mass 10 kg, drag area 0.307 m\(^2\)) was considered. For each trial, one of a range of mean power outputs (200 – 600W, 50W increments) were considered, and within-race power was systematically varied by ± 0, ± 5, ± 10 or ± 15% for periods of variation of 1.25, 2.5, 5, 10, 20 and 40 km, all possible combinations were modelled. Increasing the amplitude of variation caused independent increases in completion time for all possible combinations of mean power, gradient and period of variation. Typically, though not in every case, this effect was progressively augmented as gradient increased: for a mean power output of 300 W, at 1% gradient there was an increase in completion time of 0.02, 0.10 and 0.23% when the amplitude of variation during 5 km periods was increased from 0% (constant state) to 5, 10 and 15%, respectively; at 6% gradient completion time was increased by 0.13, 0.26 and 0.43%, respectfully. Manipulation of the period of variation revealed a complex interaction with mean power, gradient and amplitude of variation; when the period of variation was longer than hill length, the effect was inconsistent and small across each gradient and for any given amplitude of variation. Conversely, when the period of variation was less than the length of the hill (1.25km), the performance decrement was markedly increased for all amplitudes of variation up to a mean power output of 400W at 3% gradient, and at all mean power outputs at 6% gradient: for a mean power output of 300W and a 15% amplitude of variation, completion time was increased by 0.46 and 0.76% at 3 and 6% gradient, respectively. When the period of variation matched the hill length, i.e. 2.5km, there were reductions in completion time. These effects were progressively augmented as gradient and amplitude of variation increased and typically more important at low power outputs: for a mean power output of 300W, completion time was reduced by 0.31, 0.55 and 0.74% at 1% gradient when the amplitude of variation was increased to 5, 10 and 15%, respectively. At 6% gradient, completion time was decreased by 1.2, 2.3 and 3.3%, respectfully. Varying power output during a hilly TT increases completion time, an effect which in some cases is much greater than previously published data for a flat TT. Increasing the amplitude of variation causes an independent increase in completion time which is augmented by increases in gradient; however altering the period of variation produces inconsistent effects. The latter is likely due to the extent by which the complex interaction with mean power, gradient and amplitude of variation impacts upon changes in speed during the TT. As has been shown previously, when an increase in power is maintained for the complete duration of the uphill, performance is improved.

PA8O

A profile of shots in the IBSA World Blind Football Championship 2010: Implications for coaching.

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Association Football is one of the world’s most popular sports (Macbeth and Magee, 2006: *Sport in Society, 9*, 444-462), and the primary aim at the elite level is to win as many games as possible. Performance analysis is suggested to be a key tool in improving performance and many studies have been conducted in football in attempts to determine the most effective methods of goal scoring (Grant et al., 1999: *Journal of Sports Sciences, 17*, 826-827; Hughes and Franks, 2005: *Journal of Sports Sciences, 23*, 509-514). However, little, if any, similar research has been conducted in Disability Football, especially Blind Football. The purpose of the study was to analyse all shots attempted in the International Blind Sports Federations (IBSA) World Blind Football Championship 2010 in order to make recommendations for enhancing the coaching of shooting at individual and at international team levels. Media
accreditation was obtained to film all twenty seven games of the tournament which were then analysed using SportsCode Elite Review software. Ethical approval was granted through Institute ethics procedures. Coding was informed by research supporting the segmentation of the pitch and goal into identifiable zones (Pollard and Reep, 1997: *The Statistician*, 46, 541-550) so that shots could be categorised by outcome, location at the point of crossing the goal-line, and location of the shot’s origin. Further analysis considered technique used in the shot’s execution, opposition location at the time of the shot, location of the striker’s guide behind the goal and the angle of approach prior to the shot. Nine hundred and sixty three shots were attempted during the twenty seven games with fifty one goals scored giving a conversion rate of only 5%. Preliminary data analysis would suggest that the majority of shots for each team (70-90%) were taken by an individual player. Final analyses should identify if there are any identifiable trends at the level of the individual, team and sport in relation to the most common shot characteristics. The data will be interpreted in order to make recommendations for coaching in Blind Football.

PA9P

The Relationship between Injury Prevalence and Training Load in a Professional Rugby Union Squad.

Ellis-Woodley, J.

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The impact of training volume and content on match and training injuries is a complex issue (Brooks et al., 2008: *Journal of Sports Sciences*, 26, 863-873). Conflict exists in the literature as to whether increased training load (TL) causes an increased incidence of injury in athletes (Anderson et al., 2003: *Journal of Strength and Conditioning Research*, 17, 734-738) or whether TL has no affect on injury incidence (Brooks et al., 2008: *Journal of Sports Sciences*, 26, 863-873.). The purpose of this study was to examine whether or not a relationship exists between the TL that players are exposed to and the incidence of injury within the group throughout a competitive season. Following ethical approval, 23 healthy, male professional rugby union players (age = 25.96 ± 5.06 yr, mass = 101.30 ± 11.42 kg, height = 185.96 ± 8.39 cm) gave informed consent to take part in the study. Data concerning TL that the players were exposed to and the injuries that the group sustained was then retrospectively audited. Injuries were divided into groups concerning their mechanism (Contact or Non-contact), the position of the player (forward or back) and the state of competition in which they occurred (Training or Match). Pearson’s tests revealed a moderate correlation ($P = 0.034, r = 0.43$) between weekly TL and the incidence of injury within forwards and a moderate correlation ($P = 0.025, r = 0.52$) between TL and the incidence of injuries that occurred during training. However, correlation was not found between TL and; incidence of injury within backs, incidence of contact injuries, incidence of non-contact injuries and the incidence of match injuries ($P = 0.530, 0.200, 0.088, and 0.651, r = 0.14, -0.28, 0.39 and -0.11$ respectively). Whilst it has been suggested that increases in training load cause an increased incidence of injury (Gabbett, 2004a: *Journal of Sports Sciences*, 22, 409-417; Gabbett, 2004b: *British Journal of Sports Medicine*, 38, 743-749.), findings of the current study do not provide clear evidence that TL directly affects the incidence of injuries within an elite professional rugby union cohort. This could imply that TLs may be increased by staff working at clubs to try and gain further performance benefits, without increasing the risk of injury. Further research is needed in this area so that a deeper understanding of the effects that TL has on injury can be gained.
Time motion analysis has been applied to various team and individual sports to obtain indirect quantitative data regarding the physiological demands of competition (D’Auria et al., 2008: International Journal of Sports Physiology and Performance, 3, 305-319). However, one sport yet to receive such attention is amateur boxing. This is surprising given the increasing popularity of the sport, the observable demands of its dynamic environment and the seemingly pivotal emphasis on tactical manoeuvres. The purpose of this study was to elucidate the movement demands of competitive amateur boxing with respect to weight category and ability, and winning or losing performances. With institutional ethical approval, 84 boxing performances by 42 novice, 18 intermediate and 20 open class fighters across ‘light’ (48 - 60 kg), ‘middle’ (63.5 – 75 kg) and ‘heavy’ (81 – 91+ kg) weight categories were recorded from 2 angles using digital cameras and subsequently analysed for offensive, feinting and defensive performance indicators using Dartfish TeamPro (Version 4.0, Switzerland). Data will be analysed using a two-way repeated measures ANOVA with the appropriate post-hoc tests utilized to identify where main effects are observed in order to determine any interaction effect of ability level and weight classification upon performance indicators. Tukey’s post hoc test will be used in the event of a statistically significant F-ratio in the ANOVA analysis. An independent samples t-test will be performed to explore differences between winning and losing performance. It is anticipated that differences in performance will become evident across the defined ability levels and weight categories. Furthermore, consistent with previous research, specific performance indicators will distinguish a typical winning and losing performance (Csataljay et al., 2009: International Journal of Performance Analysis of Sport, 9, 60-66).

Training load, physiological assessment and team performance of a University Netball team.
Arabshahi, R., & MacLeod S. 
Heriot-Watt University

Over the course of one academic year physiological support was provided to a female University Netball team. Physiological support included the quantification of training load via Heart Rate (HR) telemetry, the assessment of physiological capacity through a range of field based protocols and the development of training interventions designed to maximise squad performance. Training load data were compared to match results in order to establish whether training interventions and correlates of fitness were conducive to team success. Prior to commencing support all coaching and playing staff were informed of the purpose of the study and gave their written consent. Ten healthy and trained female netballers aged between 19-25 years (mean ± SD: height 1.7 ± 0.08 m and weight 66.0 ± 8.06 kg) were selected for the 1st squad. All work undertaken adhered to institutional documented guidelines. Players wore Polar HR monitors (Polar Team2 system, Finland) during squad training sessions for the quantification of training load. Data was analysed according to the summated HR zone method and subjected to weighting factor calculation for the determination of individual training load (Stagno et al., 2007. Journal of Sport Sciences, 25, 629-634). Physiological assessment included a 15 m sprint from a standing start and countermovement jump, both using the same timing system (Smartspeed, Fusion Sport) for the quantification of sprint speed and lower body power. A YoYo Intermittent Endurance protocol was used to establish aerobic endurance amongst the squad. Physiological assessments were carried out on 3 separate occasions throughout the season. All assessments were conducted indoors and on the same surface. Team performance was classified as a win, loss or draw. Results from
physiological assessments and training load calculations were used to plan, monitor and evaluate training interventions designed to improve sport specific fitness and squad performance. On the completion of this study, at the end of the academic year, retesting of physiological assessments will be administered and further conclusions can be drawn on the effectiveness of the training intervention on physiological performance.

PA12O
Assessment of the accumulated load of football specific tasks in amateur footballers.
Curran, J.
Edge Hill University

Global positioning satellite (GPS) systems have recently been adopted by performance analysts, particularly in team sports, to quantify the movement demands of competition and training (Jennings et al, 2010: International Journal of Sports Physiology and Performance, 5, 328-341). The majority of research has assessed the validity and reliability of the GPS systems with sampling rates of 1Hz-5Hz, typically failing to utilise the other functions of the systems. Currently only one study has evaluated the accumulated load of whole body dynamics in sports using a GPS system, which reported load values for offensive (5:28 ± 1:51) and defensive drills (4:29 ± 1:41) in basketball (Montgomery et al, 2010: International Journal of Sports Physiology and Performance, 5, 75-86). The aim of the current study was to quantify the differences in loading during football specific agility and linear tasks, with and without a ball. Following approval from the institutional ethics committee, ten male amateur football players (mean±SD: age 21±0.7 yrs, height 178.7±6.7 cm, mass 72.6±7.5 kg) completed two familiarisation trials and then were instructed to complete all four drills at maximum speed. Measurements of accumulated load were recorded by a GPS system (10Hz). Data were analysed using a repeated measures ANOVA. Results indicated that loading during the agility drill with a ball (5±0.8) was significantly higher than in the other three drills (P<0.01). No significant differences were reported between sprint trials, however results indicated a significant (P<0.01) increase in loading during the agility task without a ball (3.8±0.5) vs. sprinting with a ball (3.1±0.4). Results suggest that agility tasks with and without a ball place more physical stress on the body than sprinting. Coaches need to consider such implications when prescribing training sessions in order to monitor the volume of training workloads. Future research should investigate the accumulated load during a match situation to gain a clearer understanding of the overall physical demands of a football match.

PA13P
The effects of playing position and playing level on selected fitness test results in female soccer players.
Angwin, E.
University of Wolverhampton

Analysis of soccer match play has found that the distances covered during the game are similar across different playing levels and playing positions. The differences between playing level and playing position are seen when the total distance is broken down into different activities. Higher level players cover more distance at a higher intensity during match play. Within these total distances are around 1400 changes in activity, about one every 4 seconds (Mohr et al., 2008: Journal of Strength and Conditioning Research, 22, 341-349). These findings suggest that aerobic endurance, speed and agility are vital components of a soccer player. The purpose of this study was to investigate whether selected soccer-specific fitness tests can distinguish between playing position and playing level. Following institutional ethical approval, 40 female soccer players from one English soccer club (age 21.12 ±5.06 years) were classified by both playing position (Full Back (FB) (n = 8), Centre Backs (CD) - (n = 10), Wide Midfielders (WM) (n = 9), Central Midfielders (CM) (n = 9) and Forwards (F)
(n = 4) and playing level (National (N), (n = 15), Regional (R) (n = 5) and County (C) (n = 12) ). As part of pre-season preparation participants undertook the YoYo Intermittent Endurance Test Level 1(YIET1) followed by a 30 m sprint test and the Balsom Agility test 2 days later. Two-way (level x position) ANOVA and post-hoc Bonferroni test revealed no difference between playing positions for any of the fitness tests. The mean distance covered in the YIET by the National players was greater than that covered by the Regional (P = 0.015) and County (P = 0.000) players. No difference between playing level was found for the 30 m sprint test. National level players had faster Balsom test times than County (P = 0.027) players and no difference was found between National and Regional players. The level x position interaction was not significant (P < 0.05) for all fitness tests. Whilst differences have been found between match activities between positions these differences are not shown in the selected fitness test results for female soccer players (Vescovi et al., 2006: Journal of Sports Medicine and Physical Fitness, 46, 221-226). The results suggest that playing position has no effect on aerobic endurance, speed and agility fitness test results. However significant differences were found amongst playing level in aerobic endurance and agility. This implies that although analysis shows that during match play different positions cover larger distances and at different intensities these differences are not shown by the selected fitness tests.
Sport and Exercise Psychology

Ps1P
The Effect of Extroversion-Introversion Level on Exercise Motivation and Sport Participation.
Grayson, M., & Wakefield, C.
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Research studies (Lochbaum & Lutz, 2005: Individual Difference Research, 3, 153–161) have shown that ‘big five’ personality factors have positive influences on exercise motivation and participation. Personality type and exercise motivation have also been linked by Huang, Lee, and Chang (2007), who found that individuals with a positive personality displayed higher levels of exercise motivation and participation. There is evidence that high-level exercisers show higher levels of extraversion than low-level exercisers, and non-exercisers (Davis & Fox, 1993: Addictive Behaviour, 18, 201 – 211), but this is yet to be assessed in relation to exercise motives. Therefore, the purpose of this study was to investigate whether team sports players, individual sports players and non-exercisers differ in their types of motivation and extroversion level. Participants (n=100, mean age = 21.07±1.77) completed the Exercise Motivations Inventory–2 (EMI-2; Markland & Ingledew, 1997: British Journal of Health Psychology, 2, 361-376), the Eysenck Personality Questionnaire (EPQ; Eysenck & Eysenck, 1975: Manual of the Eysenck Personality Questionnaire. London: Hodder & Stoughton), and demographic questions, such as preferred sport type and exercise regime. A one-way ANOVA revealed no significant differences in motives between exercisers and non-exercisers for; stress (p=.123), social (p=.238), health (p=.787), appearance (p=.842), strength (p=.675). Additionally, no significant differences were found in extraversion (p=.562). A further one-way ANOVA revealed no significant differences in motives between team and individual exercisers and non-exercisers for; stress (p=.529), social (p=.104), health (p=.741), appearance (p=.663), and strength (p=.935). However, a significant difference was found between team and individual exercisers and non-exercisers for extraversion (p=0.001). The results from this study suggest that individuals who prefer team based sports are more extraverted than their individual sport counterparts. This is in line with previous research (Eagleton, McKelvie & de Man, 2007: Perceptual and Motor Skills, 105, 265 – 276) and indicates personality differences/traits may determine the type of sport someone participates in. Additionally, it appears that motives are similar amongst this population, despite being an exerciser, or non-exerciser, team or individual preference; thus implying alternative reasons for the difference in participation levels. As a result of the similarity in motives, it is recommended that further study is carried out to assess the reasons and potential barriers of participation, particularly in non-exercising individuals. Additionally, physical activity promotion could centre on those activities best suited to the personality type, and therefore sport preferences, of the non-exercisers. This information can then be combined and used to tailor promotional campaigns to increase exercise levels in these populations.

Ps2P
Mental toughness: Linking business and sport.
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Sheffield Hallam University

Many sporting ex-professionals, coaches and sport psychologists consult or speak in the business sector, often, with an aim of improving corporate performance and productivity. However, it has not been shown that factors which are important in the sporting environment are relevant in the business sector. In recent years, mental toughness has become one of the most talked about topics in sport and is considered important for optimal performance (Jones et al, 2002: Journal of Applied Sport Psychology, 14, 205-218). The purpose of the present
The mission of UK Sport is ‘to work in partnership to lead sport in the UK to World Class Success’ (UK Sport, 2009: Available from http://www.uksport.gov.uk/pages/about_uk_sport/ (Accessed 31/12/2008). British sporting achievements have been on the increase over the last number of years, with the climax being at the Beijing 2008 Olympics and Paralympics. UK Sport’s aim for these games was to be 8th in the medal table. For this to be achieved, the athletes were required to perform the best medal performance since 1920. Team GB achieved this aim and far more, finishing an incredible 4th in the medal table; the aim for London 2012. Excellence is something everyone wants to achieve in whatever they do whether in sport, business or life. Neuro Linguistic Programming (NLP) looks at modelling excellence. O’Connor and Seymour (1995: XII: Introducing NLP, 2nd ed. Torsons: London) state that ‘NLP is the art and science of personal excellence’. At present there is no research on how NLP can help professionals involved in sport, whether a coach, athlete or support staff. Professional development is essential to success and enhancing performance, which is the vital component in a highly skilled performance. Both NLP and professional development have a common link of enhancing performance. Therefore, in light of this gap in research, the aim of this study was to assess the long-term benefits and efficacy of the High Performance Coach Programme (NLP Practitioner) for professional and personal development. Eighteen participants took part in the study (12 male; 6 female) who had all attended the High Performance Coach Programme as part of the UK Sport Elite programme. Participants completed an online, specifically designed questionnaire, which was distributed through a third party so complete anonymity was kept. A content analysis was performed on the questionnaire results. The results showed that 100% of UK Sport respondents stated the programme had had a positive impact on their Personal and Professional Development. 100%
of UK Sport respondents reported professional benefits resulting in a direct impact on key performance variables for athletes. 100% of UK Sport respondents reported personal benefits resulting in a direct impact on their professional role as a coach. The analysis also provided seven main topics: 1) being positive, 2) resolving conflicting situations, 3) improving communication, 4) improving confidence, 5) feedback, 6) understanding people and behaviour; and 7) taking responsibility that were identified in professional and personal development. 100% of respondents reported an improvement in their understanding of people. 75% of respondents reported an improvement in their communication abilities. 38% of respondents reported they now take more individual responsibility. 50% of respondents reported they became more positive. 61% of respondents report using skills learnt on the programme to resolve conflicting situations. 66% of respondents report an improvement in personal and professional confidence. 22% of respondents report an improvement in the way they deliver feedback to athletes. The findings show that coaches and practitioners consider attending this programme as beneficial to both personal and professional development, and that based on the responses provided, benefits are seen in the following 7 areas: Understanding People and Behaviour; Improving Communication Skills; Taking Responsibility; Resolving Conflict Situations; Improving Confidence (self and others); Ability to Provide Feedback and Creating a Positive Mindset. Therefore, the assumption was made that this enhanced performance. Future research would need to be conducted to fully conclude whether the NLP skills enhanced performance in others, as at present it was how someone else perceived NLP skills to help them.

Ps4O
An Exploration of the Stress Process experienced by Field Event Athletes During Competition.
Glover, L., & Thomas, O.
University of Wales Institute, Cardiff

Athletes are commonly exposed to some form of stress during sporting competition. The transactional perspective views stress as an ongoing transaction between the person and their environment and recognises the dynamic nature of this process. Fletcher and Fletcher (Fletcher et al., 2006: An organisational stress review: Conceptual and theoretical issues in competitive sport: In Literature Reviews in Sport Psychology, edited by S. Hanton and S. D. Mellalieu. Hauppauge, NY: Nova Science) illustrated this process within their meta-model of stress, emotions and performance. However, to date, research has tended to focus upon the discrete stages of this stress process failing to adopt a holistic approach to studying the stress process as a whole. The purpose of the present study was to explore the stress process of three jump event athletes (a male triple jumper, female long jumper and female pole vaulter during competition. The participants were of elite (n = 1) and non-elite (n = 2) standard, with discipline specific competitive experience of 4 – 6 years (M = 4.7; SD = 1.2) and aged between 19 – 24 years (M = 21; SD = 2.65). A naturalistic method of inquiry was used that involved video recording participants during competition (performance data) and collecting post-competition diaries and conducting interviews reflecting on the event. The performance data and competition diaries formed the basis of the self-confrontation interviews targeted towards expanding the information collected regarding the stress process. Content analyses revealed athletes experienced both competition (environment, technical, performance and injury) and organisational stressors (equipment, officials and competition organisation). Positive and negative thoughts and feelings were reported along with behavioural responses (nervous habits). A greater amount of negative compared to positive thoughts and feelings were experienced by participants. Appraisals were limited but classified as positive and negative, with the majority of stressors appraised as positive. A variety of automatic coping strategies were demonstrated which were often used in combination with each other. Problem-, emotion- and avoidance-focused strategies were implemented in order to cope with specific stressors suggesting a link between the stressor and type of coping strategy used. The
strategies did not always result in an effective coping outcome. This study has demonstrated stress as a holistic process within field event athletes. Practically, these findings suggest athletes need to be aware of organisational and competition demands. Sport psychologists should structure interventions to improve the use and effectiveness of coping strategies in performance and help athletes in identifying which strategies are most appropriate for specific stressors. Organising competition more effectively should serve as a primary intervention to eliminate potential sources of organisational stress. Finally, at a conceptual level, the addition of behavioural responses as well as thoughts and feelings to Fletcher and Fletcher’s model may be a necessary adaptation in the future.

