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D. Barr; W. Gregson; L. Sutton; T. Reilly. *A practical cooling strategy for reducing the physiological strain associated with firefighting activity in the heat.* S. 413–420.

The aim of this study was to establish whether a practical cooling strategy reduces the physiological strain during simulated firefighting activity in the heat. On two separate occasions under high ambient temperatures ($49.6 \pm 1.8^\circ\text{C}$, relative humidity (RH) $13 \pm 2\%$), nine male firefighters wearing protective clothing completed two 20-min bouts of treadmill walking (5 km/h, 7.5% gradient) separated by a 15-min recovery period, during which firefighters were either cooled (cool) via application of an ice vest and hand and forearm water immersion (19°C) or remained seated without cooling (control). There was no significant difference between trials in any of the dependent variables during the first bout of exercise. Core body temperature (37.72 ± 0.34 vs. $38.21 \pm 0.17^\circ\text{C}$), heart rate (HR) (81 ± 9 vs. 96 ± 17 beats/min) and mean skin temperature ($31.22 \pm 1.04^\circ\text{C}$ vs. $33.31 \pm 1^\circ\text{C}$) were significantly lower following the recovery period in cool compared with control ($p < 0.05$). Core body temperature remained consistently lower ($0.49 \pm 0.02^\circ\text{C}$; $p < 0.01$) throughout the second bout of activity in cool compared to control. Mean skin temperature, HR and thermal sensation were significantly lower during bout 2 in cool compared with control ($p < 0.05$). It is concluded that this practical cooling strategy is effective at reducing the physiological strain associated with demanding firefighting activity under high ambient temperatures.

- **Keywords:** firefighter; heat stress; recovery strategy; core temperature

John P. Buckley; Julius Sim; Roger G. Eston. *Reproducibility of ratings of perceived exertion soon after myocardial infarction: responses in the stress-testing clinic and the rehabilitation gymnasium.* S. 421–427.

The purpose of this study was to compare ratings of perceived exertion (RPE; Borg's 6-20 scale) at the same exercise intensity, between a standard exercise electrocardiogram (ECG) treadmill stress test (exECG) and two subsequent bouts of treadmill exercise in a cardiac rehabilitation gymnasium. Eleven patients (mean \pm s) 60.8 ± 6.1 years performed an exECG within 12.1 ± 7.5 d after myocardial infarction (MI) and commenced their first exercise-based rehabilitation session (gym-1), which included the use of a motorised treadmill, within 5.0 ± 1.3 d after the exECG. A second gym session (gym-2) was performed within 4.2 ± 1.3 d of gym-1. Gym-1 and gym-2 treadmill exercise was performed at an intensity that equated to the penultimate testing stage of exECG, and RPE and heart rate were compared at this level between the three sessions of testing.

The mean work rate at the penultimate testing stage of the exECG was 6.0 ± 1.0 metabolic equivalents; $\square 67\%$ of peak work rate. The RPE at this work rate during exECG, gym-1 and gym-2 were 15.8 ± 2.7 , 13.3 ± 3.4 and 13.0 ± 3.6 , respectively. A repeated measures ANOVA revealed these RPE responses to be significantly different ($F_{2,20} = 9.8$; $p = 0.001$). Post-hoc Bonferroni-corrected pairwise t -tests showed significant differences ($p \leq 0.008$) between exECG and gym-1 and exECG and gym-2 but not between gym-1 and gym-2. There was no significant difference in heart rate between the three testing sessions ($p = 0.076$) but it showed signs of a similar trend to RPE. The intra-participant agreement in RPE between gym-1 and gym-2 was substantial; intraclass correlation coefficient ($ICC_{2,1}$) = 0.85 ($p < 0.001$) and in all but one participant, RPE differed by ≤ 2 scale points. The RPE responses during standardised exECG treadmill testing, in patients soon after MI, are inflated compared to responses at the same treadmill work rate during subsequent cardiac rehabilitation exercise sessions. Caution is advised in using RPE taken from an initial exECG to guide physical activity in MI patients, but introducing RPE at this point contributes to its subsequent reliable use.

- **Keywords:** exercise ECG testing; ratings of exertion; cardiac rehabilitation

Michiel de Looze; Tim Bosch; Jaap van Dieën. *Manifestations of shoulder fatigue in prolonged activities involving low-force contractions. S. 428–437.*

Shoulder fatigue has been suggested to be a useful risk indicator for shoulder disorders in repetitive, low-force work tasks. In contrast to high-force or purely isometric tasks, it is unclear whether measurable fatigue develops in realistic low-force work. The question addressed in this review was: 'Is there evidence of objective signs of fatigue in the shoulder region in realistic, low-force work tasks?' Studies on objective measures of fatigue applied in realistic low-force work tasks were systematically reviewed, using a task duration of more than 1 h and an intensity level of less than 20% maximum voluntary contraction (MVC) for the median trapezius activation level as inclusion criteria. Thirteen studies were found to fulfil the criteria. All these studies addressed fatigue-related changes in the electromyographic signal in the descending part of the trapezius muscle. Seven did find a combination of frequency decrease and amplitude increase over time, which is generally considered as an objective manifestation of fatigue. Thus, there is evidence of objective signs of fatigue in some of the realistic, low-force tasks. The intensity level appeared to be a main determinant here. In the studies demonstrating signs of fatigue an intensity level of 15%MVC or more was used, while the intensity level in the studies with a negative result was generally lower.