Ps5P
Birth Order and Sporting Performance.
Matthews, J.
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Usain Bolt, second of three. Asafa Powell, sixth of six. Justin Gatlin, fourth of four. Maurice Greene, fourth of four. Donovan Bailey, third of five. Leroy Burrell, fourth of five. Carl Lewis, third of four (Coyle, 2009: The Talent Code. NY: Bantam). Listed above are the world-record progressions for the 100-Metre sprint; Usain Bolt’s record being the most recent. Also listed is their birth rank; in other words, the order at which they were born in their family. Noticeably, there are no firstborns among the list. A study by Perkin (2003: British Medical Journal, 327, 1473-1474), when looking at whether birth order has any effect upon playing position among professional football league players, found that of the total number of participants, the majority were youngest children: 110 youngest; 68 eldest and 54 middle-borns. More recently, Sulloway and Zweingenhaft (2010: Personality and Social Psychology Review, 14 (4), 402-416) found younger siblings have longer careers and play in more Major League Baseball (MLB) games than their respective elder siblings; they were also more likely to hit home runs. The above studies highlight a propensity for younger siblings to outperform their older siblings within the sporting arena. The present study will measure the incidence of birth order among two performance standard groups of youth football players, when compared to birth order statistics from the National Office for Statistics (2009: Statistical Bulletin: Who is having Babies?, 1-11). The research will further the scarce pool of research in this field at present and as a consequence, highlight avenues for further investigation. Group 1 participants’ (N = 30) with a mean age (M = 12.67 SD 2.202) and were part of the U12, U14 or U16 age groups in the Dorset County Girls Centre of Excellence. Group 2 participants (N = 41) with a mean age (M = 12.59 SD .974) and were part of the U12, U13 or U14 age groups in the AFC Bournemouth Centre of Excellence. A case study approach was utilised via a convenience sampling method, in order to analyse the two performance standard groups stated above. The research design involved the collection of primary, quantitative data via a questionnaire. The questionnaire required the participants parents to provide minimal details of their child, pertaining to their age, what birth rank they are and the age gaps between their nearest older and younger siblings, if applicable. Results were generated by implementing an online version of the chi-squared test in order to measure the significance of difference between the observed and expected frequencies. The P value produced was 0.0015, and therefore statistically significant. Participants in the study had a higher mean number of siblings (n = 1.85) than would be expected in the general population (n = 1.9 children per women born in 1964 (Office for National Statistics, 2009: Statistical Bulletin: Cohort Fertility, 1-8). This highlights a propensity for children from larger families to excel in sport. Furthermore, the mean birth rank was 2.06, indicating a greater proportion on participants to be later-born children. The findings of the study therefore, extend those of Perkin (2003: British Medical Journal, 327, 1473-1474) that highlight a greater proportion of later-born siblings earning a career in sports. As yet, no research has studied the incidence of birth order among performance standard youth football players and so will further the findings of Sulloway and Zweingenhaft (2010: Personality and Social Psychology Review,
Ps6O
A qualitative investigation of the effects of type 1 diabetes on anxiety levels in everyday life.
Moore, M., & Wasley, D.
University of Wales Institute, Cardiff

Living with chronic disease and infirmity is linked with a need to modify daily living patterns and compliance to medication regimes can lead to anxiety. This study investigates the relationship in type 1 diabetics’ day to day living experience and their experiences of anxiety. A mixed method design was used to collect data on state anxiety, trait anxiety and their perception of control over the symptoms of their diabetes. Semi structured interviews were used to obtain in depth detail on daily experiences, symptoms, physical activity and anxiety. The sample comprised of 3 female and 4 male type 1 diabetics, ranging in age between 18-80 years without any reported co-morbidities. Preliminary findings include: increased state anxiety when sugar levels were at hypoglycaemic or hyperglycaemic levels, especially when there was no known reason for the change in levels. State anxiety also increased when participants were unable to follow a set routine because of circumstances outside their control. A common theme from the interviews included anger and frustration from participants about their condition, because of changes that had to be made to their lifestyle following being diagnosed with the condition. The majority of female participants associated feelings of embarrassment toward the condition, resulting in medication only being taken in private – a theme not observed in the males experience. This work suggests that type 1 diabetics and especially those newly diagnosed, suffer anxiety in everyday life as part of the symptoms of the disease and the accompanying medication routine. Type 1 diabetics should receive support to address these issues that may be high enough to prevent them from normal day to day activities.

Ps7O
A qualitative investigation into the effects of anxiety on netball performance.
Williams, C., & Neil, R.
University of Wales Institute, Cardiff

The purpose of the present study was to qualitatively investigate how anxiety influences the performance of netball players through an approach that allows responses to actual performance to be examined. Through the adoption of a qualitative design, five participants were filmed over three games each, with video footage being clipped into six specific performance scenarios for each player. Supported by the video footage scenarios, semi-structured interviews were conducted to gain in-depth information about the performers experiences of anxiety and implications on actual performance during each scenario. The findings of the current study provide partial support for the descriptive predictions of the CAT model (Fazey and Hardy, 1988: British Association of Sports Sciences Monograph no.1. Leeds. The National Coaching Foundation.), with specific explanations as to how and why anxiety effects performance also identified. These explanations were coherent to the hypotheses of PET (Eysenck and Calvo, 1992: Cognition and Emotion, 6, 409–434.), suggesting that performance is affected (either positively or negatively) when experiencing anxiety, through the mechanisms of focus and effort. However, there were cases that did not support any of the models or theories, suggesting that there may be merit in researching other emotions that may be experienced alongside anxiety, and their combined affect on performance.
From youth team to first team: An investigation into the transition experiences of young professional athletes in football.
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Within recent years, talent development in sport has received much consideration (Pummell et al., 2008: *Psychology of Sport and Exercise, 9*, 427-447). To reach the top level of competitive sport, athletes commit heavily physically, socially and financially until participation is terminated. Research over the past 25 years (e.g. Grove et al., 1997: *Journal of Applied Sport Psychology, 9*, 191-203) has examined athlete retirement from sport, reporting career termination as potentially very difficult for many athletes, with up to 15% facing serious difficulties after they retire (Wylleman, 1995: Symposium presented at the IXth European Congress of Sport Psychology, Brussels, Belgium). This literature also suggests that athletes tend to adjust to retirement better if they do so voluntarily, having made plans for their future outside sport. Wylleman (1995) suggested that this is because having an identity that is not solely defined by sporting success but also by social experiences, and success outside the sporting domain can help an athlete to adjust to retirement. Although there has been an expansive amount of literature on retirement from sport, very little research has been carried out into within-career transitions. As a consequence, little is known about the within-career transitions an elite athlete must go through in order to be successful, including the transition from being a youth athlete to a professional athlete. As a result, the aims of this study were to explore the subjective experiences of players going through a transition from full time youth level to full time first team football, and to assess the social support mechanisms used to help players deal with this transition. Five male players who underwent a career transition from being a full time youth footballer to a full time first team footballer at a Scottish Premier League (SPL) football club were interviewed. The inclusion criteria for this study entailed that all participants had been contracted to play football with the SPL club’s youth team and that they had been offered, and accepted, a contract to play and train with the first team squad full time. This inclusion criterion was selected in order to capture the experience of the subjects going through the transition, rather than using retrospective interviewing which may miss out on essential data which could have had a profound effect on the experience of the athlete (Wengraf, 2001: *International Journal of Sport Psychology, 17*, 337-363). At the time of the interview, all participants were aged between 17 and 19 years of age and two had competed at international youth level for Scotland. Interviews were based on the work of Pummell et al. (2008) and Bruner et al. (2008: *Journal of Applied Sport Psychology, 20*, 236-252). The players were interviewed twice, once before they made the transition into the first team and once after they had made the transition into the first team. Inductive and deductive data analyses were conducted on the data. Supporting the work of Pummell et al. (2008), five categories were identified (motivation for the transition, perceptions of the transition, stressors, social support and post transitional changes). It was found that family, friends, coaches and teammates were crucial throughout the transition, providing emotional, technical and tangible support to the players making the transition. Furthermore, players were found to make considerable sacrifices in their pursuit of an elite football career. Overall, the findings suggest that young athletes, family, friends and coaches should be made aware of the possible stressors a player may face moving into elite sport to ensure the effects of those stressors can be alleviated as far as possible.
The Effect an Imagery Script Has On Force Production in the Squat Jump.
Moore, J., & Harper, D.
University of Central Lancashire

Researchers have long been interested in the study of imagery and its effect upon motor and skilled performance (Nordin et al., 2006; Journal of Applied Sport Psychology, 18, 345-362; Feltz & Landers., 1983; Journal of Sport Psychology, 5, 25-57.). The purpose of this study was to examine how using an imagery script over a long term (4 weeks) and immediately preceding period will effect force production on a maximal effort squat jump. With institutional ethical approval 30 healthy male untrained higher education volunteers (age 20 ± 1.7years, height 179.8 ± 7.9cm, body mass 77.5 ± 12.4kg, body fat % 17.9 ± 2.4) were randomly allocated to one of three groups, long term intervention (EX.1: n = 10 males), immediately preceding intervention (EX.2: n = 10 males), and control group (CG: n = 10 males). EX.1 undertook four weeks of guided self administered imagery by means of a audio cd using a diary to record adherence once a day, in the morning, for six minutes, three days a week (Wakefield & Smith, 2009; Journal of Imagery Research in Sport and Physical Activity, 4, 7); EX.2 received supervised guided imagery immediately preceding the exercise and the CG immediately undertook the exercise receiving no imagery intervention. Pre- and Post-testing using an Olympic bar (20kg) was used for the three groups. Displacement data was recorded for each trial using a linear encoder. The participants were fully instructed in the squat jump according to the protocols recommended by Beachle and Earle (2008) and asked to perform the jump three times, using the best effort as maximal. Data analyses from pre-test and post test will be investigated by use of a 3 x 2 repeated measures ANOVA to determine the effect of the interventions over the CG. The results of this study will show if there is a relationship between imagery and neuromuscular coordination in the squat jump, therefore assisting potentially in the development of strength and conditioning practice thus validating the benefits of this type of intervention.

A comparison of approach-avoidance achievement goals between female team and individual sport athletes.
Burke, S., & Maher, J.
Loughborough College

Findings regarding achievement goal orientations among team and individual sport athletes have been somewhat inconsistent. Additionally, research focused directly upon goal orientations among female athletes is limited. Grounded in the 2x2 achievement goal framework (Elliot and McGregor, 2001: Journal of Personality and Social Psychology, 80, 501-509), the purpose of this study was to examine and compare levels of achievement motivation between 76 female athletes from a range of team and individual sports including field hockey (n=23), netball (n=22), taekwondo (n=13) and football (n=18), (M=22.50, ± 6.517). Achievement motivation was assessed through the use of the AGQ-S (Conroy et al., 2003: Journal of Sport and Exercise Psychology, 25, 456-476). The AGQ-S comprises four 3-item subscales which measures the four goals. Responses were scored on a 7-point Likert scale ranging from 1 (“not at all like me”) to 7 (“completely like me”). The AGQ-S has reported strong psychometric properties in terms of stability and external validity. The lead researcher visited each club before a regularly scheduled training session to distribute and collect the questionnaires. A one way ANOVA was used to analyze the data, sports were compared against one another in relation to the four goal types. Results revealed that hockey (p=.018), taekwondo (p=.005) and netball (p=.000) were all significantly different to football in relation to mastery approach goal orientation. Mean averages revealed that football players possess the lowest level of mastery approach orientation (6.037) compared to athletes from the other sports. Furthermore, mean averages also indicated that football players display the
highest levels of performance avoidance goal orientation (4.537). From an applied perspective sport psychologists and coaches may find it beneficial to target female footballers to design and implement interventions which will reduce levels of performance avoidance motivation, which has been linked with negative outcomes such as fear of failure, low self determination and impaired performance. Interventions should encourage, enhance and facilitate mastery approach goal orientation in an attempt to elicit positive outcomes regarding self determination in sport.

Ps11O
The Influence of Social Support upon Adherence to Rehabilitation Programmes.
Wareing, G., & Mitchell, I.
University Wales Institute, Cardiff

Social support is an important process that has been researched in both general and social psychology. However, due to the prevalence of sporting injuries, the complexity of associated psychological responses during rehabilitation and the implications these experiences may have upon performers, many psychologists are now acknowledging this important construct within the injury and sport performance literature. Social support has been defined as a complex, multi-dimensional process that is divided into structural, perceptual and functional dimensions (Bianco and Eklund, 2001: Journal of Sport and Exercise Psychology, 23, 85-107). The process operates by influencing health and well-being, inducing a positive outcome (Shumakeer and Brownell, 1984: Journal of Social Issues, 40, 11-36). Another important variable in the rehabilitation process is adherence to rehabilitation, which is also multi-factorial in nature (Webborn et al., 2007: Journal of Sports Rehabilitation, 6, 54-61). Both social support and adherence have been identified as coping resources, in the comprehensive stress-response model proposed by Wiese-Bjornstal et al. (1998: Journal of Applied Sport Psychology, 10, 46-69). A number of researchers have studied social support and adherence behaviours and reflect the importance of social support when undertaking sport rehabilitation programmes. The main purpose of this study was to expand upon this research and explain how important social support is upon adherence behaviours. The study utilised a purposive sample of 4 female participants, competing in variety of sports, at county and international level. The data was collected via semi-structured interviews that allowed participants to reflect upon and articulate their experiences when injured. All interviews were transcribed verbatim and subjected to thematic content analysis. The findings revealed a variety of common themes and supported the themes reported in previous studies. The key findings included: 1) social support provides injured athletes with confidence in relation to adherence; 2) emotional support is important during the initial stages of injury rehabilitation, and; 3) perception of social support is vital in order to achieve adherence behaviours. With regards to practical implications, it is important for coaches to provide both emotional and informational support to the injured athlete. Additionally, measures should be taken to ensure there is a perceived availability of support for athletes.

Ps12P
An investigation of coping antecedents in relation to injury.
Parry, E., & Mitchell, I.
University Wales Institute, Cardiff

The purpose of this study was to investigate an athlete’s ability to cope and the possible existence of coping antecedents when coping with sporting injury. With sport being considered as a breeding ground for physical injury, investigating an athlete’s ability to deal with the resultant stressors is an important area of research. The aim of the study, therefore, was to focus on the influence of person-related antecedents on an athlete’s ability to cope with sporting injury. The sample used for this study was made up of four female footballers from
the University of Wales Institute, Cardiff. All participants suffered an injury in the last 12 months which kept them out of training and competition for at least 6 weeks. A semi-structured interview guide was used to conduct the interviews, which involved discussions about appraisals, stressors, coping, responses and antecedents. The interview recordings were then transcribed and coded. The results suggest the existence of three person-related antecedents: confidence, anxiety and previous injury experience. Also the type of injury which the athlete experienced appeared to affect which coping strategy they chose, with the athletes who suffered an on-going overuse injury choosing avoidance or emotion-focused coping. These findings should provide suggestions for ways to help an athlete recover as effectively and efficiently as possible from injury. Future research should investigate the existence of socio-environment antecedents as well as other person-related antecedents, which may influence an athlete’s ability to cope with injury. The interaction between person-related antecedents and socio-environment antecedents should also be examined as this may affect the individual antecedent’s effect on coping.

Ps13O

Behaviours of world-class athletes: What do we see on the pitch?
Dalton, S., Minniti, A. M., & Hill, R.
Nottingham Trent University

The key concepts of sport psychology and mental skills are seldom introduced to athletes in adolescence when the greatest gains in understanding and development might be made (Sherman & Poczwardowski, 2005: In Sport Psychology in Practice, edited by M. Andersen. Champaign, IL: Human Kinetics). When athletes can spot how particular actions lead to certain outcomes, this helps to raise their self-awareness of what are 'good' or less good behaviours. The purpose of the current study was to assess young athletes' awareness of the influence of positive and negative behaviours on an international playing environment. Following university ethics approval, young spectators (11 – 16 years) completed behaviour checklists whilst observing England Women (n=5) and Great Britain Men (n=4) field hockey matches during international tournaments held in the East Midlands. Based on the literature, eight primary behaviours (along with examples) were identified for the checklist, comprising confidence, motivation, anxiety, attention/concentration, teamwork, communication, leadership, and aggression/anti-social behaviour. Seventy-six young spectators (male = 23; female = 37; not specified = 16; (M ± SD) 13.32 ± 1.47 years of age, and 4.29 ± 2.87 years of hockey experience) independently completed the behaviour checklists during the match they attended. Young spectators’ observations were compared to those of an expert coder who analysed video output of each match using software (Dartfish). A series of one-sample t-tests were conducted to compare observations of young spectators with the expert coder. Several differences were found for both England Women and Great Britain Men matches. Young participants tended to note fewer occurrences than the expert for all eight behaviours. In particular, young spectators were less likely to identify concentration and communication behaviours than they were to recognise anxiety and aggression. Overall, the results indicated that young spectators were aware of and able to successfully identify behaviours on the pitch; however, some of the behaviours appeared more difficult to identify then others. Findings could reflect differences in age (across young participants and compared to the expert coder), amount of previous hockey experience, and/or the tendency for spectators to notice negative behaviours in the playing environment more frequently than positive behaviours. The current research provides preliminary support for the need to raise awareness of psychosocial behaviours in sport. Future research should include follow-up measures with observers to assess their perceptions of how particular behaviours may influence subsequent performance. A long-term objective would be to develop a mass self-regulation initiative by using participant assessments of the environment to inform and educate their own behaviour.
Ps14O
Reinvestment within Action sports; how risk will affect any stage of a career.
Douglass, D., Tayler, M., & Golby, J.
Teesside University

The aim of this study was to explore the influence of risk on the potential differences within an athletes’ propensity to ‘reinvest’ in their actions. The current study focused on the arena of action sports such as skateboarding and BMX, which have yet to be examined with regard to the cognitive processes that take place throughout skill execution. One of the main cognitive actions is the tendency to consciously moderate the performed action during the movement. This relates to the term ‘reinvestment’, which is defined as the ‘manipulation of conscious, explicit, rule based knowledge, by working memory, to control the mechanics of one’s movements during motor output’ (Masters and Maxwell, 2004, *Skill Acquisition in Sport: Research, Theory and Practice*, London, Routledge). Reinvestment has been shown to have a significant detrimental effect on motor performance when combined with a stressor. Successful stressors include physiological fatigue (Poolton et al., 2007, *Consciousness and Cognition*; 16, 456-468), and psychological stress such as evaluation apprehension (Gucciardi and Dimmock, 2008; *Psychology of Sport & Exercise*; 9, 45-59). Therefore, it is feasible for such an effect to occur in action sports due to the elevated risk factor coupled with mass audience spectatorship. Reinvestment has been measured using multiple scales, with the most applicable for sport being the Movement Reinvestment scale (Masters et al., 2005: In *Proceedings of the ISSP 11th World Congress of Sport Psychology*, Sydney, Australia, 15-19 August, edited by T. Morris et al.). This scale is comprised of two factors: Movement Self-Consciousness and Conscious Cognitive Processing, and a total score. A total of 613 participants were analysed from five action sports (AS) stores across the United Kingdom and a network within Europe and the United States. In addition, a control sample of 248 was obtained from a combination of clubs that were considered to be of a general sporting nature (General Sports group [GS]). The first independent variable was ‘experience’, which divided the sample into six groups according to number of years of experience they held within their chosen sport (AS novice, AS intermediate, AS experienced, GS novice, GS intermediate, GS experienced). The second independent variable was ‘status’, which developed four groups (AS amateur, AS professional, GS amateur, GS professional). Results showed that excluding the novice groupings, those within the AS groups scored significantly higher on both in total and subscale measures than their GS counterparts within both independent variables. The patterns of ‘reinvestment’ displayed by the GS groups were in agreement with literature demonstrating a significant decline as experience increased. Contrary to this, reinvestment within the AS groups increased significantly between novice and intermediate stages followed by a significant decrease with the progression to an experienced level. The AS professional group scored significantly higher than the AS amateur group, while a reverse effect was found within the GS counterparts. The key implication of these findings for coaching, therefore, is that action sports should adopt a means of implicit based training that would be more sensitive to the characteristic of reinvestment.

Ps15P
The difference in sources of sport confidence in netball and trampolining.
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Newman University College

Self-confidence can have an important influence upon sporting performance (Vealey, 2001: in *Handbook of sport psychology* edited by R.N. Singer, H.A. Hausenblas, & C.M. Janelle. New York: John Wiley & Sons, Inc). As such, understanding the sources of confidence used by athletes to inform their own efficacy perceptions is an important consideration if coaches and sport psychologists are attempting to maximise performance. Previous research has shown that the importance placed upon specific sources varies depending on individual or team sport
participation (Vealey, et al 1998: Journal of Sport & Exercise Psychology, 20, 54–80) and gender (Hays, et al. 2007: Journal of Applied Sport Psychology, 19, 434–456). As there is little research on differences in sources of sport confidence between team and individual sports on females specifically, the purpose of this study was to examine differences in sources of sport confidence of females in individual and team sports. Specifically, the study examined sources of sport confidence in netball players (team sport) compared to trampolinitis (individual sport). Following institutional ethical approval, the study employed 42 female undergraduates (netball = 21, trampolining = 21), who completed the Sources of Sport Confidence Questionnaire (SSCQ) (Vealey, et al 1998: Journal of Sport & Exercise Psychology, 20, 54–80) once within a normal timetabled training session a week before a match or competition. The results shown mastery [netball (M= 27.86 ± 4.25); trampolining (M= 27.95 ± 4.07)], demonstration of ability [netball (M= 30.14 ± 7.60); trampolining (M= 29.48 ± 7.17)], physical self presentation[netball (M = 14.05 ± 3.99); trampolining (M= 13.86 ± 3.88)], social support [netball (M=35.81 ± 4.59); trampolining (M= 32.48 ± 5.15)], coaches leadership [netball (M=26.76 ± 5.85); trampolining (M= 24.10 ± 4.16)], vicarious experience [netball (M= 25.48 ± 5.17); trampolining (M= 21.86 ± 4.04)], environmental comfort [netball (M = 19.67 ± 4.85); trampolining (M = 18.10 ± 2.84)] situational favourableness [netball (M=15.05 ± 2.85); trampolining (M= 12.48 ± 2.79)], physical/ mental preparation [netball (M= 31.52 ± 5.16); trampolining (M= 28.95 ± 4.19)]. The Independent t-test and Cohen’s d suggested only three of the subscales; social support (t_{39.47} = 2.131, P = .033, d=0.7), vicarious experiences (t_{17.79} = 2.526, P=.016, d=0.8) and situational favourableness (t_{17.98} = 2.954, P=.005, d = 0.93) showed significant differences between the two sports. It is evident from the findings that netball participants rank social support and physical/mental preparation as the two most important sources of sport confidence, whereas trampolining rank social support and demonstration of ability as most important. Social support could be ranked highest for both sports, as females rely on support from their coaches, family and team mates in order to do well in comparison to males. The difference in the other two sources could be that netball players as a team will have an optimal focus on the game, whereas trampolinitis need to compare their ability to their team mates in order to be successful and improve. The findings support previous research (Vealey, et al 1998: Journal of Sport & Exercise Psychology, 20, 54–80) as social support, physical/mental preparation and mastery were rated the highest ranked for college athletes. These findings overall emphasise the benefit of considering sources of sport confidence as team and individual sports rely upon different sources.

Ps16P  
Experiences of Olympic competition: Home advantage or disadvantage?  
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The Olympic Games can be the most challenging and important competition that athletes will experience. In this unique pressurised environment some athletes are able to cope with the added demands and meet, or exceed, expectations, whilst others fail to fulfil their aspirations (e.g., Greenleaf et al., 2001: Journal of Applied Sport Psychology, 13, 154–184). Therefore, investigations into peak performance and perceptions of Olympic competition have become fruitful lines of enquiry in further understanding elite performance. Despite the importance of this line of investigation, there is little information on athletes’ experiences of competing in the Olympic Games at a home venue. Therefore, the aim of this study was to explore how participants’ experiences differ at home and away Olympic Games, and thus ascertain any different pressures perceived in relation to a home Olympics. Participants were two Summer Olympic athletes and one coach who had competed at a home and away Olympic Games, between Barcelona 1992 and Beijing 2008. Semi-structured interviews were completed via the telephone, transcribed verbatim, and analyzed using both a content analysis and case study approach. Positive and negative Olympic experiences compared favourably to existing
Recent research has revealed that various psychological syndromes such as a reduced sense of accomplishment (RA) and devaluation towards sport participation (DE), as well as physical and emotional exhaustion (EE) characterise burnout in athletes (e.g., Hill et al., 2010: *The Sport Psychologist, 24*, 16-34). Athlete burnout is a negative outcome associated with psychological and physical ill-being altogether (Cresswell & Eklund, 2004: *Journal of Science and Medicine in Sport, 7*, 481-487). One of the main personality characteristics that can underpin burnout is perfectionism (Hill et al., 2008: *Psychology of Sport and Exercise, 9*, 630-644). Perfectionism is a stable personality trait that is commonly typified by striving for flawlessness, combined with critical tendencies and contingent self-worth. Therefore, it could be argued that all outputs will be unacceptable because of the perfectionist’s critical tendencies. Two dimensions that capture the debilitating nature of perfectionism are self-oriented perfectionism (SOP) and socially-prescribed perfectionism (SPP). Both SOP and SPP are associated with excessive concern over mistakes and negative evaluation, leading to little satisfaction (Flett & Hewitt, 2002: In *Perfectionism: Theory, research, and treatment*, edited by G. L. Flett and P. L. Hewitt, Washington, DC: American Psychological Association). Given the negative effects of SOP and SPP, it is crucial for sport psychologists to protect athletes from the perils of these perfectionism dimensions. According to Appleton et al. (2009: *Psychology of Sport and Exercise, 10*, 457-465), this may be possible via the coach-created motivational climate. However, no study to date has investigated whether a motivational climate will help protect athletes from the deleterious consequences of perfectionism. The purpose of this research was to address this shortcoming in the research, and determine whether the coach-created motivational climate reduces and/or exacerbates the negative effects of SOP and SPP on athlete burnout among athletes with or without hearing disabilities. A total of 320 deaf (Age: $M = 27.36$, $SD = 9.5$) and hearing athletes (Age: $M = 21.14$, $SD = 4.3$) were recruited from different sports clubs across the UK. Participants completed a multi-section questionnaire pack before or after a training session, which included the Multidimensional Perfectionism Scale (Hewitt & Flett, 2004: *Multidimensional Perfectionism Scale: Technical Manual*. Toronto, Canada: Multi-Health Systems Inc); the Perceived Motivational Climate in Sport Questionnaire-2 (Newton et al., 2000: *Journal of Sports Sciences, 18*, 275-290); the Autonomy-Supportive Coaching Questionnaire (Williams et al., 1996: *Journal of Personality and Social Psychology, 70*, 115-126); the Social Support Questionnaire (Sarason et al., 1987: *Journal of Social and Personal Relationships, 4*, 497-510); the Controlling Coach Behaviors Scale (Bartholomew et al., 2010: *Journal of Sport & Exercise Psychology, 32*, 193-216), and the Athlete Burnout Questionnaire (Raecke & Smith, 2001: *Journal of Sport and Exercise Psychology, 23*, 281-306). Moderated regression analyses revealed that negative facets of the motivational climate were a significant moderator of the relationship between SOP, SPP, and indicators of athlete burnout (RA: $R^2 = .17, F(8, 311) = 9.31, p < .001$; EE: $R^2 = .14, F(8, 311) = 7.24, p < .001$; DE: $R^2 = .23, F(8, 311) = 12.64, p < .001$) in deaf and hearing athletes. These
results indicated that the negative effects of SOP and SPP were exacerbated by the maladaptive aspects of performance and controlling-coach climates. The adaptive aspects of mastery, autonomy-supportive, and socially-supportive climates did not emerge as significant moderators ($p > .05$). It is concluded that the research findings may provide coaches with useful insights into how the coach-created motivational climate may protect athletes from the perils of both self-oriented and socially-prescribed perfectionists.

Ps18O

The impact of exercise on body image.

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Concerns about body image have traditionally been thought to be a female preoccupation. However, societal and cultural trends suggest that body image concerns may also affect males. Davis (2004: In Body image and athleticism, edited by T. Cash and T. Pruzinsky. New York: Guilford Press) suggested that satisfaction/dissatisfaction with the body may be influenced by an individual’s exercise and physical activity behaviour. Research has favoured the participation in aerobic exercise as it has been shown to enhance body image (Hausenblas and Fallon, 2006: Psychology and Health, 21, 1, 33-47). The purpose of the study was to examine the impact of exercise on body image and the variables that may moderate this relationship, namely gender and exercise mode. It was hypothesised males would have a more positive body image than females and that individuals who engage in aerobic exercise would also have a more positive body image in comparison to their counterparts. Following ethical approval from the University’s Research Ethics committee, an opportunistic sample of 100 adults (male = 51, female = 49) was collected. Participants’ gender, age and the exercise variables of interest; exercise frequency and mode, were assessed using a demographic questionnaire. Body image was measured with the Multidimensional Body-Self Relations Questionnaire (MBSRQ) (Cash, 2000: The multidimensional body self-relations questionnaire. Virginia: Old Dominion University). Internal consistency coefficients for five of the ten MBSRQ subscales were found to be acceptable (0.771 ± 0.896). The results of the Independent t-tests suggested there were statistically significant differences between gender in health orientation ($t_{93.030}=4.619$, $P=.041$). Cohen’s $d$ suggests large effect sizes between gender and appearance evaluation ($d=0.94$), fitness orientation ($d=0.86$), illness orientation ($d=0.94$) and health orientation ($d=0.92$). The results of the Pearson’s correlations suggested there was a statistically significant relationship between the frequency of aerobic exercise and fitness orientation ($r= .329$, $P=.001$). $R^2$ suggests 10.82% of the variation in fitness orientation can be explained by the frequency of aerobic exercise. The results of the Pearson’s correlations suggested there were statistically significant relationships between the frequency of resistance exercise and appearance evaluation ($r=.283$, $P=0.004$), fitness evaluation ($r=.259$, $P=0.009$), fitness orientation ($r=.438$, $P=0.001$), health evaluation ($r=.329$, $P=0.001$), health orientation ($r=.418$, $P<0.0001$) and body areas satisfaction ($r=.367$, $P<0.0001$). $R^2$ suggests 8.01% of the variation in fitness orientation, 6.71% of the variation in fitness evaluation, 19.18% of the variation in fitness evaluation, 10.82% of the variation in health evaluation, 17.47% of the variation in health orientation and 13.47% of the variation in body areas satisfaction can be explained by the frequency of resistance exercise. Participants who engaged in resistance exercise were found to have a more positive body image. Higher means and statistically significant relationships were found for those who engaged in resistance exercise in comparison to aerobic exercise. This finding contradicts that of Hausenblas and Fallon (2006: Psychology and Health, 21, 1, 33-47) who found that participation in both aerobic and anaerobic exercise was associated with a more positive body image. These results can be explained by the greater importance on appearance when it comes to resistance exercise, resulting in a more diligent exercise regime, with the effect of feeling more satisfied with their appearance because of moving closer to achieving one’s goal or ideal. Exercise frequency was similar between genders, however, resistance exercise was significantly higher...
in men. From looking at descriptive statistics, a more positive body image was reported in men, therefore supporting the findings by Furnham and Calnan (1998: European Eating Disorders Review, 6, 58–72) that women are more dissatisfied with their body than men. The results suggest that gender has no statistically significant effect on body image whereas exercise mode appeared to be important in participants’ evaluation of a number of variables, showing statistically significant relationships with resistance exercise in particular.

Ps19P
The relationship between physical and mental fatigue during training for professional rugby league players.
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Bartley (1976: Psychological Aspects and Physiological Correlates of Work and Fatigue, 13, 94-97) indicates fatigue is biological incapacitation. Holding (1983: Stress in Human Performance, Wiley 145-167) suggests that only physical activity leads to fatigue. These early researchers suggest fatigue is a unidimensional construct. However, Urhausen (2002: Sports Medicine, 32, 95-102) and Filare (2001: European Journal of Applied Physiology, 82, 179-184) demonstrated that rigorous exercise increases physical and mental fatigue. Mental fatigue was defined by Akerstedt (2003: Acta Psycholgica, 113, 45-65) as cognitive impairment. Physical fatigue is defined as the inability to maintain power output (Newsholme, 2011: The Journal of Nutrition, 45, 274-276). Contemporary research suggests fatigue is a multidimensional construct. Training for rugby league players is high intensity and high in volume. It incorporates multi-faceted aspects of physical conditioning (Argus, et al., 2010: Journal of Sports Sciences, 28, 679 - 686). To achieve the greatest amount of physical adaptation, players typically train multiple aspects of performance; this may cause physical and mental fatigue (Kraemer et al., 1995: Journal of Applied Physiology, 78, 976-989). In this study mental fatigue was expected to have a significant effect on physical fatigue. Mental and physical fatigue was expected to change over the six week measurement period. Twenty-two subjects at elite level in rugby league were given an adapted version of Wessely and Powell’s (1989: Journal of Neurology, Psychiatry, 52, 940-948) Fatigue Symptoms Assessment Questionnaire. The questionnaire features thirteen items that assess levels of mental and physical fatigue. A likert scale was used to assess the two constructs; the items were scored and anchored by levels of truth, 1 (untrue) to 5 (true). Participants completed the questionnaire once per week at the same time, over six weeks. Participants’ scores were measured in order to assess any changes in levels of physical and mental fatigue. Data will be analysed using a paired sample t-test to determine the significant effect of mental fatigue upon physical fatigue. A repeated measures ANOVA will be conducted to identify changes in fatigue over the six week period.

Ps20O
Exploring the 4 W’s of self talk in elite fast bowlers: Where, When, What and Why?
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Self talk has been researched for many years. The most complete definition of self talk is by Hardy, Hall and Hardy, (2005: Journal of Sports Sciences, 23, 905) which defines self talk as a “multidimensional phenomenon concerned with athletes’ verbalizations that are addressed to themselves, which can serve both instructional and motivational functions”. Self talk is a complex psychological technique therefore understanding where, when, what, and why athletes self talk needs to be established. Previous research on ‘where’ athletes use self talk has identified that it is employed both in the sporting environment and in other areas of the athlete’s lives for example at home. ‘When’ athletes self talk has been divided into pre, during
and post training and competition. Research on ‘what’ athletes self talk considers the nature, structure, person, and task instruction of the content. Findings suggest that there is a close link between athletes self talk and coach feedback; if they receive negative feedback then the athlete will self talk in a negative manner. Research on ‘why’ athletes use self talk has established that it can help improve in the learning and maintenance of new skills, motivation, focus, confidence, pain control, arousal and anxiety control. The aforementioned research into self talk has considered a wide range of individual and team sports at different levels. However research within cricket is sparse. The author is aware of two studies that have used self talk as an intervention in cricket batting but to date is unaware of any studies that have explored the use of self talk by fast bowlers. Fifteen professional fast bowlers who have played at least one first class match prior to the study consented to participate (8 ex- or current international and 7 current county cricketers, mean age 28.4 years old). Data was collected through the use of the 4 W’s questionnaire (Hardy, Gammage and Hall, 2001, *Sport Psychologist, 15*, 306-318) and individual follow up interviews. The data was collected over the English county cricket season 2010. Data was inductively and deductively analysed for themes and displayed in hierarchical trees similar to (Hardy, Gammage and Hall, 2001, *Sport Psychologist, 15*, 306-318). Results showed most common responses for ‘Where’ and ‘When’ were similar to findings from previous research (Hardy, Gammage and Hall, 2001, *Sport Psychologist,15*, 306-318) The ‘What’ category revealed task specific instruction such as ‘get the yorker full’, ‘drive at the target’ and ‘attack the run up’ and phrases like ‘be aggressive’, ‘stay patient’ and ‘top of off’ had the highest frequency which differs from previous research. The ‘Why’ category motivational (72.5%) was similar to previous research, specifically; increase drive, self confidence and focus. Cognitive revealed all participants used self talk for skill execution. The findings highlight that coaches and sport psychologist should provide feedback in phrases form to facilitate the self talk already being used. However understanding the players self talk prior to feedback is vital.

**Ps21P**

**Investigating the Effects of Pre-performance Routines on Quadrathlon Performance and Performance Consistency.**

Boulter, M., Fitzpatrick, N., Leach, H., & Church, D.

*University of Chichester*

Pre-performance routines are commonly recommended by sport psychologists to help athletes overcome issues relating to anxiety and disrupted concentration induced by the pressure of competition (Mesagno, Marchant & Morris, 2009: *The Sport Psychologist, 22*, 439–457; Singer, 2002: *Journal of Sport & Exercise Psychology, 24*, 359–375). The current study aimed to examine the effects of a pre-performance routine on overall performance and performance consistency i.e., in a real life setting using competitive athletes in a self paced, power sport. The participants were three competitive male athletes all currently in their winter training phase. They had all competed, within their individual disciplines (2 javelin throwers and 1 hammer thrower), to a minimum of county standard. They were aged either 16 or 17 (M = 16.3 years, SD = 0.6 years). A single-subject staggered multiple-baseline-across-participants design was used in this study. The study took place over a 9 week period and the intervention was introduced across Participants 1, 2 and 3 at the beginning of weeks 4, 5 and 6 respectively. Performance data were collected from each participant, during weekly training sessions, through completion of the Max Jones Quadrathlon (http://www.brianmac.co.uk/quad.htm, 1997). The quadrathlon consisted of four power events; overhead shot, 30 metre sprint, standing long jump and three jump. Participants completed each event three times in each session, with a rest period of approximately 3 minutes between each jump, throw or sprint. A mean score for each of the four events was established for each participant. A consistency score was calculated by establishing the difference in points between the best and worst of the three performances in each event. These values were then added together to form an overall quadrathlon consistency score for
that week, with lower scores reflecting more consistency. A social validation questionnaire (Thelwell & Maynard, 2003: Psychology of Sport and Exercise, 4, 377–396) was used to evaluate the intervention programme. The PPR used in this study was based on one employed by Lidor & Chen (2003: New Studies in Athletics, 18:1, 29-34) and consisted of three stages; stage one “readiness”, stage two “focusing attention” and stage three “being in the zone”. At the beginning of the session on their intervention week, participants were given a copy of the PPR. The participants were presented with a standardised routine which was read through to them by the researcher. They were then asked if they understood the PPR and if there were any aspects of it they wanted to change or remove to make it more individualised. Visual inspection of the overall quadrathlon performance data indicated, that once the intervention had been introduced, all three participants’ performance scores increased by between 7% and 26%. Visual inspection of the overall quadrathlon consistency data showed that all three participants’ consistency improved after introduction of the PPR by between 20% and 40%. The main findings from the current study are that the introduction of a pre-performance routine can improve both overall performance and performance consistency in competitive athletes, with immediate effect. The implications of this are that employing a PPR prior to competition may be an effective strategy for improving accuracy and overall performance.

Ps22O
Investigating the Effects of Pre-performance Routines on Quadrathlon Performance and Performance Consistency.
Fitzpatrick, N., Boulter, M., Church, D., & Leach, H.
University of Chichester

Pre-performance routines are cognitive behavioural skills defined as a ‘sequence of task-irrelevant thoughts and actions which an athlete engages in systematically, prior to their performance’ (Cohn et al., 1990: The Sport Psychologist, 4, 33-47). Boutcher and Crews (1987: International Journal of Sport Psychology, 18, 30-39) proposed that pre-performance routines enhance performance by improving attentional control, automatic skill execution, and warm-up decrement. It has also been proposed that pre-performance routines can enhance consistency (Cohn, 1990: The Sport Psychologist, 4: 301-312). However, there have been no attempts to study this proposal. Therefore the aim of this study was to examine whether the introduction of a pre-performance routine increases training performance and consistency. Following ethical approval, five athletes of mixed gender between the ages of 18 and 32, participated in a single subject multiple baseline study over a period of nine weeks. Performance was measured weekly using the Max Jones Quadrathlon (http://www.brianmac.co.uk/quad.htm, 1997), a widely used training test in track and field athletics. Each week at a standard training session, the athletes completed 3 trials of the quadrathlon. Performance was measured by taking the best result of the three trials. The range of the three scores was used as a measure of consistency. After a staggered baseline of between four and six weeks the athletes were introduced to the pre-performance routine. The pre-performance routine used was based on Carl Lewis’s three phase pre-race routine consisting of ‘readiness’, ‘focus’ and ‘in the zone’ stages (Lidor & Chen, 2003: New Studies in Athletics, 18:1, 29-34 ). The data were analysed through visual inspection, using the criteria suggested by Martin and Pears (Martin et al., 2003: Behavior modification: What it is and how to do it (7th ed.). Englewood Cliffs, N J: Prentice Hall.). Results indicated that once the athlete had begun using the pre-performance routine their consistency improved by between 25% and 45%, while their performance standard also improved by between 2 % and 25% per participant. This implies that the pre-performance routine had a positive effect on the athlete’s ability to consistently perform well. The paper concludes by suggesting that further research into which area of the pre-performance routine is required, as well as research testing the pre-performance routine in actual competition.
Ps23P
Exploring the relationship between social physique anxiety, emotion regulation abilities, and physical activity behaviours.
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Social Physique Anxiety (SPA) is a negative emotion that may affect an individuals’ decision to partake in physical activity behaviours, and thus, impact their wellbeing. The ability to regulate emotions may help individuals deal with negative emotions (e.g., SPA) associated with physical activity. Therefore, the purpose of this study was to examine the relationship between individuals’ experience of SPA and physical activity behaviours, and the potential mediating role of emotion regulation abilities. Following institutional ethical clearance, questionnaire packs were completed by 231 participants (age 20.25 ± 3.46) taking roughly 30 minutes to complete. The questionnaire packs included validated measures of SPA (Social Physique Anxiety Scale; Hart et al., 1989: Journal of Sport and Exercise Psychology, 11, 94-104), Alexithymia (20-ItemToronto Alexithymia Scale; Bagby et al., 1994: Journal of Psychosomatic Research, 38, 23-32), Emotion regulation (Emotion Regulation Questionnaire; Gross & John, 2003: Journal of Personality and Social Psychology, 85, 348-362), and physical activity behaviours (International Physical Activity Questionnaire; Craig et al., 2003: Medicine and Science in Sports and Exercise, 35, 1381-1395). The questionnaire pack was piloted prior to the main study in order to reveal any deficiencies in its design and check the suitability of completion-time. Data was analysed using Spearman’s correlation coefficients. The study established negative correlations between SPA and physical activity levels (r = -.375, p < .01), and between SPA and positivity (r = -.186, p <.01). No relationship was found between Alexithymia or emotion regulation strategies and physical activity levels, however, individuals that reported higher alexithymia values used more suppression regulation strategies (r = .328, p <.01) and fewer reappraisal strategies (r = -.97, p <.05). Whilst the findings support the hypothesis that SPA is negatively correlated with physical activity behaviours, they do not support the hypothesis that emotion regulation abilities mediate this relationship. Therefore, further research is required to examine psychosocioemotional variables that mediate this relationship. This information may better inform practitioners aiming to improve physical activity participation and adherence.