- **Keywords:** EMG; mechanography; muscle contraction; task duration; trapezius

Digby Elliott; Steve Hansen; Lawrence E. M. Grierson. *Optimising speed and energy expenditure in accurate visually directed upper limb movements. S. 438–447.*

Traditional models of speed-accuracy relations and limb control are steady-state models that fail to consider the learning history and strategic approach of the performer. Work from this laboratory indicates that a performer adjusts his/her behaviour from trial-to-trial to optimise not only the speed and accuracy of performance, but also energy expenditure. Because some errors have greater temporal and energy costs than others, most performers execute movements that are prepared such that potential errors are of minimal expense. The trajectories and subsequent endpoint distributions of rapid aiming movements depend on advance knowledge about the availability of afferent information for online control, as well as the costs associated with undershooting or overshooting the target position with the initial impulse. With practice, a performer is able to reduce the trial-to-trial variability associated with goal-directed movement through more consistent movement planning processes and more rapid online control. Part of the optimisation

process is related to the development of an internal model of performance against which early afferent feedback can be evaluated. This framework for examining speed, accuracy and energy expenditure in goal-directed reaching can be used to help understand the breakdown of efficient limb control due to fatigue, ageing and pathology.

- **Keywords:** aiming; energy; limb control; optimisation; speed-accuracy

S. Fullick; C. Grindey; B. Edwards; C. Morris; T. Reilly; D. Richardson; J. Waterhouse; G. Atkinson. *Relationships between leisure-time energy expenditure and individual coping strategies for shift-work.* S. 448–455.

A total of 13 to 14% of European and North American workers are involved in shift work. The present aim is to explore the relationships between coping strategies adopted by shift workers and their leisure-time energy expenditure. Twenty-four female and 71 male shift workers (mean \pm SD age: 37 ± 9 years) completed an adapted version of the Standard Shift-work Index (SSI), together with a leisure-time physical activity questionnaire. Predictors of age, time spent in shift work, gender, marital status and the various shift-work coping indices were explored with step-wise multiple regression. Leisure-time energy expenditure over a 14-d period was entered as the outcome variable. Gender ($\beta = 7168.9$ kJ/week, $p = 0.023$) and time spent in shift work ($\beta = 26.36$ kJ/week, $p = 0.051$) were found to be predictors of energy expenditure, with the most experienced, male shift workers expending the most energy during leisure-time. Overall 'disengagement' coping scores from the SSI were positively related to leisure-time energy expenditure ($\beta = 956.27$ kJ/week, $p = 0.054$). In males, disengagement of sleep problems ($\beta = -1078.1$ kJ/week, $p = 0.086$) was found to be negatively correlated to energy expenditure, whereas disengagement of domestic-related problems was found to be positively related to energy expenditure ($\beta = 1961.92$ kJ/week, $p = 0.001$). These relations were not found in female shift workers ($p = 0.762$). These data suggest that experienced male shift workers participate in the most leisure-time physical activity. These people 'disengage' more from their domestic-related problems, but less from their sleep-related problems. It is recommended that physical activity interventions for shift workers should be designed with careful consideration of individual domestic responsibilities and perceived disruption to sleep.

- **Keywords:** domestic work; exercise; nocturnal work; sleep-wake cycles

J. R. Jakeman; R. Macrae; R. Eston. *A single 10-min bout of cold-water immersion therapy after strenuous plyometric exercise has no beneficial effect on recovery from the symptoms of exercise-induced muscle damage.* S. 456–460.

The purpose of this study was to examine the effectiveness of a single bout of cold-water immersion on recovery from exercise-induced muscle damage. Eighteen physically active female volunteers (age $19.9 (\pm 0.97)$ years), height $1.66 (\pm 0.05)$ m, mass $63.7 (\pm 10)$ kg, completed 10 sets of 10 counter-movement jumps to induce muscle damage and were randomly allocated to a control or treatment group. The treatment group was given a single 10-min bout of lower limb cold-water immersion therapy at 10°C immediately following damage-inducing exercise. Indicators of muscle damage (plasma creatine kinase activity, perceived soreness and maximal voluntary contraction of the quadriceps) were assessed immediately prior to counter-movement jumps, and at 1, 24, 48, 72 and 96 h, following the damaging exercise. Significant ($p = 0.05$) time effects were recorded on all indicators of muscle damage, but there were no significant group or group \times time interaction effects found on any of the measured variables. The results indicate that a single bout of cold-water immersion after a damaging bout of exercise has no beneficial effects on the recovery from exercise-induced muscle damage.