Ps24P
Comparing the relationship between task orientation and competency in adolescence sport.
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University Of Gloucestershire

Deci and Ryan (2000: American Psychologist, 55, 58-68) stated that competence is a universal, innate, and psychological need of all people. People who have high-perceived competence are more likely to have higher expectations of themselves and be more persistent compared with people with low perceived competence. Evidence exists (e.g., Standage, 2003: Journal of Sports Sciences, 21, 631-647) that sports people who are high in task motivation orientations have high perceived physical competence. However, we do not know whether sports people high in task motivation orientations are also high in different types of competence. It is important to explore the relationship between task motivation orientations and different types of competence because findings of such research may shed light on issues of transferability of skills (i.e., achievement goals and competence as life skills). To this end, the purpose of the current study was to explore the relationship between task motivation orientations and different types of competence. We employed a cross-sectional correlational design to examine the relationships between task motivation and competence (e.g., leisure competence, academic competence, interpersonal competence and general competence). Thirty sport participants, who were enrolled on sports courses at a British University,
completed the TEOSQ (Duda, 1989: *Journal of Sport and Exercise Psychology, 11*, 318-335) and the perceived competence scale (Harter, 1982: *Child Development, 53*, 87-97). We conducted a series of Pearson’s correlations to examine the relationship between task motivation and the different types of competence. Task orientation was significantly correlated with general competence ($r = .596$, $p$ (two-tailed) < .01), leisure competence ($r = .543$, $p$ (two-tailed) < .01), and interpersonal competence ($r = .636$, $p$ (two tailed) < 01). The relationship between task orientation and academic competence ($r = .286$, $p$ (two-tailed) > .05) was non-significant. The results support the findings of Gill and Williams (1995: *Journal of Sport and Exercise Science, 17*, 363-378) who also established that task orientation has a direct influence on perceived competence. Nicholls (1984: *Psychological Review, 91*, 328-346) has also stated that when an individual is task oriented in sport this reflects in high competence. Future research may wish to explore the causal direction of this relationship to help understand whether scholars and practitioners can intervene in order to increase task motivation and competence.

Ps25O

**The Neophyte practitioner: Reflective practice as a tool for Sport Psychology Consultation Effectiveness.**

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The British Association of Sport and Exercise Sciences (BASES) values the use of reflective practice (RP) amongst its applied practitioners and it is a requirement for accreditation and reaccreditation of its members. Reflective Practice is taught as a tool that neophyte practitioners are encouraged to use and is considered an appropriate framework for their professional training (Anderson et al., 2004: *The Sport Psychologist, 18*, 188-203). Cropley et al. (2007: *The Sport Psychologist, 21*, 475-494) have suggested that reflection improves self-awareness and generates knowledge in action, thus, reflection can be used to inform and improve future consultation. This research, aimed to employ structured, shared and individual reflections as a tool to enhance delivery of sport psychology workshops. Two BASES Probationary Sport Psychology practitioners employed RP over a 14 week period, in line with the delivery of an Academy Rugby workshop program. Both practitioners completed individual as well as shared reflections immediately after workshop delivery and 48 hours following delivery. On completion of the workshop program transcripts were reviewed and thematic analysis was employed following discussion with the second author (who is already a BASES Accredited Sport Psychology Consultant). Subsequently, comparisons were made between both of the neophyte consultant’s reflections as well as the immediate and delayed reflections. Analysis revealed that immediate reflections were heavily emotion focused, whilst delayed reflections were more action orientated and solution focused. In addition, shared reflections were much lengthier and in depth than individual reflections. Moreover, workshop development and delivery was significantly informed by the information shared in delayed reflections. The authors recommend that neophyte practitioners should ensure that delayed and shared reflections are utilised as part of practitioner development.

Ps26O

**The Effect of a Centering Intervention on Performance and Anxiety in a Golf Putting Task.**

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Centering is a breathing technique intended to produce physical balance and allow the individual to mentally focus before attempting the task at hand (Nideffer, 1994: *Psyched to Win*. Champaign, IL: Leisure Press). Centering is often utilised as part of MST packages, but
as of yet there appears to be a lack of empirical research supporting the efficacy of centering as a stand-alone intervention (Rogerson and Hrycaiko, 2002: Journal of Applied Sport Psychology, 14, 14-26). Only one study (Haddad and Tremayne, 2009: The Sport Psychologist, 23, 118-136) has investigated the effects of centering in isolation, finding centering to improve basketball free-throw performance in five young players. The aim of the present study, therefore, was to investigate the effect of a centering intervention on golf putting performance, competitive state anxiety and physiological arousal in an adult sample. Following institutional ethical approval, 18 novice golfers (mean ± s; age 23.39 ± 5.40), allocated to either a control or centering group, took part in a golf putting task. The pre-test consisted of participants completing 10 familiarisation putts and twenty test putts towards a target 4.5 m away from the starting place, with performance being measured as distance (cm) from the centre of the target. Measures of competitive state anxiety (MRF-3) and heart rate were taken at five putt intervals throughout the twenty test putts. Prior to the post-test, the intervention group were provided with a centering intervention. The participants were given an information sheet to read describing the centering process, and then viewed a video of an applied sport psychologist delivering the centering intervention. Following this, participants completed the same procedure outlined in the pre-test. A 2 (group) x 3 (test) analyses of variance revealed significant interaction effects for the impact of centering on cognitive anxiety (P = 0.014) and somatic anxiety (P = 0.012), a significant main effect for performance (P = 0.011), and no significant effects for physiological arousal. Post-hoc analyses indicated a significant decrease in the centering group’s levels of cognitive and somatic anxiety between the pre-test and post-test, and no significant differences for the control group. These findings indicate that centering can be used to decrease an individual’s levels of cognitive and somatic anxiety. Further research is needed to validate these findings, and to further investigate the efficacy of centering.

Ps27P

The psychophysical effects of motivational music video on treadmill walking.
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Liverpool Hope University

Brisk walking is advocated as a cost effective, easily prescribed, mode of exercise often integral in the regaining and maintenance of aerobic and functional capacity for those in tertiary care. Prolonged low intensity exercise, such a treadmill walking, promotes boredom rapidly, adversely affecting adherence, potential recovery, and subsequent life quality. It is well documented that motivational music can improve the experience of exercise, increase energy expenditure, and improve endurance (Edworthy and Waring., 2006: Ergonomics, 49, 1597-1610; Karageorghis et al., 2009: Journal of Sport & Exercise Psychology, 3, 18-36). However, less is known about visual stimulus effect during exercise. Accordingly, the purpose of this study was to determine if music video harboured similar motivational qualities to music. The investigation examined, and compared, the effects of motivational music, and music video, on a range of psychophysical measures before, during, and after, low intensity (6.4 km·hr⁻¹), 30 minutes, treadmill walking exercise (TWE). Following ethical approval, participants (N = 10; female = 5, male =5, mean age = 23.5 ± 5.8), walked under each of 3, counter-balanced, experimental conditions; in silence (control), watching music video, and listening to music. Participant motivation for exercise (Behavioural Regulation in Exercise, BREQ-2), and mood (Profile of Mood State, POMS) towards impending TWE was measured on arrival at the laboratory, again following pre-exercise exposure to 5 minutes of music video, music, and control conditions, and finally, on completion of TWE. Ratings of perceived exertion (RPE) were recorded at 5 minutes intervals. Paired samples t-tests analysed dependant variables in each of the conditions. Results showed RPE was significantly less in the music video (p = 0.012), and music (p = 0.02) compared to the control conditions. No difference in RPE between video and music conditions was observed (p = 0.318). No difference in vigour following pre-exercise exposure to 5 minutes of either music video (p =
0.423) or music (p = 0.247) was observed. However, a significant increase for vigour was observed between pre, and post, exercise in the music video (p = 0.017), and music (p = 0.026) conditions. No difference in vigour was observed pre, and post, exercise in the control condition (p = 0.239), or between music video and music conditions post exercise (p = 0.118). Intrinsic regulation did not change following 5 minutes pre-exercise exposure to either of the music video (p = 0.143), or music (p = 0.342). A significant increase in intrinsic regulation was observed between pre, and post, exercise in the music video (p = 0.029), but not in the music condition (p = 0.257). No difference in intrinsic regulation post exercise between video and music conditions (p = 0.110) was observed. These results indicate that motivational music video can positively impact upon feelings of exertion, vigour, intrinsic motivation, and potential attitude toward future exercise, in a similar manner to music. No such positive effects were observed under the control condition. Our findings offer no evidence that pre-exercise exposure to music video or music can influence mood or motivation towards impending exercise.

Ps28P
Perception of adolescent male body image: Comparing physical activity to non-physical activity.
Brook, L., & Wakefield, C.
Liverpool Hope University

Body image is self-belief based on perceived views of physical appearance, including height, body shape and weight (Garner, 1981, *International Journal of Psychiatry in Medicine, 11*, 263-84). It has been widely reported that women are more susceptible to be concerned about their body image in comparison to males (Miller & Halberstadt, 2005: *New Zealand Journal of Psychology*, 34, 189-195; Smith et al, 2006: in Body Image: New Research, edited by M. Kindes. Nova Sciences Publishers Inc., New York). However males, especially adolescents, are also exposed to influences to achieve an “ideal” physique: a tall mesomorphic masculine build, consisting of an inverted “V” shaped, muscular frame (Koff & Rierdan, 1990: *Journal of Early Adolescence*, 10, 56–68). It has also been shown that this phenomenon is not restricted to elite athletes (Ravaldi et al., 2003: *Psychopathology, 36*, 247-254) and little research has been conducted regarding the relationship of body image to actual weight and physical activity levels, focussing instead on individual perception. Therefore, the purpose of this study was to investigate the relationship between body image, physiological measurements and physical activity participation. Thirty-six male volunteers (mean age= 17.3±0.81 years) completed the Bodybuilder Image Grid – Original (BIG-O; Thompson & Gray, 1995: *Journal of Personality Assessment, 64*, 258-269), indicating their perceived actual and ideal body shapes. This scale was implemented due to a dissatisfaction of previous resources, such as the Silhouette Measure of Body Image, developed for females, testing an aspiration for thinness (Cohane & Pope, 2001, *International Journal of Eating Disorders, 29*, 373–379). Self-reported physical activity data was also collected, in addition to actual and perceived height and weight measures. Pearson's correlation tests revealed significant positive relationships between actual weight and perceived weight (r=.93, p<.05) and actual and perceived height as well (r=.69, p<.05). Interestingly, there was also a significant positive relationship between current figure rating and actual weight (r=.55, p<.05) but not between ideal figure rating and actual weight (r=.28, p>.05). One way ANOVAs revealed no significant differences in their perceived current physique and ideal physique, depending on whether they played sport or not, or whether they would like to engage in sport. These results indicate that adolescent males have a good awareness of their physique, height and weight. However, actual weight was not related to ideal physique, indicating that their ideals are formed based on alternative influences rather than their current physique. Additionally, this is not influenced by the amount of physical activity that they engage in. This implies that playing sport is not always the most important factor in determining how the male looks, as well as targets of what they want to look like. Therefore
other influential sources may have an impact, such as media or peer pressure: both of which warrant further investigation.

Ps29P
The effects sports advertising has on body image and participant in sport in adolescents.
McCarron, V., & Wakefield, C.
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A great deal of research attention has been paid to body image (Miller & Halberstadt, 2005: New Zealand Journal of Psychology, 34, 189-195) and how it is developed, particularly in adolescent girls. Studies have focussed on differences in body image between physically active and sedentary individuals (Kirkcaldy et al., 2002: Social Psychiatry and Epidemiology, 3, 544-550), and those exposed to advertising (Sullivan et al., 2006: Journal of Eating Disorders, 14, 355-364), indicating that body image can be influenced by external factors. However, research conducted on the topic of body image and the effects of advertising has been largely laboratory based (e.g. Smith et al. 2006: In, Kindes, Body Image: New Research, Raven Press). Therefore, the purpose of this study was to assess the effect of sport advertising on adolescents in their natural environment. 104 participants (aged 13-14 years) completed Figure Rating Scale (Hart et al., 1989: Journal of Sport and Exercise Psychology, 11, 94-104) and the Social Physique Anxiety Scale (Stunkard et al., 1983: In Kety et al., Genetics of Neurological and Psychiatric Disorders, p.115-120, New York: Raven). They were then split into two groups; exposure to advertisement group and a control group, according to their timetabled Physical Education lessons. Interventions were completed over a six week period. For the ‘exposure’ group, posters of ‘ideal’ female physiques were displayed in the P.E. changing rooms during changing times. The changing rooms of the control groups remained conventional. After the intervention period, participants completed the questionnaires again. A repeated measures ANOVA revealed a significant effect for group F(1,90) = 53.97, p<0.01 for figure rating scale, with the group exposed to posters showing a significant increase in perceived current physique compared to the unexposed group. A further repeated measures ANOVA revealed a significant effect for group (1,90) = 49.22, p<0.01 for the social physique anxiety questionnaire, with the group exposed to posters showing a significant increase in social physique anxiety compared to the unexposed group. The results suggest that exposing adolescent girls to sports advertising that contain young, fit and healthy women, can have a negative effect on how they perceive their own body and how much anxiety can be caused by their bodies being evaluated by others. This study highlights the potential negative effects on adolescents from exposure to media images, even when not directly presented with them. In particular, it indicates how comparisons between themselves to the images in a sporting environment can increase their social physique anxiety and may have a subsequent negative effect on their willingness and motivation to exercise.

Ps30P
The effects of an audience on mental readiness and the performance of the penalty in football.
Malpass, J.
Newman University College

Hundreds of studies have been conducted on the effect an audience has on performance since Trippelt’s (1898) archetypal studies (Bond and Titus, 1983: Psychological Bulletin, 94, 265-292; Strauss, 2002: Psychology of Sport and Exercise, 3, 237-256). The findings generally support intuitive observations that suggest an audience can increase the performers’ efforts so improving performance in effort-based tasks. This can also be the case in skill based tasks in situations where a performer may otherwise lack motivation (Wallace et al., 2005: Journal of Sports Sciences, 23, 4, 429-438). However, skilled tasks appear to be more vulnerable to
performance impairment, where audiences can be a source of performance pressure causing anxiety and performance detriments. This is particularly the case when self-focused attention is directed to inner processes that normally involve automatic non-conscious skill execution (Wallace et al., 2005: Journal of Sports Sciences, 23, 4, 429-438). Given the potential for performance detriment in the presence of an audience, the purpose of this study was to determine whether the presence of an audience might not only affect the performance of the penalty kick within football, but also have an impact on mental readiness (cognitive, somatic and self-confidence components). Twenty-one participants participated in the study, each completing the Mental Readiness Form (MRF) before taking ten penalty kicks with and without an audience present. The investigation utilised a counter balance design in order to prevent possible order effects. Means and standard deviations were calculated (Cognitive: M = 5.81, SD = 2.18; Somatic: M = 6.10, SD = 1.79; Self confidence: M = 4.81, SD = 1.33; performance scores: M = 5.90, SD = 1.26) for audience scores, as well as means and standard deviations (Cognitive: M = 4.33, SD = 1.02; Somatic: M = 4.14, SD = 1.31; Self confidence: M = 3.95, SD = 1.28; performance scores: M = 6.48, SD = 1.21) for no audience scores. Results revealed a significant difference between performance and two of the subcomponents; cognitive (t = 2.677, p = .014) and somatic (t = 3.459, p = .002), as well as performance scores (t = -2.098, p = .049), yet no significant difference was found for self-confidence scores (t = 1.247, p = .227). However, Pearson’s correlations revealed no significant relationship between performance scores and Cognitive anxiety (r = .138, p = .550), Somatic anxiety (r = .138, p = .550) and Self confidence (r = -.131, p = .572) during the presence of an audience, a result mirrored during no audience conditions: Cognitive (r = -.322, p = .155), Somatic (r = -.343, p = .128) and Self confidence (r = -.245, p = .285). The results suggest that the presence of an audience negatively impacts upon the performance of the penalty kick, a result which may be caused by the participants choking, due to the change in their attentional focus while the performers consciously attempt to control different aspects of their performance due to performance pressure from the audience (Wallace et al., 2005: Journal of Sports Sciences, 23, 4, 429-438). While cognitive and somatic anxiety significantly increased in the presence of an audience compared to when performed with no audience conditions, the investigation found that other factors must be the cause for change in performance, as no relationship was found between the three subcomponents of the MRF and performance during either test condition. Future studies should therefore look to examine these different factors that may cause a change in performance, such as motivation, as well as investigating the impact of larger audiences on performance and whether participants believe their anxiety to be facilitative to their performance.

Ps31P

A multivariate generalisability analyses of perceived support in the coach-athlete relationship.

Gwynne, F., Rees, T., & Freeman, P.

University of Exeter

Athletes with high perceived social support have been shown to perform better (Freeman and Rees, 2008: European Journal of Sport Sciences, 8, 359-368.). To help develop effective support interventions it is imperative to understand how support judgements are formed. The present study used generalisability theory (Cronbach et al., 1972: The Dependability of Behavioural Measurements: Theory of Generalisability of Scores and Profiles. New York: John Wiley) to examine the extent to which support judgements reflect characteristics of the people making judgements (perceivers), the characteristics of the people being judged (providers or targets), and the unique relationship between perceivers and targets. In addition, the study investigated relationships between perceived social support and self-efficacy, self-confidence, anxiety, excitement, dejection, happiness and anger at perceiver, target and relationship levels. Ethical approval was gained from the University of Exeter prior to the study taking place. Purposive sampling was used to recruit 50 martial artists and 5 martial arts
coaches, all of whom provided informed consent prior to taking part in the study. The participants completed questionnaires rating the supportiveness of each coach, and their own self-efficacy, self-confidence and emotions when in the presence of each coach. Univariate generalisability analysis was used to determine the extent to which judgements reflected perceiver, target and relationship components. Multivariate generalisability analysis was then used to estimate the correlations between supportiveness and the other self-efficacy, self-confidence and emotions at perceiver, target, and relationship levels.

Univariate generalisability analyses found that the largest variance component was for relationships ($\sigma^2 = 0.29$, 95% CI: 0.23 to 0.35), accounting for 46% of the total variance. The next largest variance component was for perceiver ($\sigma^2 = 0.14$, 95% CI: 0.05 to 0.22), accounting for 22% of the total variance. The target component did not account for significant variance ($\sigma^2 = 0.08$, 95% CI: -0.04 to 0.20) accounting for only 13% of the total variance. Following these findings, multivariate generalisability analysis was used to calculate correlations between social support and emotions, self-efficacy and self-confidence at the relationship and perceiver levels of analysis. At the perceiver level, social support correlated significantly ($p < .05$) with self-efficacy (0.68, 95% CI: 0.49 to 0.87), self-confidence (0.12, 95% CI: 0.23 to 0.42), excitement (0.46, 95% CI: 0.17 to 0.76) and happiness (0.69, 95% CI: 0.42 to 0.95) but not anxiety, dejection and anger. At the relationship level social support was significantly correlated in a positive direction with excitement (0.68, 95% CI: 0.60 to 0.76), happiness (0.74, 95% CI: 0.67 to 0.81) and self-efficacy (0.64, 95% CI: 0.52 to 0.76) and self-confidence (0.60, 95% CI: 0.45 to 0.74), and in a negative direction with anxiety (-0.45, 95% CI: -0.59 to -0.31), dejection (-0.45, 95% CI: -0.63 to -0.26), and anger (-0.57, 95% CI: -0.75 to -0.40). The findings emphasize that support judgments primarily reflect characteristics of the perceiver and unique relationship between perceivers and targets. Further, support is more consistently related to outcome variables at the relationship level. Therefore, this shows that the unique relationship which is developed between an athlete and a support provider needs further investigation to identify the specifics of a successful relationship. If this can be determined then perhaps there is the possibility of optimal matching between coaches and athletes to enhance performance.

Ps32P

Knowledge of results after good trials enhances learning and motivation.

Smith, A., & North, J.
Sheffield Hallam University

There is a general consensus within motor behaviour literature that augmented feedback (knowledge of performance and knowledge of results) is one of the most significant variables for motor learning. Feedback is suggested to have both motivational and informational functions. The majority of research has focused on the informational component, whilst the motivational function has been largely neglected. It has recently been demonstrated that when participants were allowed to self-control their feedback schedule, they performed significantly more accurately than a yoked group of participants (Chiviacowsky and Wulf, 2005: Research Quarterly for Exercise and Sport, 76, 42-48). Interviews with participants revealed they preferred feedback after they perceived themselves to perform successfully. Subsequent research by Chiviacowsky and Wulf (2007: Research Quarterly for Exercise and Sport, 78, 40-47) reported that when feedback frequency was identical, participants who received feedback after good trials learned a throwing task significantly better than those who received feedback after bad trials. Taken together, it was suggested that receiving feedback after good trials encouraged feelings of motivation, which enhanced learning. However, motivation was only inferred and was never directly measured. The aim of this study was to investigate the effect of providing KR after successful or unsuccessful trials and the effect this has on accuracy of cricket bowling and intrinsic motivation. There were three conditions: good KR, bad KR, and a no KR control group. Each participant bowled a tennis ball at a 1m radius target presented at 13 yards from the participant, which had incremental 10cm
concentric rings, each representing a score. 100 points awarded for hitting the very centre and 10 points were deducted for each ring away from the centre. 0 points were awarded if the target was missed. A direction (left or right) and a plus or minus was provided alongside the accuracy score to represent where the outcome of the trial was in relation to the centre ring. The Intrinsic Motivation Inventory (IMI) questionnaire measuring perceived competence, enjoyment and effort was completed at pre test, block 3, post and retention tests. A no-KR pre test (6 trials) was completed, followed by a 36 trial acquisition phase (six blocks of six) and a no-KR post and retention test. Participants either received KR on their three best trials (good KR), three worst (bad KR) or nothing at all (control) for each block of six trials during acquisition. Ethical approval was granted prior to recruiting any participants. A two way mixed design ANOVA (Group x Time) suggested a main effect of KR Type (good vs. bad vs. control) on accuracy (P = 0.0003, r = 0.69) with good KR participants more accurate than bad (P = 0.012) and control (P = 0.0002) groups. A two-way mixed ANOVA on accuracy (Group x Time) showed that good KR participants were more accurate than bad KR at retention (P = 0.015, r = 0.63), whereas there was no difference at pre-test (P = 0.927, r = 0.24). Also, a separate two-way mixed design ANOVA on perceived competence (Group x Time) revealed a main effect of good KR having higher perceived competence levels compared to bad KR (P = 0.013, r = 0.55). These findings providing direct evidence to suggest that feedback has important motivational functions as well as informational qualities. Specifically, providing feedback after successful trials enhances feelings of motivation (perceived competence) which positively impacts upon learning. These findings have a direct implication to coaches as it is more beneficial to learning when providing feedback after a successful performance. The findings also extend the theoretical understanding of exactly how feedback influences learning.

Ps33P

Effect of bowling age on a cricket anticipation task in expert batsmen of different age groups.
Stone, J., & North, J. Sheffield Hallam University

It is becoming evident that perceptual-cognitive skill can distinguish between skilled and less-skilled sport performers (Ward and Williams, 2003: Journal of Sport and Exercise Psychology, 25, 93-111). In fast ball sports such as cricket, perceptual-cognitive skill is believed to help counteract the severe time constraints placed on performance. Research into the development and acquisition of these attributes in younger elite players has been limited (Ward and Williams, 2003: Journal of Sport and Exercise Psychology, 25, 93-111). Researchers have found anticipatory differences within sports performers aged as early as 8-11 years old, between skilled and less skilled performers. However, to date the results have not been statistically significant until adulthood. Two proposed explanations are that firstly at younger ages the time constraints of the task are not severe enough for anticipation to be crucial for success, the second being that subtle postural information requires repeated exposure to an opponent’s movement patterns and at the younger ages there has been insufficient time to acquire these expert traits (Weissensteiner et al. 2008: Journal of Sport and Exercise Psychology, 30, 663-684). An alternative explanation not previously considered can be linked to a limitation that all the previous studies have only used adult performers when creating the anticipation task. Expert performance is very domain specific therefore, by neglecting the specific domain youth experts perform in (i.e., they have repeated exposure to junior and not adult bowlers), could lead to misleading results. The aim of the current investigation was to assess the effect of different age group bowlers (Under 13 vs. Over 18 years) on anticipation skill of batsmen of different ages (Under 13 vs. Over 18) during a simulated video based anticipation test. 14 Adult (Over 18 yrs) and 13 Junior (12-13 yrs) cricket players who had attained county and/or national representation completed a film-based anticipation test measuring response accuracy and response time. The test film
consisted of 60 trials, each lasting 5 seconds, in which participants viewed a video image from a batsmen's viewing perspective in an indoor cricket pitch. The video showed the bowlers run up and delivery up to the point of ball release. The test film consisted of 2 over 18 (O18) and 2 under 13 (U13) right-handed fast bowlers with 15 trials taken from each bowler. Each bowler’s 15 trials consisted of 5 short delivers (S), 5 full inswing (FIn) and 5 full outswing (FOut) deliveries. Trial order was randomised and kept consistent across participants with an inter-trial interval of 5-seconds. For each trial, participants were informed that they had to make an anticipation decision of ball type in the fastest and most accurate way possible. Participants responded by pressing a push button switch to measure response time, whilst simultaneously verbalising the ball type to measure response accuracy. Results showed Over 18’s were more accurate than U13’s in all conditions, (O18F_P = 0.001, r = 0.67, O18S_P = 0.002 r = 0.78, U13F_P = 0.003 r = 0.61, O18FIn_P = 0.001 r = 0.58, O18FOut_P = 0.014 r = 0.47, U13FIn_P = 0.008 r = 0.70). Both groups performed more accurately in the O18 bowler’s conditions compared to U13. There was no difference in response time (O18F_P = 0.78, U13F_P = 0.957, O18S_P = 0.364, U13S_P = 0.863). However during type of delivery (full length) mean values of (O18FIn 32.22%, O18FOut 28.52%, U13FIn 32.96%, U13FOut 24.07%) suggest responses were not above guessing level. The result supports evidence that extensive domain practice is required to reach expert performance levels. Results also support previous research that the use of anticipatory cues do not become significant until adulthood. A second main finding suggested the advance cues in the bowler’s delivery allow adults to predict ability of adults to predict ball length, but not ball type. The results suggest that advanced cues are not required for elite performance in youth cricket batters, therefore advance cue training may not be appropriate for the youth populations.

Ps34O

Other efficacy and rock climbing performance.
Lisle, S., & Hardy, J.
Bangor University

Findings from meta-analyses confirm performance to be positively influenced by self-efficacy (SE). However, within certain contexts it is likely that there are more than SE beliefs at play. A tripartite model of efficacy beliefs in close relationships has been proposed (Lent & Lopez, 2002: Journal of Social and Clinical Psychology, 21, 256-286), which conceptualises three forms of efficacy beliefs including SE and two additional relationally oriented beliefs: other-efficacy (OE) and relation-inferred self-efficacy. OE is defined as ‘an individual's beliefs about his or her significant other's ability to perform certain behaviours’ (Beauchamp & Whinton, 2005: Journal of Sport and Exercise Psychology, 27, 245-252), and was the primary focus of the current study. Previous research by Beauchamp and Whinton (2005) offers some, albeit inconsistent support, for a positive relationship between OE and 3-day equestrian eventing performance. The present study extends research by examining this association within a context where close (human-human) relationships are of critical importance via an experimental approach. Following a successful manipulation of OE it was predicted that a higher OE group would exhibit better rock climbing performance compared to their lower OE counterparts. Thirty three active climbers (men = 22, women = 11, mean age = 29.42 years, SD = 9.79) were recruited and were randomly assigned to a higher or lower OE group. All participants performed a single belayed climb one grade below their climbing limit following the OE manipulation (climbers had not previously met the belayer). Participants also completed the Climbing Performance Evaluation Inventory (Hardy & Hutchinson, 2007: Anxiety, Stress & Coping: An International Journal, 20, 147-161.) and a SE (α = .91) and OE (α = .95) inventory. Supportive results from the manipulation check indicated significant OE differences (t = 7.56, p < .001) across the groups but importantly no SE differences (p > .2). Moreover a significant performance difference emerged between the OE groups (t = 2.15, p < .05). These results offer some support for the hypothesis, and are in line with theorizing by
Lent and Lopez (2002) in suggesting that OE may be an important predictor of performance within dyads. This emphasises the importance of supportive behaviour within close relationships, and highlights that consultants working with clients in sports where close relationships are integral (e.g., doubles in badminton) should also consider the role of relationally based efficacy beliefs in order to optimise performance effectiveness.

Ps35O

**Transitions into academy and Premiership football and the impact on the identity and development of young players.**
Houghton, L. J., Nesti, M., & Littlewood, M.
*Liverpool John Moores University*

Athletes experience a number of transitions throughout their career (Wylleman, et al., 2004: *Psychology of Sport & Exercise, 5*, 7 - 20). Transitions within football have received considerably less attention, particularly the transition into a first team Premiership environment. The purpose of the present study was to examine the transitioning experiences of young athletes within an academy, reserve, or first team environment. One-on-one, in-depth qualitative interviews and follow up interviews were conducted with 3 footballers who had recently undergone one or more transition, the academy’s Education and Welfare Officer and the parent of one of the players based on Wylleman and Lavallee’s (2004) developmental model. Interview data was analysed inductively using a 6 stage form of thematic analysis (Braun and Clarke, 2006: *Qualitative Research in Psychology, 3*, 77 - 101) and presented schematically using Pen Profiles (Ridgers, Knowles & Sayer, in press). Results identified five categories (Challenges, Factors Helping the Transition, Impact of the Transition, Positive Experiences and Uncertainty over New Experiences). These findings offer preliminary evidence that transition experiences have a significant impact on the development of players. The use of techniques to ease players into new environments such as day release programmes, mentoring systems and pre-transition planning may be beneficial. Young athletes particularly entering into an elite sport environment should be encouraged to explore other life roles in order to attempt to maintain a healthy level of athletic identity, however, playing at a professional level does not necessarily mean a one-dimensional identity. Further research into career transition experiences is needed to add weight to the current findings.

Ps36O

**“Getting on the scales is the first competition”: Stress and coping in making weight for combat sports.**
Sitch, M., & Day, M.
*University of Chichester*

Based on transactional theory (Lazarus & Folkman, 1984: *Stress, appraisal and coping*, New York: Springer) the present study sought to examine the stressors experienced and coping strategies used by combat athletes when making weight for competition. The rationale was to further understanding of the stress and coping process in a previously unexplored but vitally important aspect of competitive sport so as to potentially inform weight loss practice. Based on previous stress and coping literature a qualitative methodology was utilised. Ten male (n=9) and female (n=1) current combat athletes, with varied levels of experience making weight, were interviewed using a semi-structured protocol. Questions investigated the most recent occasion making weight, the most stressful occasion, and the least stressful occasion. Interviews were recorded, transcribed verbatim, and then subjected to inductive content analysis. Participants revealed a wide range of stressors including, physical (e.g. hunger, tiredness, dehydration), psychological (e.g. cognitive effort, boredom, peer pressure), and organisational (e.g. weight-in, weight loss methods, resource investment). Identified coping strategies utilised in response to stressors included problem focused (e.g. controlled eating
and diet, increased training load), emotion focused (e.g. adopting a positive cognitive appraisal, relaxation), and avoidance focused strategies (e.g. isolation, music). An additional strategy included participants’ use of social support as a coping mechanism. Findings could be used by an athlete, coach, and or applied practitioner to create a less stressful ‘making weight’ process by eliminating potential stressors or suggesting potential coping strategies. The present study proposes that future research should examine the effectiveness of coping strategies to further inform applied practice.

Ps37O
The concurrent validity of the Risk Taking Behaviour Inventory.
Hill, M., & Woodman, T.
Bangor University

It is accepted that people engaged in high-risk sports take significant risks. However, what has not been studied is whether people take these risks knowingly and attempt to minimise them, or whether they take these risks in a reckless manner. The Risk Taking Behaviour Inventory (RTBI) was developed to measure the propensity to take risks in this high-risk domain, yielding two factors: deliberate risk-taking behaviours (DRTB) and precautionary risk taking behaviours (PRTB) (Woodman & Bandura, 2010: under review). The current study assessed the concurrent validity of the RTBI with the Brief Sensation Seeking Scale (BSSS), Behavioural Inhibition System/Behavioural Activation System (BIS/BAS) scales and Urgency, Premeditation (lack of), Perseverance (lack of) and Sensation seeking (UPPS) scale. After the study had received institutional ethics approval, a questionnaire package of the four scales was issued via the Bristol Online Survey to participants on risk-taking sports forums. 518 participants provided informed consent and provided full responses. Preliminary analysis indicates that deliberate risk taking behaviours correlate significantly (p < .01) with UPPS sensation seeking (r = 0.32*), BAS fun seeking (r = 0.35*), BSSS thrill and adventure seeking (r = 0.39*) and BSSS disinhibition behaviours (r = 0.33*); precautionary risk taking behaviours correlate with UPPS premeditation (r = 0.32*) and UPPS perseverance behaviours (0.26*). As expected, the two RTBI factors had opposing relationships with several (but not all) sub-factors of the concurrent scales (e.g., UPPS premeditation: DRTB, r = -0.26; PRTB, r = 0.26). The results provide further support for the validity of the RTBI and the conceptualisation of risk-taking behaviours along two orthogonal dimensions: deliberate risk-taking behaviours and precautionary risk-taking behaviours.

Ps38O
An inductive investigation into the interaction between decision making and decision communications in elite rugby union officials.
Cunningham, I1, Mellick, M.C.2, Fleming, S2, & Mascarenhas, D.R.D1
1Glyndwr University; 2University of Wales Institute, Cardiff

The application of law, contextual judgment and communication have been shown to be essential skills of the elite sports official (Mascarenhas et al., 2005: The Sport Psychologist, 19, 364-379). Furthermore, the behaviours that officials demonstrate to communicate decisions to sport participants have important implications on match outcomes and perceptions of fairness (Mellick et al., 2005: Football Studies, 8, 42-57). The purpose of the present study was to explore higher-order decision-making and decision communication processes in three international rugby union referees. Semi-structured interviews were conducted with three elite rugby union officials to explore the routines, psychological strategies and processing skills they utilise to meet the decision-making demands of the game. Participating officials all have experience of officiating full senior international test matches and are all still active at the elite level. Interview data was analysed by means of thematic content analysis and provided four general themes related to expert decision making.
processes and decision communications. These were corporate theatre, pre-game preparation and post-game analysis, refereeing philosophy and approach, and within-game psychological skills. Corporate theatre was identified as ‘selling’ a decision to a range of audiences (e.g. players, spectators, media commentators) through self-presentation behaviours and explanations with assistant officials and players. The referees described pre-game preparation and post-game analysis as a collection of training processes undertaken to inform and maintain standards of decision making and communications. These areas were underpinned by the referees’ philosophy and approach that guides their application of law. Finally, within-game psychological skills highlighted the higher-order decision-making processes and strategies a referee uses during performance. It is anticipated that the results of this investigation will provide information to develop training interventions as a pedagogic tool to assist pre-elite officials in developing appropriate higher-order understandings of decision-making processes and communication patterns.

Ps39O

Examining the relationship between emotion regulation strategies and cohesion in sport organizations.

Baulsom, M.P.

University of Portsmouth

The general domains of group dynamics and emotion in sport have received considerable attention from sport psychologists. However, despite recent suggestions that the area of emotional abilities may provide an insight into relational dynamics in sport (Woodman et al., 2010, Psychology of Sport and Exercise, 11, 345-352), the specific relationships between these lines of inquiry have received little attention. Therefore, the aim of the present study was to examine the relationship between emotional abilities (Woodman et al., 2010, Psychology of Sport and Exercise, 11, 345-35) and cohesion (Carron et al., 1985; Journal of Sport and Exercise Psychology, 7, 244-266) in a sporting environment. Following ethical approval, 302 undergraduate students (age 20.52 ± 3.73) completed a questionnaire pack that contained, the emotion regulation questionnaire (Gross and John, 2003; Journal of Personality and Social Psychology, 85, 348-362), group productivity (Carron et al., 1985: Journal of Sport and Exercise Psychology, 7, 244-266), Toronto Alexithymia Scale-20 (Bagby et al., 1994: Journal of Psychosomatic Research, 38, 23-32) and the affectivity ratio (Barber et al., 2010, Personality and Individual Differences, 49, 663-666). The questionnaire pack was counter-loaded and provided in a continuous format to reduce the likelihood of self-presentation bias. Inclusion criteria required participants to have performed within a sport team for more than two years to ensure appropriate exposure to group dynamics and affective transactions. Data was analysed using Pearson’s correlation coefficient. The data showed a negative correlation between total alexithymia and social attraction to group ($r = -.307, p <0.03$), and a negative correlation between total alexithymia score and total positivity ratio ($r = -.379, p <0.01$). The findings provide partial support for the hypothesis that individuals with poor emotion abilities are likely to find it difficult to formulate and maintain strong interpersonal relationships in their sport organization and are more likely to languish in terms of emotional health. However, due to the moderate correlation scores found here, more research is required to examine other psychosocioemotional variables which may influence group dynamics, relationships and positivity in sport organizations.
Ps40P
Age related effects on empathetic accuracy in national level swimmers and their male coach.
Jones, G., & Naseby, J.
University of Hertfordshire

In recent years the coach-athlete relationship has gained greater recognition for the impact it may have on sporting performance. Empathic accuracy, the ability to accurately infer what another is thinking and feeling (Ickes, et al., 1990: *Journal of Personality and Social Psychology, 59, 730–742*), has recently become an area of interest for sport psychologists. Although research in this field is growing, currently the majority of research has investigated gender differences or individual compared to team sports. Findings conclude that female coaches and athletes alike have greater empathic accuracy than males and coaches in individual sports have higher empathic accuracy than team sports (Ickes et al., 2000. *Personal Relationships, 7, 95-109*; Lorimer & Jowett, 2009: *Psychology of Sport and Exercise, 10, 152-158*; 2010: *Psychology of Sport and Exercise, 3, 206-211*). However, only one study has examined the sport of swimming and little research has been conducted with younger athletes. How empathic accuracy differs as an athlete matures is not yet clear. The purpose of this study was to investigate age-related effects on empathetic accuracy in swimmers and their male coach. Ethical approval was volunteered by all subjects. Fourteen swimmers were divided into the groups of A or B, 12-15 years (n=7) and 16-18 years (n=7) respectively. The empathic accuracy of these swimmers and their male coach was assessed using recordings of their training sessions as used by Lorimer & Jowett (2009: *Psychology of Sport and Exercise, 10, 152-158*). All participants viewed selected sections of video footage that displayed personal interactions that had naturally occurred during training sessions. The coach and swimmers independently reported what they remembered thinking and feeling while making inferences about what the other individual had thought and felt at the selected points. Comparisons of swimmers and coach’s’ self-reports and inferences allowed their empathic accuracy to be calculated by rating each response on a similarity scale of 0-2 (0 = essentially the same content, 1 = somewhat similar but not the same content, 2 = essentially different content). Thirty-one interactions were viewed by both groups. A t-test was performed and results showed a significant difference between the two groups, with the older age group exhibiting greater empathetic accuracy compared to the younger age group (p=0.006061). Results therefore support the prediction that as swimmers mature, their empathic accuracy increases. This paper concludes with the suggestion that coach’s need a greater awareness of the age related differences in factors affecting the coach athlete relationship to enhance the opportunities for successful performances by all athletes.

Ps41P
Effects of self-selected versus experimenter-selected asynchronous music on levels of intrinsic motivation during circuit training exercise.
Sly, D., & Karageorghis, C.I.
Brunel University

An individual who exhibits higher levels of intrinsic motivation is more likely to exhibit greater engagement and enjoyment during performance of any given task. In the exercise domain, empirical evidence has shown that music can play an integral role in promoting increased levels of intrinsic motivation (Karageorghis et al., 2008: *International Journal of Sports Medicine, 29, 613-619*). Such research also points to a link between music preference and levels of intrinsic motivation. In a study that assessed levels of intrinsic motivation among females during an aerobic dance workout delivered via a videocassette, it was found that those who performed while listening to their preferred choice of music reported increased levels of intrinsic motivation compared to the control group (Dwyer, 1995: *Health Values, 19, 18-26*). The purpose of the present study was to investigate the effects of self-selected versus
experimenter-selected asynchronous music on levels of intrinsic motivation after completion of a circuit training class. Asynchronous music refers to when there is no conscious synchronisation between movement patterns and music tempo, and the present study tested the hypothesis that the self-selected asynchronous music would yield increased levels of intrinsic motivation when compared to experimenter-selected asynchronous music. Following adherence to institutional ethical guidelines, a sample of male and female attendees (N = 8) of a weekly circuit training class were asked to complete a 16-item version of the Intrinsic Motivation Inventory (Ryan, 1982: Journal of Personality and Social Psychology, 43, 450-461). The items were presented on a 7-point Likert scale anchored by 1 (not true at all) and 7 (very true), and were completed on two separate occasions with a week’s gap in between. The first questionnaire was administered after a circuit training session in which the music had been selected by the experimenter. In this session the music was purposely selected to be unfamiliar but of an appropriate tempo for the nature of the activity. Upon completion of this initial questionnaire, participants were required to list three songs they enjoyed listening to during exercise. A week later, participants were re-administered the questionnaire after taking part in the same circuit training class which was accompanied by a music programme based on their reported musical preferences. Following checks for the relevant parametric assumptions, the data were analysed using a one-way repeated measures MANOVA. Results indicated that there was no significant (p > .05) difference between the experimenter-selected and self-selected music conditions in relation to reported levels of intrinsic motivation. However, the analysis was critically underpowered owing to a relatively small sample size. Examination of the omnibus effect size (ηp² = .28) and effect sizes for each of the four IMI subscales used (Interest-Enjoyment, ηp² = .05; Competence, ηp² = .15; Effort, ηp² = .14; Value, ηp² = .02) revealed that there were meaningful differences between the two music conditions for the IMI subscales of Competence and Effort. Replication of the present quasi-experimental study is warranted with a larger sample size and the addition of a no-music control condition in order to facilitate a full experimental design.

Ps42P
Internal and external factors affecting food choice amongst athletes and non-athletes in a university population.
Mayhew, S.
University of Hertfordshire

Food choices are part of everyone’s daily routine, influenced by different factors internal and external (Shepherd & Ratts, 2006: The Psychology of Food Choice. Oxfordshire: CABI Publishing). The purpose of the study was to determine the main influencing factors affecting food choice in university students, and highlight any differences between athletes and non-athletes. With ethical approval from the University of Hertfordshire, 200 student volunteers (age 24 ± 6 years) completed the Food Choice Questionnaire, within are 9 categories; health, mood, convenience, appeal, natural content, price, weight content, familiarity and ethnic concerns (Steptoe et al. 1995: Appetite, 25, 267-284). Athletes were defined as individuals exercising ≥ 2 times a week and competing once a week, non-athletes were defined as exercising ≤ 2 times a week and not competing. The questionnaires were completed when students entered and exited the library based at the university. The results were analysed using One-Way Anovas within the categories, and Persons Correlation tests where completed within the groups. The One-Way Anovas showed significance between athletes and non-athlete results within 3 of the categories; familiarity, price and appeal. Within the athlete population strong significance was found between the results for ethnic concerns and natural content, also in the weight control and natural content (P= 0.01). Within the non-athletic population strong significance was found between the results of health and mood (P= 0.01). The results from the study suggest a combination of factors influence food choice, and the factors will differ depending on exercise levels.
Burns (1978: *Leadership*. New York: Harper & Row) suggests that both leadership styles rely upon each other in what is known as the ‘Leadership-member exchange’ (LMX). During the 1980s Bass (1985: *Leadership and performance beyond expectation*. New York: Free Press) re-developed this idea giving rise to the MLQ-5X (Multi-factor leadership model). This then provided the theoretical framework for the basis of the two leadership styles: transactional and transformational, which are seen and used within the organisational setting. However, uncertainty arose regarding whether the two leadership styles were characteristics of different leader ‘types’ as suggested by Burns (1978: *Leadership*. New York: Harper & Row) or whether they were different classes of leadership ‘behaviour’, as indicated by Bass (1985: *Leadership and performance beyond expectation*. New York: Free Press). Bass also argues that the concepts of these styles are separate from each other conflicting with Burns who believes that they are opposite ends of a single continuum. Bass (1985: *Leadership*. New York: Free Press) believes the best leaders acquire both transactional and transformational styles, with the most effective leaders utilising both styles interchangeably (Avolio, Bass & Jung, 1999: *Journal of Occupational and Organizational Psychology*, 72, 441-462). Earlier research by Verba (1961: *In A Definition and Illustration of Democratic Leadership*, edited by K, Grint. Oxford, UK: University Press) suggested that depending upon the whole situation faced, no ‘one’ leadership structure is best. Additionally, with the exception of leadership styles being applied to the sport administrators (Doherty, 1997: *Journal of Sport Management*, 11, 275-285; Doherty & Danylchuk, 1996: *Journal of Sport Management*, 10, 292-310), little research has been completed relating this concept to a sport setting. Therefore, the purpose of the study was to examine whether or not transactional and transformational leadership styles can be interchangeable within a sports team. This investigation was carried out using six participants from a male (n=3) and female (n=3) university hockey team. Inclusion criteria consisted of a captain, a vice-captain and a regular player. A qualitative approach was employed. Semi-structured interviews (approximately 45 minutes to one hour) were conducted with the findings transcribed verbatim and analysed through thematic analysis. Five higher order themes emerged from the analysis. These were: experience, situational balance, personality, responsibility and the effectiveness within a sports team. Results showed that players in a position of responsibility (captain and vice-captain) exhibited a greater awareness of leadership styles compared to players and a similarity of common goals emerged between those working together. Changes in leadership style and language used were also apparent dependent upon current match scores and level of opposition, in both males and females. This research identified a gap in the knowledge within the sporting context, specifically in terms of transactional and transformational leadership styles. This has practical implications in terms of applying the concept of the leadership styles into education settings, specifically towards Physical Education in schools. This may then result in leadership styles being carefully tailored to the group and increasing sport participation and potentially reducing drop out levels. This study could also apply at ‘elite level’ assisting managers, coaches and athletes in understanding and developing, not only the team’s ability but also the abilities of individuals in becoming potential leaders within the sport setting.
Ps45O
The developmental activities of elite soccer players aged 16 years in Brazil and Mexico.
Moreno, J.W., Fritzler, W., Garces, M., Salmela, J., Marques, M., & Ford, P.R.
Liverpool John Moores University

Expert athletes have been shown to engage during their development in either the ‘early diversification’ or ‘early specialization’ pathway. Early diversification involves engagement in several sports in childhood with specialization in adolescence, whereas early specialization involves high amounts of practice and competition in the primary sport from childhood onwards (for a review, see Ford et al., in press: In Beyond "talent or practice?": The multiple determinants of greatness, edited by S.B. Kaufman and D.K. Simonton. Oxford: Oxford University Press). The purpose of this study was to examine the developmental activities of elite soccer players from Latin America to test whether their engagement followed one of these pathways. Participants were elite 16 years of age soccer players at two top league professional clubs in Brazil (n = 50) and one in Mexico (n = 50). They completed the Participation History Questionnaire (PHQ; Ford et al., 2010: Journal of Sport and Exercise Psychology, 32, 638-654) under supervision. The PHQ recorded their developmental milestones (e.g., start age in soccer); hours in soccer-specific deliberate practice, deliberate play and competition; and number of other sports. Elite youth players in Latin America started playing soccer at 5 years of age. They began participating in an elite training academy at 13 years of age. Their soccer participation between 6 and 15 years of age comprised of 41.66 ± 22.71 hrs/yr in competition, 266.56 hrs/yr ± 126.06 in deliberate practice, and 170.17 hrs/yr ± 102.08 in deliberate play. The number of other sports during this period was low (i.e., 1 to 2 other sports). A 2 (Group) x 3 (Activity) ANOVA revealed that between 6 and 15 years of age the elite youth soccer players in Mexico (M = 181.64 hrs/yr, ± 134.75) had a higher amount of average hours per year per activity compared to the players in Brazil (M = 137.29 hrs/yr, ± 95.47), F_{1,98} = 14.76, P<0.05, d = 0.4. Deliberate practice in soccer (M = 266.57 hrs/yr, ± 126.06) was engaged in more than deliberate play (M = 170.17 hrs/yr, ± 102.08) and competition (M = 41.66 hrs/yr, ± 22.71), whilst deliberate play was engaged in significantly more than competition, F_{2, 196} = 185.11, P<0.05, f = 1.4. Players in Mexico engaged in more deliberate practice in soccer (M = 322.50 hrs/yr, ± 132.25) compared to players in Brazil (M = 210.64, ± 90.73), but not deliberate play (M = 168.44 hrs/yr, ± 87.80 vs. M = 171.90 hrs/yr, ± 115.49, respectively) or competition (M = 53.97 hrs/yr, ± 21.24 vs. M = 29.34 hrs/yr, ± 16.77, respectively), F_{2, 196} = 13.41, P<0.05, f = 0.4. The number of other sports between 6 and 15 years of age did not differentiate players in Mexico (M = 1 sport ± 1) from those in Brazil (M = 1 sport ± 1), t_{98} = -0.851, P>0.05, d = 0.0. However, players in Brazil engaged in 181 hours per year across 4 years on average in futsal, whereas players in Mexico did not. The developmental activities of elite soccer players aged 16 years in Latin America did not follow the early diversification pathway. Number of other sports engaged in during childhood, which indicates early diversification, was very low. The results suggest that elite soccer players aged 16 years in Latin America followed the early specialization pathway. However, two aspects of the developmental pathway of the players in Brazil differed from the strict definition of early specialization (i.e., engagement in futsal and amounts of deliberate play before 12 years of age), which will be discussed in the presentation.

Ps46O
The acute effects of walking and isometric exercise on cigarette cravings and attentional bias.
Haasova, M., Oh, H., & Taylor, A.H.
University of Exeter

Previous qualitative reviews (e.g. Taylor et al., 2007: Addiction, 102, 534-543.) have shown that an acute bout of physical activity reduces cigarette cravings. The purpose of this study was to evaluate the effects of a 10-minute bout of walking and isometric exercise, compared...
with a passive control condition, on Strength of Desire to smoke (SoD) (West et al., 1989: Psychological Medicine, 19, 981-985) among temporarily abstinent smokers. Attentional bias to smoking related images, compared with neutral and snack food images, was also investigated. Following ethical approval, 13 volunteers (8 males; 5 females; age 33.2 ± 9.9 y), smoking at least 10 cigarettes a day for at least 2 years were allocated in either a control, walking or isometric exercise condition in a within-subject counterbalanced randomised design. Following a minimum of 3 hours of smoking abstinence (10.55 ± 4.03 h), anthropometric measures and Fagerström Test of Nicotine Dependence (Heatherton et al., 1991: British Journal of Addiction, 86, 1119-27.), were collected. Mood and Physical Symptoms Scale (West & Hajek, 2004: Psychopharmacology, 177, 195-199.) and SoD were recorded at four time points (baseline, post probe task, post intervention and post second probe task). Attentional bias towards smoking images was examined using the dot probe task (E-prime v1.2). Pairs of images (smoking related with neutral or snack food) appeared side by side for 1000ms on a computer screen prior to the presentation of a probe (a dot). Subjects struck a key as quickly as possible to indicate the target location. Attentional bias scores were calculated before and after each condition. The Reaction Time (RT) in detecting targets replacing smoking images was subtracted from RT in detecting targets replacing control images (neutral and snack images). Two-way (3 x 4) ANOVA revealed a group by time interaction on SoD scores (F3,221,38.658 = 3.5, p = 0.022; Greenhouse-Geisser correction). Post hoc t-tests with a Bonferroni correction (α = 0.017) identified a difference in pre and post SoD scores in walking condition (t12 = -3.860, p < 0.01) and in control condition (t12 = 2.941, p = 0.012). Cravings decreased in the walking condition (3.38 ± 1.758) and increased in the control condition (4.08 ± 1.706). One-way ANOVAs of change in SoD from pre to post treatment scores revealed a main effect of group (F2,24 = 12.913, p < 0.01; assumption of sphericity was met). Post hoc t-tests with a Bonferroni correction (α = 0.017) identified a difference between the control and walking conditions (t12 = 4.398, p < 0.01) and between control and isometric conditions (t12 = 4.416, p < 0.01). Change in pre to post SoD scores showed a decrease in cravings for both physical activity conditions in comparison with the control condition. Attentional bias towards smoking stimuli compared with both neutral (28.4, SD = 40.20) and snack food images (17.4, SD = 34.30), were indicate. However, a two-way (3 x 2) ANOVA revealed no group by time interaction on attentional bias scores in either smoking and neutral (F2,24 = 1.144, p = 0.335) or smoking and snack food picture pairs (F2,24 = 0.044, p = 0.957). These results support previous findings (Taylor et al., 2007: Addiction, 102, 534-543.) and suggest that 10 minutes of walking may be more beneficial that 10 minutes of isometric exercise in decreasing SoD. Abstaining smokers showed attentional bias towards smoking stimuli in both pairs of images; when combined with neutral images as well as when combined with snack images. This is interesting as both weight gain and increased snacking is reported after smoking cessation. Although there was no effect of physical activity on attentional bias scores, the observed power to identify such effects was absent. Thus, more participants or direct measurements (such as eye-tracking methods) are needed to further investigate effects of physical activity on attentional bias.
Sociology of Sport and Exercise

S1O
The Significance of Family Culture for Sports Participation.
Wheeler, S.
University of Chester

In a recent study by Birchwood, Roberts and Pollock (2008: *European Physical Education Review, 14*, 283-298), the significant and lasting influence of socialisation within the family for individuals’ sports participation over the life course was highlighted. Indeed, the findings in the study led the scholars to hypothesise that crucial dispositions to participate in sport are acquired during childhood via cultures transmitted through families. While there is a large body of research investigating children’s socialisation into sport by family members, much of this research is unintegrated, decontextualised and quantitative in nature. The central objective of this study, therefore, was to investigate family cultures in relation to sport from a sociological perspective. In particular, the study sought to establish whether, indeed, there are sporting cultures transmitted through families, and what these cultures are and how they are transmitted, by collecting in-depth, qualitative data. In terms of methodology, semi-structured interviews were conducted with eight ‘sporty’ children who attended a primary school in North Wales and their parents. The children were aged 10 years and the parents between 35 and 44 years. The families were all of the same structure (two-biological-parent) and from the middle and upper-middle class strata of society. Grounded theory was employed in this study to inform the research process; sensitising concepts were used to guide data collection and analysis, the sample of families were chosen on theoretical grounds, and the transcripts were analysed using a grounded theory specific coding process (Charmaz, 2006: *Constructing Grounded Theory*. London: Sage). The results revealed that sporting cultures were transmitted through the families in the present study. These cultures are perhaps best described as ‘habituses’ – sets of beliefs and behaviours in relation to sport, with historical and social dimensions. Indeed, it was clear that the parents held specific ‘goals’ in relation to their children’s sports participation, and employed a set of ‘strategies’ and ‘practices’ in order to achieve such goals. These goals, strategies and practices were shaped by the parents’ developmental histories, as well as their current relations with other parents. It is hypothesised that the combination of parenting goals, strategies and practices identified in this study are likely to impact upon children’s sporting capital, motivation, and enjoyment, which, in turn, are likely to influence their long-term propensity to participate in sport.

S2O
The participation of young disabled pupils and those with special educational needs in mainstream physical education: Voices, views and experiences.
Emerton, L.
University of Chester

In recent decades growing political emphasis has come to be placed on the inclusion of all young people in education, and particularly those who are disabled and/or have special educational needs (SEN) (Every Child Matters, 2006). This concern has prompted the development of a growing body of research that has explored the views and experiences disabled pupils and those with SEN have of school subjects such as physical education (PE). To date, with some notable exceptions (Coates and Vickerman, 2010: *Disability and Rehabilitation, 32*, 1517–1526; Spencer-Cavaliere and Watkinson, 2010: *Adapted Physical Activity Quarterly, 27*, 275-293), almost all of the research conducted within PE has been based on teachers’ views and experiences of inclusion in PE, rather than those of disabled pupils and those with SEN (Haycock and Smith, 2010: *British Journal of Sociology of Education, 31*, 291-305; Smith and Green, 2004: *British Journal of Sociology of Education,*
After being granted ethical approval from the Sociology of Sport and Exercise Ethics Committee at the University of Chester, 6 participants (5 males; 1 female) aged 11-15-years-old with a statement of SEN or disability were purposively selected to offer their consent to be involved in the study. All 6 participants involved in the study were studying PE at either Key Stage 3 or 4 in a comprehensive school in South-East England. Each participant took part in a semi-structured interview that sought to generate data on participants’ views and experiences of National Curriculum PE (NCPE) in mainstream education. All interviews were transcribed verbatim and subjected to thematic analysis. The most prominent themes derived from the interviews included: pupils’ feelings and experiences of participating in sport and exercise generally; experiences of NCPE; pupils’ perceptions of learning support assistants (LSAs) and their role within PE lessons; and the extent to which pupils were included in NCPE and extra-curricular PE according to their particular needs. The findings of the study suggest that the experiences of young disabled pupils and those with SEN in PE were rather mixed and differential and in some cases, at least, may reflect a policy outcome that government neither desired or expected (Haycock and Smith, 2010: *British Journal of Sociology of Education, 31*, 291-305). More specifically, although most participants in the study reported largely pleasurable and positive experiences of NCPE, these experiences were limited to a small number of sports and activities that were often performed in segregated settings away from their non-disabled peers. These experiences were often exacerbated by the dominance of traditional sports and team games in NCPE, and the severity of pupils’ individual needs or disabilities, experiences which appear to question the extent to which the government has been successful in achieving its inclusion policy goal of enhancing the educational experiences of all pupils in mainstream education settings and subjects such as PE (Haycock and Smith, 2010: *British Journal of Sociology of Education, 31*, 291-305; Smith, 2004: *Physical Education & Sport Pedagogy, 9*, 37-54).

**S30**


Hibberd, A.J., Bright, J.L., Sayner, C.J., Weal, T.C., Bradshaw, C.T., & Evans, A.B.

*Lincoln University*

Previous feminist research demonstrates that women’s participation in sport is subject to patriarchal values, which produce and reproduce gender inequity in elite sport (Rowe, D. (2004). *Critical Reading: Sport, Culture and Media*. Berkshire. McGraw Hill.). Cricket is one sport in which patriarchy remains prevalent. Despite the recent success of the England Women’s cricket team, female participation in elite cricket remains low. The latest Active People Survey (2010) suggests the number of women participating in cricket has decreased between 2008 and 2010, further widening the gender gap (Sport England. (2011). *Active People Survey 4: Detailed Sports results*. [online]. Available from http://www.sportengland.org/research/. Accessed 22 February 2011). This key aim of this study was to evaluate an intervention with the stated aim of reducing gender inequity in cricket in a city in the East of England. The intervention was conducted in conjunction with a multi-agency partnership developed by the authors, including an ECB premier league club, county board and University. A needs assessment highlighted the lack of opportunities for women’s cricket. The intervention therefore targeted women of all cricket abilities, with a view to creating a sustainable women’s team. Project actions included sourcing facilities, staff and equipment, producing advertising material and facilitating partnership work. This study employed a theory-driven programme evaluation to assess the effectiveness of this cricket intervention. Programme evaluation uses programme theory to assess the efficacy of sports development interventions (Rossi et al., 2004, *Evaluation: A systematic approach*. Sage, London.). In this case, the programme’s theory is founded upon a feminist rationale. Critical success factors have been incorporated. These included assessing participation rates, quality
of facilities and the appropriateness of the session all of which were achieved at a short term level. Semi structured interviews were triangulated with questionnaire data to assess participant and stakeholder perceptions of the services. Feedback was on the whole positive. Recommendations gauged from the data suggested further sessions for participants to attend. This could be in conjunction with the existing established team within the area and county board coaches.

S4O
“Inspiring Imps”: Programme Evaluation of a football intervention targeting mental ill health services users through a professional Football Club.

Williams, J.M., Henderson, R.M., Hill, E., Bennett, L.L., & Evans, A.B.
Lincoln University

The Active People survey (2010) shows that only 6.5% of disabled individuals participate in sport and exercise 3 times per week, compared with 16.5% of able bodied adults in the UK. Individuals with recognised disabilities have long been excluded from mainstream society. Particularly in sport, disability athletes can be afforded minority status and are treated as such (Nixon, 2000: In Handbook of Sports Studies, edited by J. Coakley and E. Dunning. London: Sage). This stigmatisation can be particularly acute among participants with diagnosed mental or psychological disabilities. Previous research concluded that sport can have positive psychological and social benefits, including improved well-being, motivation and social confidence (Crone and Guy, 2008: International Journal of Mental Health Nursing. 17, 197-207). The aim of the present study was to investigate the feasibility of a 6 week exercise programme targeting mental ill health service users aged 16+. A weekly 2 hour session of football was introduced to promote health and wellbeing in the target group. Partners included county Football Association and a professional football club. The project enhanced local partnerships and partnerships with other professional football clubs. The key remaining aim is to ensure a sustainable “legacy” is achieved to ensure the continuation delivery of the project.

The feasibility of the present study will be assessed using programme evaluation. Programme evaluation uses programme theory to produce a structured framework for assessment of the project (Rossi et al 2004; Evaluation: A systematic Approach. London, Sage). This allows a clear and logical progression from planning to implementation. Participant attrition rates and attendance records will be collected. However, the primary aim of the critical success factors will be based around the impact on the participants’ health and well-being and the overall programme development. Semi-structured interviews with project stakeholders have been conducted. Project stakeholders have noted that a number of performance indicators have been achieved, including successful dissemination of service information and the development of a regular football-based activity session for the target group. Further interviews will be conducted with participants to assess health and wellbeing indicators. Shared learning practice on similar interventions nationwide has been produced.

S5O
Inclusive or exclusive? Listening to the voices of young disabled people and children with special educational needs, regarding their relationships with Learning Support Assistants in PE.

Lappin, T.
University of Chester

Over the last 25 years, the education of young disabled people and those with special educational needs (SEN) in England has been subject to rapid development, not least in relation to the emergence of inclusive education (Hodkinson, 2010: British Journal of Special Education, 37, 61-67). However, even though there has been a significant increase in research surrounding the extent to which these pupils are educated in subjects such as physical
education (Goodwin, 2009: In Disability and Youth Sport, ed. H. Fitzgerald, 91-105.), there is still a general dearth of research, not only in Britain, but in many other countries, which focuses specifically on the views and experiences of young disabled people and pupils with SEN in PE in order to develop a more adequate understanding of their experiences of PE, and how successful inclusion strategies in the subject have been (Coates and Vickerman, 2008: Support for Learning, 23, 168-175; Smith and Thomas, 2006: European Journal of Special Needs Education, 21, 69-83). The purpose of this study was to explore the perceptions and experiences of young disabled people and children with SEN, regarding their relationships with Learning Support Assistants in PE. The study examines the relationships between LSAs and the children who receive their support, and how, if at all, this has impacted on their views and experiences of PE. The study also examines the extent to which PE is providing inclusive education for all pupils, and the perspectives of LSAs in PE regarding their relationships with other members of staff, colleagues and students, and how these impact on pupils’ experiences. A total of 12 young people (6 males; 6 females) participated in three focus groups from one school in Shropshire, England. All the pupils, with the exception of one 12 year old male (Year 7), were in Year 9 of school and were between the ages of 13 and 14 Years old. Group 1 (FG1) was a mixed gender focus group, containing two Year 9 females with physical disabilities (Delphine and Ellen), and one male (Luke), who had a physical disability and was in Year 7. Group 2 (FG2) was a single-sex focus group containing five Year 9 males, four of whom had a learning or behavioural difficulty. Group 3 (FG3) was a single-sex focus group, containing four Year 9 females who had a learning or behavioural difficulty. Two LSAs were also interviewed. One LSA was male (22 years old) and one was a female aged 52 years old. The female participant had worked at the school for over 10 years, had recently been promoted to Head of the Learning Support Department, as had recently qualified as a Higher Learning Teacher Assistant (HLTA).

S6O
Young footballers in transition: Implications for leisure.
Platts, C.
University of Chester

Since the 1970s, young people’s transitions from youth to young adulthood have become prolonged and destandardized as, amongst other things, many young people are opting to stay in education longer, are entering employment and getting married later than previously, and have longer periods of time in which to establish their leisure habits and relationships. Indeed, leisure is a particularly important context for young people for it is within these situations that they; establish friendship networks that influence their tastes in music and clothes, their consumption of alcohol and other recreational drugs, and begin to assert their independence from adults as they learn to engage in sexualized roles with peers, and acquire their self-identity in their own spaces. Drawing on interview data, the purpose of this paper is to explore the leisure lives of a rather different group of young people: 302 apprentice footballers at 21 professional football clubs in Britain. Drawing on data gathered during focus group interviews, the paper argues that, contrary to their peers, apprentices are constrained to spend less time engaging in popular leisure activities such as drinking, smoking and clubbing with their friends, and are required to deal with the pressures brought about by leaving their families and the changing nature of their relationships with friends. It concludes that, for these young people, their involvement in the competitive, masculine and adult world of professional football accelerates their transition from youth to young adulthood and has implications for their lives and relationships in ways that are not generally experienced by other young people in British society.
The contribution of school commuting to young people’s total free-living physical activity levels in rural and suburban schools.
Collins, P., Al-Nakeeb, Y., Nevill, A., & Lyons, M.
Newman University College

The daily journey that young people make to and from school offers an invaluable opportunity to participate in regular habitual exercise. Previous literature has stated that active commuting to and from school benefits young people’s overall physical activity (PA) levels and subsequent health (Davison et al., 2008: Preventing Chronic Disease, 5, A100; Cooper et al., 2005: American Journal of Preventive Medicine, 29, 179-184). Thus, given the increasing obesity epidemic and declining activity levels in British youth, the opportunity for health enhancing habitual exercise presented by active school commuting cannot be underestimated. Research has already demonstrated that the geographical setting in which young people live can have a major influence on their interaction with the surrounding built environment and subsequent PA levels (Panter et al., 2008: International Journal of Behavioral Nutrition and Physical Activity, 5, 34-47). Furthermore, the commuting journeys of young people attending rural based schools, compared with those attending suburban schools, could present young people with very different barriers to active commuting due to the differing built environments in which they live. Research utilizing traditional PA measurement tools have formed the basis of the argument regarding the important contribution that active commuting has on total MVPA and health. Therefore, the recent introduction of the global positioning system (GPS) as a viable and objective method of measuring PA and tracking an individual’s route to or from school could extend current knowledge on this topic. In this study, GPS was combined with heart rate monitory to investigate potential differences in commuting patterns and activity levels between young people attending rural based and suburban based schools, an issue that has received little attention in previous literature. A total of 50 adolescents (22 males; 28 females) wore GPS and heart rate devices over a period of 7 days. Adolescents’ physical activity was measured from the end of the school day until bedtime with particular focus on the journey from school to home. Comparisons will be made between active commuting and non-active commuting adolescents. The nature and intensity of the active commuters’ journeys will be explored in addition to investigating possible differences due to school location and gender. The commuting patterns of the rural and suburban dwelling adolescents will be analysed with special reference to factors such as gender, weight status and overall free-living daily PA levels. The outcomes of the study should contribute towards better understanding of the potential benefits of active school commuting.

Bigger, Faster, Stronger: The management of pain and injury in elite rugby union academies.
Thorne, J.
University of Chester

Since the formal advent of professionalism in 1995, there has been an increase in the prevalence and kinds of injuries in rugby union (Garraway et al., 2000: British Journal of Sports Medicine, 34, 348-351; Targett, 1998: Clinical Journal of Sport Medicine, 8, 280-285), particularly at elite level, which has drawn attention to the ways in which pain and injury is managed in the sport (Malcolm, 2006: In Pain and Injury in Sport, edited by Loland, Skirstad & Waddington, Oxon: Routledge). Relatively little is known, however, about the extent to which the professionalization and commercialization of elite rugby union has impacted on the management of pain and injury among young elite players attending rugby union academies. The purpose of this study, therefore, was to build on existing research on pain and injury in elite
rugby union to explore the extent to which the growing professionalization and commercialization of elite rugby union comes to impact on the management of pain and injury of young players in elite rugby union academies. In addition, the study explored: the constraints generated by players’ figurations (or, sportsnets) in the academy; how the academy managed pain and injury; the amount and kind of medical provision available; and how professionalization and commercialization have come to impact on these experiences. After ethical approval was gained from the Sociology of Sport and Exercise Ethics Committee at the University of Chester, six semi-structured interviews took place with ex-players of one professional Premiership rugby union team’s academy between November 2010 and January 2011. The interviews lasted for 20-35 minutes and were conducted in a variety of locations. A number of themes were identifiable in the players’ responses. Firstly, the players suggested that professionalization has helped improve the access and quality of medical provision available to them during their time in the academy, encouraged the consumption of sports supplements to enhance performance, and increased their use of specialist medical staff. All players claimed to regularly play with pain since this was perceived as being ‘a part of rugby’ and there was a cultural expectation that players would risk their bodies by repeatedly engaging in this occupational hazard that characterized the ‘culture of risk’ associated with the game (Liston et al., 2006: Sport in Society, 9(3), 388-402; Nixon, 1992: Journal of Sport and Social Issues, 16(2), 127-135). Whilst players claimed to play with pain, they were not generally expected to play with injury, particularly when the academy physiotherapist had been informed of their injury. This finding partially contradicts those studies of elite senior rugby which concluded that even when physios are informed of a player’s injury, they are still subject to external pressure from other, generally more powerful, personnel such as coaches to allow players to continue competing whilst injured (Malcolm and Sheard, 2002: Sociology of Sport Journal, 19(2), 149-169). In this study, the academy coach appeared to be more sensitive and sympathetic to injuries as the players were frequently seen as possible future assets for the club and this view meant that players’ welfare should not be significantly compromised at such an early stage in their career. The paper concludes by suggesting that the professionalization and commercialization of rugby union have had a strong indirect impact on academy players’ experiences and the management of pain and injury, whilst helping to lengthen and increase the complexity of the ‘sportsnet’ which increases the entrapment of players within the ‘culture of risk’ characteristic of the sport (Nixon, 1992).

S90
Lost in transitions: Exploring the relationship between life transitions, health and lifelong participation in sport and physical activity.
Haycock, D.
University of Chester

The purpose of this paper is to examine, sociologically, the constraints that significant life transitions (e.g. getting married, buying a house, having children, changing jobs) have on the sporting biographies of adults in north-west England, and explore the implications of these for health. In doing so, the paper reports on data generated by semi-structured interviews conducted as part of a broader study of adults’ involvement in sporting and leisure activities between June and July 2009 with 19 30-35-year-olds. As part of these interviews participants were asked questions about the development of, and changes in, their sport and physical activity involvement from childhood to adulthood, while attempting to locate this these changes within the context of their lives more broadly. The findings of the study suggest that the extent to which adults’ sporting biographies changed over the life course from childhood,
through to youth and then young adulthood, was significantly related to the constraints posed by the numbers and kinds of transitions experienced (especially since age 16), family relationships and cultures, the development of sporting habituses, and the construction of ‘wide sporting repertoires’ during youth. On the basis of the findings here and elsewhere, it may be fair to suggest that a developmental and processual approach to understanding sport and physical activity participation may help to provide a more adequate understanding of adults’ current level of participation in sport and physical activity, and, therefore, help inform the design of more effective policy focused on the promotion of lifelong participation and health.

S100
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University of Chester

It is widely acknowledged throughout the history of secondary schooling, that physical education (PE) has been seen as the most sex-differentiated and stereotyped subject on the secondary school curriculum, particularly in relation to its content, organisation and delivery (Penney & Harris, 1997: Sport, Education and Society, 2, 41-54; Green, 2008: Understanding Physical Education. London: Sage). In this regard, concerns have been raised regarding males’ and females’ unequal access to facilities, opportunities and learning experiences in PE (Flintoff & Scraton, 2005: In Physical Education: Essential Issues, edited by K. Green & K. Hardman. London: Sage). Despite the abundance of research within this area, little research has been conducted since the implementation of the current National Curriculum for PE (NCPE) in 2008. In light of these observations, the purpose of the study was to explore the relationship between gender and secondary school PE in terms of its content, organization and delivery in the twenty-first century. In particular, the study sought to examine the views and experiences of PE of both males and females and the differences, if any, between the views and experiences of BTEC and Core PE students. A cross-sectional research design including four single-sex focus groups was adopted and opportunity sampling was used to select participants for the focus groups. Eighteen participants (10 male; 8 female) aged 15 to 16 years old who attended a semi-rural, mixed comprehensive school in Greater Manchester were recruited for the study. Focus groups were used to gather data regarding their views and experiences of PE. These views were analyzed using thematic analysis, which was used to identify the key themes from the participants’ responses. Participants in each focus group reported to have undertaken a ‘variety’ of sports and activities in PE. The data indicates, however, the content of girls’ PE lacked the opportunity and access to participate in traditional male dominated sports such as rugby and football. Likewise, the boys rarely participated in activities seen to be more feminine such as gymnastics and dance (Green, 2008: Understanding Physical Education. London: Sage). Core PE classes were found to be sex-segregated and delivered by the same-sex teacher throughout pupils’ schooling. Conversely, BTEC PE was organised in mixed groupings and had been delivered by both male and female teachers. Girls in BTEC PE reported males to be more dominant in a mixed-sex environment, impacting on their opportunity, choice and confidence in PE. Core PE boys reported similar heightened masculinity traits possessed by boys in the ‘top set’ that as a result, impacted upon their PE experience. In conclusion, the findings of this study at this school suggest PE to be gendered when measured in terms of content, organisation and delivery. In addition, male dominance was apparent of which the experiences of girls and some boys were affected.
The influence of parental physical activity upon child’s physical activity. Impact of parents’ physical activity on mode of travel to school.

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University of Essex

Children’s physical activity (PA) is influenced by numerous external factors, particularly their parents (Pugliese et al., 2007: Journal of Family Psychology, 21, 331-343). Active travel to school is one way to increase habitual PA. The aims of this present study were to establish whether there was an association between parental and child PA, and investigate if children of physically active parents’ were more likely to actively commute to school. Children’s PA was determined by self-report, using the PAQ-A (Kowalski et al., 1997: Pediatric Exercise Science, 9, 342-352), in 4095 participants (53.5% boys, aged 10.0-15.8 yr). Perceived parental PA (ppPA) and usual mode of travel to school were assessed by questionnaire. PA z-scores were created, standardising for age and sex (Voss and Sandercock, 2010: Medicine and Science in Sports and Exercise, 42, 281-287). Families were classified as: neither parent, one parent or both parents active. Distance to school, socio-economic status (SES), and urban/rural classification (URindex), were assessed via Geoconvert using home postcodes. Mode of travel to school was dichotomised as active or passive. Differences in PA z-scores between ppPA groups were analysed by one-way ANOVA with post-hoc Tukey tests. Odds Ratios (OR) for active travel according to the ppPA group were calculated using binary logistic regression, controlling for: age, sex, distance to school, SES and URindex. The University of Essex ethical review committee approved the study. PA was lower in children who perceived neither parents, or one parent to be active when compared to those with two active parents (P < 0.001). Sex, SES, distance to school and URindex were all associated with active school travel (P < 0.05), but there was no association between ppPA and travel to school. Parents may exert a modelling influence, as children of two active parents reported greater levels of PA. The children of active parents were not, however, more likely to actively commute to school. Other factors, particularly geographical barriers, are clearly more important in determining mode of travel to school. Due to the impact of parental modelling, initiatives aimed at increasing children’s PA should concomitantly target parental PA. Such initiatives are, however, unlikely to have an impact on active school transport.

Why do they do it?” Understanding reasons for participation in Ironman triathlon.

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Ironman triathlon (IM) comprises 2.4 miles of swimming, 112 miles of cycling, and 26.2 miles of running and is an event that requires significant commitment and sacrifice from its participants. The first IM race took place in 1978; approximately 40,000 people now compete in the 25 IM events worldwide every year many with the objective of qualifying for the IM World Championship held every October in Kona, Hawaii. The purpose of this study was to discover the attraction, appeal, meanings, beliefs and significance of pain and suffering to IM participants. Some researchers contend that tolerating pain makes athletes “real men”; others relate pain and suffering to traditional middle class values drawing on the work of Norbert Elias. This study proposes that participants come to relish physical suffering as a way of sharing what Pierre Bourdieu called a socially learned personality structure. The 43 study participants were all IM competitors within a specific age group classification. All had competed in at least one IM and several had completed multiple events. An ethnographic approach was used to apply a theoretical framework based on Herbert Blumer’s symbolic interactionism. This framework allowed the study participants to explain their social world in their own words. A combination of questionnaires, field notes from conversations and participant observation were used in a preliminary study which forms part of an ongoing
ethnography. Research sites were varied and included a range of training venues and occasions including an IM event (Klagenfurt, Austria July 2010). A qualitative discourse analysis was used as a method of extracting meanings and values from the data collected. The findings suggest that IM competitors believe that participation provides them with social capital by making them physically superior in comparison to the general population which is part of a process of identity formation. As training groups form the ability to persevere through athletic suffering is recognised as social bonding capital and through a process of socialization members adopt the values and perspectives of the group which adds further to the exciting significance of the experience. IM participation is primarily an escape from reality through which social capital is acquired leading to the construction of an athletic identity. Through social interaction, this, in turn, leads to group distinction adding further exciting significance to the experience. These are preliminary findings based on data gathered so far, the broader ethnographic research, including structured interviewing of participants, is ongoing and will be completed in spring 2012.
Strength and Conditioning

SC1O
A Study to Investigate the Validity and Reliability of the repeated-sprint test as an indicator of aerobic capacity in university-level Men’s field hockey.
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Currently there is limited research into the reliability and specificity of the repeated-sprint test, especially within the sport of Field Hockey. Despite these issues and the outcomes of the test not being fully understood, the protocol is continued to be used by national hockey squads as one test of their players’ fitness levels. The aim of this study was to investigate whether the repeated-sprint test was a reliable test within field hockey and whether it is a valid indicator of aerobic capacity in university-level men’s Field Hockey. Following ethical approval, 24 volunteer male university hockey players performed three repeated-sprint tests (6 x 40m on a 30 second rolling clock) over a period of three weeks. The mean height of the subjects prior to testing was 177.8cm (±6) and the mean weight of the subjects was calculated at 75.5kg (±7.7). Each of the participants then performed a V02max laboratory test on a motorised treadmill and using the Oxycon gas analysis system to determine maximal oxygen uptake. The reliability of the repeated-sprint test was assessed from total sprint time for each session. Inter-rater reliability coefficients showed no significant correlations between each repetition of the trial (r = 0.846, p>0.05). To calculate the validity of the repeated-sprint test to indicate aerobic capacity Pearson’s Correlation coefficient was performed on subject’s total sprint time and V02 max. There was shown to be no correlation (r=0.034, p>0.05) between total sprint time and V02max levels. It is concluded that the repeated-sprint test was not a reliable test within Field Hockey or is it a valid indicator of aerobic capacity in university-level male Field Hockey.

SC2O
Relationship between game activity profiles and 24-hour post-game serum creatine kinase concentrations in senior elite standard rugby league players.
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Rugby league is a collision sport that induces muscle damage as observed by clinically elevated serum creatine kinase (CK) levels following competition of >900µL⁻¹ (McLellan et al., 2010: Journal of Strength and Conditioning Research, 24, 2908-2919). Peak CK following rugby union competition has been shown to correlate with a number of game specific activities, for example tackles made (Takarada, 2003: British Journal of Sports Medicine, 37, 416-419). Linear regression techniques have been used to develop models to predict peak post-game CK and infer the magnitude of muscle damage following rugby union competition (Smart et al., 2008: British Journal of Sports Medicine, 42, 198-201). The purpose of the study is to assess changes in serum CK concentration following rugby league competition and use activity profiling to develop models to predict CK and infer muscle damage. With Institutional Research Ethics Committee approval 10 professional rugby league players, playing in the European Super League will participate in the study. A finger tip capillary blood sample will be obtained 1-2 hours pre-game to determine baseline CK concentration (µL⁻¹) (Reflotron, Roche Diagnostics, Indianapolis). During the game, player’s activity profiles will be assessed using a semi-automated player tracking system (Opta, Opta Sports, London) (e.g. metres gained), global positioning system (GPSports systems Pty, Ltd., Australia) (e.g. distance covered at high intensity) and video footage (Studiocode (Studiocode, Sportstec International, California) (e.g. tackle statistics). A second finger tip capillary blood sample will be taken 24- hours post game to coincide with peak serum CK
concentration. Twenty-four hour post-game perception of muscle soreness will be assessed using a visual analogue scale (VAS) and a counter movement jump (CMJ) used as a performance measure. Assessments will be made at 3 home games between April and June 2011. Assumptions for parametric analysis will be assessed and if violated non-parametric tests will be performed. Absolute and percentage change (pre to 24-hour post game) in serum CK concentration will be correlated with activity profiles, VAS and CMJ using the Pearson Product Moment Correlation Coefficient. Positional specific (forwards and backs) predictive models for serum CK concentration will be established using hierarchal multiple regression techniques. Group differences in serum CK concentration, activity profiles, VAS and CMJ will be assessed using a two-way (group x time) repeated measures ANOVA. Statistical significance will be set at $P < 0.05$. Effect sizes (Cohen's $d$) will be evaluated according to small (0.2), medium (0.5) and large effects (0.8). Based on previous literature it is expected that serum CK concentration will rise to near clinically elevated levels ($> 1000 \mu L^{-1}$). A higher CK concentration may be found in forwards due to a greater intensity and involvement in collisions (King, Hume and Clark, 2010: International Journal of Performance Analysis in Sport, 10, 241-254). Predictive CK regression equations for forwards and backs will be developed based on the data. These equations could be used by strength and conditioning coaches in the development of player specific recovery strategies.

SC3O
Effects of potentiating volume on power output in a ten second cycle sprint.
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The contractile response of skeletal muscle to an activity is dependent upon its contractile history. The term post-activation potentiation (PAP) refers to the acute enhancement of a performance activity due to the contractile history of the selected muscle groups. A number of factors can influence the effects of potentiation on performance, such as recovery time and contraction type, which have been previously researched (Robbins, 2005: Journal of Strength and Conditioning Research, 19, 453-458). However, no known studies have examined the influence of pre-load stimulus volume on potentiation. Knowledge of this interaction may be beneficial in the understanding of PAP and fatigue under differing conditions when designing pre-competition warm-ups and training programmes (Tillin & Bishop, 2009: Sports Medicine, 39, 147-166). Therefore, the purpose of this study was to examine the effects of varying pre-load stimulus volumes on performance in a ten second cycle sprint. It was hypothesised that a single set would be sufficient to elicit PAP, and that peak and average power output would decrease following 3 sets, as a greater contraction volume would outweigh the balance between fatigue and PAP. Following ethical approval, 6 male and 4 female physically active individuals (mean ± standard deviation: age, 20.6 ±0.7 years; height, 175.3 ± 10.35 cm; body mass, 74.62 ± 15.72 kg), participating in intermittent and power related sports (e.g. football, rugby) performed a pre-load stimulus of 1, 2, or 3 sets of 5 repetitions at 85% 1RM back squat, or a control of 5 minutes unloaded cycling, followed by a 10 minute recovery interval and a 10 second cycle sprint. Peak and average power output were recorded at 5 and 10 seconds. A one-way repeated measures ANOVA revealed no significant effect of pre-load stimulus volume on average ($p = 0.492$) and peak ($p = 0.290$) power output in a 10 second cycle sprint. There were also no significant differences in average ($p = 0.831$) and peak ($p = 0.397$) power output at the 5 second interval. When the data was assessed individually, related sample t-tests revealed 5 out of the 10 participants performance was significantly improved following a pre-load stimulus. A two-way mixed ANOVA revealed no significant gender*power interaction or strength*power interaction for any 5 and 10 second performance measures ($p \geq 0.05$). The results suggest there was no significant group effect of PAP on power performance in a 10 second cycle sprint, following 1, 2, or 3 sets of a pre-load stimulus. However the variation in individual responses add to the growing body of evidence that PAP has interindividual variability, and must be considered on an individual basis.

SC4P
Mola, J.N., & Bruce-low, S.S.
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The contractile history of a muscle plays a fundamental role in its subsequent performance. Following a bout of activity, muscle is both fatigued and potentiated; this balance dictates future muscle contractibility and thus, subsequent movement outcomes. Indeed, research has shown resistance exercise creates both fatigue and potentiates subsequent activity (Bevan et al. 2009: *Journal of Strength and Conditioning Research*, 23, 1780-1785). The later phenomenon has been termed, postactivation potentiation (PAP). Power expression is fundamental for sports performance, even more so in explosive intermittent sports such as soccer. Potentiation has shown to augment explosive movements such as, jumping and sprinting (Chatzopoulos et al. 2007: *Journal of Strength and Conditioning Research*, 24, 1278-1281). PAP occurs following 12 minutes (Bevan et al. 2009: *Journal of Strength and Conditioning Research*, 23, 1780-1785) of recovery whereas Ebben et al. (2000: *Journal of Strength and Conditioning Research*, 14, 451-456) failed to observe PAP after 5 minutes of recovery (p>.05) after resistance exercise. Therefore, the purpose of this study is to determine the optimal recovery time required to elicit PAP following a bout of high-intensity resistance exercise in professional soccer players. The study will follow a randomised, repeated measures crossover design. Participants will be randomly assigned to either experimental or control groups. A pre-testing session will involve familiarisation with testing procedure. Three repetition-max (RM) free-weight squats will be determined for the experimental group. Following 48 hours of recovery, both control and experimental groups will perform a baseline countermovement jump (CMJ) followed by 10 minutes of recovery. The control will then perform a CMJ at 15 seconds and at 4, 8, 12, 16 and 20 minutes followed by a cool down and debrief, whereas the experimental group will perform the 3RM squat, followed by the jump protocol. (Kilduff et al. 2007: *Journal of Strength and Conditioning Research*, 21, 1134-1138). Peak power will be assessed utilising either portable force plate or jump mat and subsequent power prediction using the Sayers equation. Repeated measures ANOVA with simple contrast will be used to determine significance between various jumps. Paired samples *t*-test using Bonferroni correction will test between group differences.

SC5O
Evening weight-lifting performance after two nights partial sleep deprivation; are “power naps” on the day of competition useful?
Moseley, S.E., Robertson, C., & Edwards, B.J.
*Liverpool John Moores University*

Much research has shown that maximal gross muscular performance is unaffected by partial sleep deprivation (Reilly & Edwards, 2007: *Physiology & Behaviour*, 90, 274-284). However, effects of partial sleep loss on repetitive gross muscular tasks (as in weightlifting, for example), which require high levels of motivation, is less well established, and two studies have observed increased perceived exertion (RPE) during a weight-lifting session (Reilly and Piercy, 1994: *Ergonomics*, 37,107-115). Moreover, power naps have been reported to improve mood and physical performance following reduced sleep (Waterhouse et al., 2007: *Journal of Sports Sciences*, 25, 1557-1566). Therefore, the purpose of this study was to determine the effects of partial sleep-deprivation (3 h sleep for 2 consecutive nights) on weight-lifting and whether the use of a short post-lunch power nap could improve
Following ethical approval by the University Human Ethic Committee, the protocol was explained to the volunteers and questions answered. Eight untrained, intermediate chronotype, males (Mean ± SD: age, 20 ± 1.49 yrs; height, 184 ± 5.9 cm; body mass, 94.2 ± 10 kg; customary retiring time, 23:30 ± 00:0:23 h; rising time, 08:00 ± 00:44 h; Bench Press 1 Rep Max (1RM), 81.25 ± 10.7 kg; Leg Press 1RM, 270±27.8 kg) volunteered for the study. Prior to the experimental trials, normative sleep and leg and bench press 1RM were measured. The subjects were familiarised with the protocol and apparatus 3 times before undertaking the main protocol, which consisted of completing 3 conditions separated by 7 days and administered in a randomized counterbalanced fashion. The three conditions were: 1) Normal (N) retiring at 23:00 h and rising at 06:30 h, 2) Partial sleep deprivation (SD) retiring at 03:30 h and rising at 06:30 h; and 3) Partial sleep deprivation with 1 h nap at 13:00 h (SDN). Measurements of rectal and skin temperatures, tiredness and alertness, and Profile of Mood Scores (POMS) were made at 08:00, 11:00, 14:00 & 17:00 h. At 17:00 h subjects also performed 3 attempts (with 3-min rest between each attempt) at progressive sub-maximal (40, 60, 80% 1 RM) Bench Press and Leg Press. A linear encoder (Muscle Lab, Ergotest version 4010, Norway) was attached to an Olympic bar (20kg, resting on steel racks, for bench press; 40 kg and tilted for leg press). Perceived effort and ratings of perceived exertion for breathing, muscle effort and overall feeling were measured after each lift. Average force, power, velocity and time-to-peak velocity were also recorded for each lift. Data were analysed using ANOVA models with repeated measures. Alertness, and bench press (power, force and average velocity) was lower and tiredness and sleepiness were higher in SD than N and SDN. RPE for breathing and muscle feeling increased during SD for bench and leg press. General body feeling additionally increased in leg press demonstrating subjects perceived the task to be harder. Mood states for vigour, calm were lower and anger, tension depression and fatigue were higher in SD compared to N. A significant load (%1RM) effect was observed for bench and leg press (force, average velocity, time to peak velocity); similarly ‘distance’ increased (at 80% 1RM) and leg press power increased as load (%1RM) increased. Further, RPE for breathing, muscle and general body feeling increased between loads. Alertness, tiredness and sleepiness demonstrated a significant time of day effect and interaction with a 1-h power nap increasing alertness and reducing tiredness and sleepiness. Furthermore, rectal temperature values were lowest at 08:00 h and highest at 17:00 h (P<0.05). All other variables were insignificant (P>0.05). In summary, the effects of partial sleep-deprivation (3 h sleep for 2 consecutive nights) on weight-lifting was a reduction in power, force and average velocity for sub-maximal bench press. SD caused a reduction in alertness and increase in tiredness and sleepiness. Mood state (vigour, calm, anger, tension depression and fatigue) were additionally negatively affect by SD. This study suggests that the use of a short post-lunch nap may improve performance to levels of that of normal sleep by increasing evening alertness, reducing tiredness and sleepiness and improving aspects of mood.

SC6O

Is the Fatigue experienced during resistance training neural or metabolic?

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Current research is yet to explain sufficiently the phenomena of fatigue. Two existing models of fatigue, peripheral and central, are conflicting. Noakes (1997: Medicine & Science in Sports & Exercise, 29, 571-590) developed the Central Governor Model (CGM), which suggests a neural governor exists to protect the body from potentially dangerous states, induced by exercise. However, models of fatigue are usually applied to endurance events and little research exists on the causal mechanism of fatigue in strength activities. This study aims to elucidate how fatigue occurs during a strength activity. Ethical clearance, granted from the University of Worcester, required all participants to complete an informed consent form prior to data collection. The participants [n=10] were aged 20.1 ± 0.74 and were all undergraduate students. A fatigue inducing protocol, utilised by Nicolas et al. (2007: Isokinetics & Exercise
Science, 15, 117-129) was adapted to include 5 sets of 12 maximal voluntary contractions (MVC) on an isokinetic dynamometer at 60°.s⁻¹, with 90 seconds rest between sets. Each contraction was monitored using local muscular EMG of the bicep. The EMG data was analysed using a Biometrics programme and was passed through two separate filters; an RMS filter, with a rolling time window of 50 ms and a median frequency filter at 1024 Hz. Mean data was analysed using SPSS statistical package for Windows Version 17. The results showed a significant decrease in peak torque (P=0.002), and EMG amplitude (RMS) (P=0.004) over the five sets. However, the median frequency, which reflects the firing rate of the muscle, over the 5 sets, increased significantly (P=0.022). The decrease in peak torque suggests that the protocol was sufficient enough to induce muscular fatigue for all participants and therefore can be considered a reliable method. The decrease in EMG amplitude has been previously reported during fatiguing exercise by Gerdle & Fugl-Meyer (1992: Acta Physiologica Scandinavica, 145, 129 – 138). The increase in EMG median frequency is however, an interesting finding which needs further analysis and interpretation. The results require further analysis, for interaction effects and interpretation of data with previous findings.

SC7P
The effects of a single weekly session of plyometric training in conjunction with a football training session over an eight-week period on explosive muscular power of recreational adolescent male footballers.
Whitmore, A.J.
University of Bedfordshire

Although the energy expenditure in football is provided predominantly by aerobic metabolism, the most significant actions that define the outcome of the match are the result of explosive anaerobic actions such as sprinting, jumping and shooting. Therefore, muscular power and speed are as important physiological characteristics in football as aerobic and muscular endurance. (Stølen et al., 2005: Sports Medicine, 35, 501-536). Stølen et al. (2005) recommends the implementation of a resistance training program to enhance force development in footballers. Due to financial, time and gym membership restraints on an adolescent recreational football team, an alternative muscular force developing training regime is desired. Furthermore, the enhancement of force and power (rate of force developed) require different training protocols. The purpose of this study was to determine the extent of the effects of plyometric training on explosive muscular power of adolescent footballers following a single training session once a week for a period of eight weeks. Once ethical approval had been granted, 15 male volunteer recreational adolescent footballers (age 15.8 ± 0.3 years, stature 1.75 ± 0.04m, body mass 63.7 ± 7.64 kg) performed three 40 m sprint tests, three Illinois Agility tests and three Countermovement jumps at baseline testing. 0-10 m acceleration, 0-30 m speed, 0-40 m speed, Illinois agility and jump height were are recorded. After baseline testing had concluded, participants were randomly allocated to a plyometric training (n = 7) group and a control group (n = 8). The plyometric training group adhered to an eight-week training program of recommended plyometric exercises that gradually progressed in intensity and the number of foot contacts per session steadily increased from 64 foot contacts to 105 foot contacts (Chu, 1998: Jumping into Plyometrics. Champaign, IL: Human Kinetics). The control group participated in a weekly football training drill before both groups completed the training session by participating in a training football match. Following the eight-week training program, the training group and the control group will be re-assessed in the sprint, agility and jump tests. Data will be analysed using a 2 by 2 Factorial Mixed ANOVA to determine any interaction effect of time and training group on 0-10 m acceleration, 0-30 m speed, 0-40 m speed, Illinois Agility time and Countermovement jump height. It is hypothesised that the results of this study will reiterate the findings from the studies by Miller et al. (2006: Journal of Sports Science and Medicine, 5, 459-465),
**SC8O**

The effects of menstruation cycle on sprint performance in female rugby players.

Barlow, C., & Konstantaki, M.

*Buckinghamshire New University*

Previous research has investigated the effects of menstruation upon anaerobic power using the Wingate test (Miskec, 1997: *Journal of Strength and Conditioning Sciences, 11*, 4, 219-223) whilst there has not been any research conducted in to how weight bearing exercise is affected by menstruation. The purpose of this study was to investigate if the menstrual cycle affects performance in a 60 m sprint. Twelve female trained rugby players (mean ± SD: age 26 ± 8, stature 164.5± 5.5 cm, body mass 69.32 ± 2.78 kg) signed an informed consent and participated in the study. Subjects performed three trials of a 60 m sprint test with 5 min rest in between trials under two conditions; during menstruation and during the luteal phase of the menstrual cycle. The time to complete the 60 m sprints was recorded using timing gates (Brower wireless timing gates). Body temperature was recorded in degrees Celsius using a tympanic thermometer (Braun Thermoscan). The test was conducted on a same grass surface at the same time of day and similar environmental temperature in both conditions. Data was analysed using descriptive statistics and paired t-tests. Preliminary results showed that mean body temperature increased during menstruation (non-menstrual: 35.9°C menstrual: 36.575°C). The time to complete the 60 m sprint was shown to be higher during menstruation for best sprint times (menstruation: 11.97 ± 0.81 s, non-menstruation: 11.69 ± 0.83 s, P=0.0001). These results contrast those shown previously for anaerobic power. It appears that the menstrual cycle has an effect upon maximal speed in weight bearing activities. This could be an important consideration for athletes participating in multiple sprint sports.

**SC9P**

Validation of the equation proposed by Horvat et al. (2007) to predict strength in female University athletes.

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Female athletes can improve performance potential by taking part in strength training (O’Nan et al., 2000: *International Sports Journal, 4*, 131-137). Adams et al. (2000: *Journal of Strength & Conditioning Research, 14*, 254-260) noted that 1RM testing could increase the likelihood of injury, especially for untrained individuals. To lessen the chance of injury Horvat et al. (2007: *Journal of Strength and Conditioning Research, 21*, 1018-1022) created an equation to predict maximal strength in female high school athletes (14-18 yrs). The aim of the research study was to examine the validity of the equation proposed by Horvat et al. (2007) at accurately predicting 1RM strength in female University athletes. Participants were ten consenting University age (18–21 yrs) female athletes. The study was approved by the Institutional Review Board at Southampton Solent University. Initially participants took part in a familiarisation session which demonstrated correct technique (Floyd et al., 2009: *Missouri Journal of Health, Physical Education, Recreation and Dance, 19*, 95-103 and NSCA, 2008, *Exercise Technique Manual for Resistance Training*, Illinois: Human Kinetics). A separate session tested the 1RM strength of both the upper body (Pulse 750G adjustable incline bench, Congleton, Cheshire) and lower body (Pulse 576G seated leg press, Congleton, Cheshire) in all participants. The 1RM testing protocol (Heyward, 2010: *Advanced Fitness Assessment and Exercise Prescription*, Illinois: Human Kinetics) included a warm up which required participants to complete one set (5-10 reps at 40-60% estimated 1RM) followed by a maximal set using 60–80% estimated 1RM. Participants had up to 5 attempts at lifting
maximal loads (Kraemer and Fry, 1995, Physiological Assessment of Human Fitness. Illinois: Human Kinetics) with 4 min. rest between attempts (Mirzaei et al., 2008: International Journal of Fitness, 4, 9). In the final session participants performed repetitions-to-fatigue (RTF) on both the bench press and leg press. The RTF protocol (Golding, 2000: The Y’s Ways to Physical Fitness. Illinois: Human Kinetics) required participants to lift 65% (Horvat et al., 2007) of the groups average 1RM result for as many repetitions as possible at a set cadence of 30 repetitions per minute measured using a metronome (Seiko SQ 50V, Maidenhead, Berkshire). A Pearson product correlation showed that the prediction equations proposed by Horvat et al. (2007) had a strong correlation with 1RM testing for upper body strength ($r(p) = 0.723$) and a moderate correlation for lower body strength ($r(p) = 0.645$). A paired samples t-test showed a significant difference between the 1RM testing and prediction methods for measuring upper body strength ($t(9) = -2.9, p = .017$) and lower body strength ($t(9) = -2.3, p = .047$). Both the upper and lower body strength prediction equations consistently over-predicted 1RM values. Bland and Altman plots showed marginal agreement between the methods for assessing upper and lower body strength. In conclusion the prediction equations proposed by Horvat et al. (2007) cannot be considered a valid measure of maximal strength in female University athletes.

SC10P
The effect of variable resistance training on maximal strength and power in collegiate rugby players.
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Resistance training is considered an integral aspect of athlete preparation (McMaster et al., 2009: Strength and Conditioning Journal, 31, 50-64). The vast majority if not all sports, place a demand upon skeletal muscle that can be trained and adapted for by utilizing resistance training programs (Zatsiorsky and Kraemer, 2000: Science and Practice of Strength Training. 2nd ed. Champaign IL: Human Kinetics). Resistance training using free weights is widely accepted as the conventional method of training. With this method the load remains the same throughout entire the range of motion (Anderson et al., 2008: The Journal of Strength and Conditioning Research, 22, 567-574). Alternatively, the implementation of variable resistance training that utilizes resistance bands has become increasingly popular as a method of loading resistance onto a barbell. This approach has been adopted and popularized by many in the strength conditioning industry, in particular by athletes aiming to improve strength and power (Ghigiarelli, et al., 2009: The Journal of Strength and Conditioning Research, 23, 756-764)

The purpose of the study was to investigate the effects of variable resistance training on maximal strength and power compared to the effects observed in an identically structured program that featured constant resistance methods, in the form of free weights. With ethical approach from the University of the West of England, twenty-two male (mean ± SD; height 180.9 ± 6.2 cm, body mass 89 ± 8.6 kg, age 19.5 ± 1.71 years) collegiate rugby union players were selected for the six week study. Primary tests were performed on two separate days of week one, in order to establish 1 repetition maximum squat, deadlift, bench press and vertical jump. Subjects were divided into two groups using a matched paired design based on primary test results. The variable resistance group used a combination of free weights and resistance bands, while the free weights group used free weights alone. Two training session were performed per week for a total of six weeks. Data was initially analysed for normal distribution using the one sample kolmogorov-smirnov test. This was followed by independent samples T-Test, in which statistical significace was set at $P \leq 0.05$. Results illustrated that while both groups made improvements and the mean values of the constant resistance group were higher across all tests, no significant difference between the groups was observed; Vertical Jump ($P = 0.623$), Bench Press ($P = 0.11$), Squat ($P = 0.271$) and deadlift ($P = 0.77$). These results are in contrast to current variable resistance literature, suggesting that although variable resistance has a number of favourable characteristics, when compared
with constant resistance, similar gains in maximal strength and power can be elicited when using more traditional methods. Following the findings of this research, it is reasonable to say there is equivocal evidence for both training methods. Future research could highlight possible differences by undertaking long term studies with larger populations of subjects. The ratio of resistance provided by the bands in conjunction with free weights is another aspect that merits further investigation.

SC11P
Increasing individual and organisational profitability in personal training: A case study of two health clubs in East London.
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Personal training is a popular career choice with its scope for flexible work hours, vast potential for earnings and its relaxed, fulfilling and enjoyable work environment. Currently little is known about how management practices in this field of employment impact on the service quality provided by personal trainers to their current and prospective clientele. The aim of this study was to investigate from an employer’s, managers and trainer’s perspective the type of employee support afforded to personal trainers at two large health clubs. Semi-structured interviews were used to collect rich, descriptive data based on the experience of two General Managers, two Health and Fitness Managers and two Personal Trainers. Interpretative Phenomenological Analysis (IPA) was used in order to explore in detail how the participants were making sense of their personal and social world. This involved the researcher engaging in an interpretive relationship with the transcripts, with the aim of trying to understand the content and complexity of their meaning rather than measure their frequency. Key emergent themes were identified and then analysed for connections between them, with some forming clusters together and others emerging as superordinate concepts. Results suggest it is crucial for Health and Fitness Managers to consistently uphold effective communication and deliver a supportive approach to personal trainers. The importance for personal trainers to continually develop within their practice was also highlighted, as this in turn will boost their individual profitability thus successfully feeding the vision of a health club. The outcomes of this study will help inform better working practices, thus enhancing individual and organisational profitability within health clubs. Furthermore, the findings emerging from the study can be used to inform in-house professional development programmes, with the result being better delivery of personal training provision and increased client satisfaction.

SC12O
The ten to five repeated jump test: A new test for evaluation of lower body reactive strength.
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Reactive strength is generating sharp interest with research and applied practitioners as a measure to monitor an individual’s ability to change quickly (<0.25 s) from an eccentric to a concentric contraction (Young, 1995: New Studies in Athletics, 10, 88-96). In order to further replicate the rebound qualities exhibited in many sporting activities Lloyd et al. (2009: Journal of Sports Sciences, 27, 1565-1573) used a maximal bi-lateral hopping test performed over five repeated repetitions. However, the ability of this test to detect training induced changes in performance was poor. Analysis of covariance (CV) for the average height obtained was 15%. The authors acknowledged that this greater variability was likely due to difficulties in postural control. The purpose of this study therefore was to refine and develop a methodology for assessment of lower body reactive strength, examine it for test-retest reliability, determine the internal consistency of
the test across five trials and, in addition, validate measures using contact mat against those acquired from ground-fixed force plate measures. Sixteen male Super League rugby league players (age, 19.7 ± 0.8 years; body mass 88.5 ± 12.0 kg; height 177.3 ± 6.1 m) volunteered to participate in the reliability study. An additional group of seven male college academy level rugby league players (age 17.4 ± 0.6 years; body mass 81.6 ± 16.3 kg) participated in the internal consistency and validity study. All jumps were performed on a mobile contact mat (Smart-jump, Fusion Sport, Australia) with instantaneous feedback on contact time (CT), flight time (FT), peak power output (PPO), impulse (IMP) and the reactive strength index (RSI) collected and displayed via a hand-held PDA (iPAQ, Hewlett Packard, USA). For the validity and internal consistency study the mobile contact mat was positioned directly over a 900 x 600 mm ground-fixed force plate. The ten to five repeated jump test (RJT) involved participants performing optimal vertical rebounds (i.e. maximal elevation at each jump) with minimal ground contact (<0.25 s) performed for a series of eleven jumps. Participants were instructed to keep their hands on the hips to ensure no contribution from the arms. Further instructions were given to (a) “minimize ground contact time”, (b) “maximize jump height”, (c) “imagine the ground as a hot surface”, and (d) “legs like a stiff spring” (Flanagan & Comyns, 2008: Strength and Conditioning Journal, 30, 32-38). From the eleven jumps that were recorded the first jump was discarded from the analysis since this did not involve a fast stretch-shortening cycle. From the remaining ten jumps the five jumps with greatest height exhibiting ground contact of less than 0.25s was used for further analysis. The height of these five jumps was then added together to provide a repeated reactive strength score. For the validity study participants performed five trials and for the reliability study two trials were performed on each testing session which was separated by one week. All participants in both studies were given a minimum of one minutes rest between successive trials. Pearson’s correlation coefficient revealed a significant (r=0.897; P=0.01) level of agreement between the mobile contact mat and force plate for ground contact time. There was a 14.25% change in the mean height from trial 1 to trial 5, however after an 11.55% change between trial 1 and 2 the change between trial 2 to 5 varied from only 0.33 to 1.25%. The average CV across all seven participants in the validity study was 9%. The test-retest reliability results displayed a significant (r=0.782; P=<0.01) relationship between trial 1 and 2. The main finding of the present study was that the CV of the ten to five RJT was found to be 9%. The higher levels of sensitivity in the present protocol compared to Lloyd et al. (2009: Journal of Sports Sciences, 27, 1565-1573) can be attributed to the elimination of the lowest 5 jump heights that are likely to have been a result of deficiencies in postural control. Another important finding was that the ten to five RJT was found to gain consistent scores after just 2 trials. Furthermore, the mobile contact mat used in the present study was shown to have a high level of criterion validity in agreement with Lloyd et al. (2009: Journal of Sports Sciences, 27, 1565-1573). Consequently, for coaches working with large groups of athletes the ten to five RJT can provide a quick and reliable means of monitoring individual progress and evaluating the success of interventions aimed at developing the reactive strength capabilities of their athletes.

SC13O
Post-activation potentiation improves sprint performance in trained athletes.
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Post-activation potentiation (PAP) is induced by a voluntary muscular conditioning contraction performed at relatively high intensity, with a perceived potential to increase both peak force & rate of force development during subsequent twitch contractions. However the significance of PAP to functional performance has not been well established (Hodgson et al., 2005: Journal of Sports Medicine, 35, 585-95). Therefore, the purpose of this study was to determine whether performing heavy load machine hack squats (HS) versus heavy load barbell back squats (BS) prior to sprinting would improve running speed compared to a
standardised warm up control protocol (C). Fifty seven trained male (n = 51) and female (n = 6) county-level sprinters (mean ± SD: age 18.4 ± 3.6 y, stature 178.5 ± 22 cm, body mass, 68.1 ± 10.2 kg) completed 3 trials (HS, BS C) in a counterbalanced order. Each trial consisted of a 100 m sprint incorporating a 30 m split and final time measured using timing gates. HS and BS trials consisted of two sets of three repetitions using heavy load (3RM) hack-squat machine squats or barbell squats, followed by a 5 minute recovery. C trial consisted of dynamic stretching & drills only followed by a 5 minute recovery. Data were analysed using factorial within-subjects general linear models. Data was presented as mean ± SD. 30 m performance in the C trial (4.78 ± 0.42 s) was significantly (P < 0.01) slower than both the HS (4.63 ± 0.38 s) and BS (4.69 ± 0.39 s) trials. This performance affect was maintained, with 100 m in the C trial (12.40 ± 0.38 s) significantly (P < 0.01) slower than both the HS (12.14 ± 0.76 s) and BS (12.26 ± 0.76 s) interventions. However, HA and BS were not significantly different from each other (P = 0.36). The results support previous reported findings of a decrease in 100 m completion times subsequent to 1 set of 3 back squat repetitions at 90% 1RM (McBride et al., 2005: Journal of Strength and Conditioning Research, 19, 893–897). Results suggest both HS and BS protocols potentially elicit PAP prior to a 100 m sprint with lower completion times than a standardised warm-up. With no significant difference between the interventions, it might be recommended that athletes untrained in comparatively complex barbell back squat technique might still elicit a beneficial PAP effect using the hack-squat machine. In the competition environment a BS might be logistically preferable.