- **Keywords:** cold-water immersion; creatine kinase; exercise-induced muscle damage; muscle strength; recovery

K. Knaepen; E. Cumps; E. Zinzen; R. Meeusen. *Low-back problems in recreational self-contained underwater breathing apparatus divers : prevalence and specific risk factors.* S. 461–473.

Low-back problems (LBP) are one of the most common musculoskeletal disorders in the general population, with reported lifetime prevalences of 50% to 80%. Also, certain sports participants (e.g. gymnasts, alpine skiers, runners) are at risk of LBP and its repercussions. This epidemiological study was undertaken to examine the lifetime and 1-year prevalence of LBP among recreational Flemish self-contained breathing apparatus (scuba) divers and to identify general and sport-specific risk factors associated with the occurrence of LBP. A retrospective self-assessment questionnaire was developed and assessed for validity and reliability, to gather data concerning demographics, LBP prevalence and associated risk factors and injuries among active scuba divers. A total of 181 recreational scuba divers (men: $n = 138$, mean age 40.3 ± 12.8 years; women: $n = 43$, mean age 35.0 ± 10.9 years) from 10 randomly selected internationally recognised scuba diving clubs participated in the study. Lifetime and 1-year prevalence of LBP among recreational Flemish scuba divers were 55.8% and 50.3%, respectively. General risk factors for LBP were found to include prior history of LBP, structural abnormalities, heavy workload, pregnancy and parturition, general fatigue and bending forwards and backwards. Scuba divers suffering from LBP generally had a significantly higher dive certificate than those without LBP ($p = 0.007$). Symptomatic scuba divers also used significantly more weights on their weight belts during indoor training ($p = 0.003$) and during outdoor dives with a dry suit ($p = 0.044$) as compared to asymptomatic scuba divers. In scuba diving, reliable sport-specific risk factors for LBP were found to be scarce. Further biomechanical research is required to point out whether or not scuba diving characteristics actually contribute to LBP.

- **Keywords:** scuba diving; low-back problems; prevalence; epidemiology; injury

Allistair P. McRobert; Andrew M. Williams; Paul Ward; David W. Eccles. *Tracing the process of expertise in a simulated anticipation task.* S. 474–483.

Skilled perceptual-cognitive performance is assumed to require superior anticipation, yet few researchers have explored how individual differences in processing measures mediate superior performance, particularly when characteristics of the task are systematically changed from trial to trial. This study examined how advance cue information influences anticipation using a simulated cricket batting task. Skilled ($n = 10$) and less skilled ($n = 10$) batters moved in response to life-size video images of 36 deliveries by fast and spin bowlers. Skilled participants (mean 37.3, SD 2.8 mm) were significantly more accurate at anticipating ball position as it passed through the strike zone than less skilled batters (mean 48.9, SD 5.9 mm, $p < 0.05$). Skilled batters fixated on central areas of the body and searched more locations ($p < 0.05$). Batters used fixations of longer duration and focused more on the ball and hand when viewing spin compared to fast bowlers (both $p < 0.05$). Visual behaviour is constrained by the task parameters and participant skill level. An analysis of immediate retrospective reports and eye fixations indicated that skilled batters search and encode scenes at a richer and more sophisticated level than less skilled players.

- **Keywords:** cricket; expert performance approach; eye movement skill; long-term working memory

F. Perroni; A. Tessitore; G. Cibelli; C. Lupo; E. D'Artibale; C. Cortis; L. Cignitti; M. De Rosas; L. Capranica. *Effects of simulated firefighting on the responses of salivary cortisol, alpha-amylase and psychological variables.* S. 484–491.

The aim of this study was to evaluate the effects of a simulated firefighting intervention on salivary alpha-amylase (sA-A), free cortisol (sC), anxiety (STAI), and profile of mood states (POMS) in 20 male firefighters (age 32 ± 1 years, $\dot{V}O_{2\text{peak}}$: 43 ± 5 ml/kg per min). During the 12-min firefighting intervention (ambient temperature: $13 \pm 1^\circ\text{C}$; relative humidity: $63 \pm 1\%$), individuals spent $63 \pm 28\%$ of the time working at heart rate (HR) $>85\%$ of individual HR_{max} , $[\text{La}]_{\text{peak}}$ 9.2 ± 2.9 mM and ratings of perceived exertion 16 ± 2 . At 30 min post-intervention significant ($p < 0.001$) increases in sA-A (174%) and sC (109%) were found with regard to values recorded before and after 90 min of the firefighting intervention. Since no differences emerged between pre-intervention and post intervention for STAI and POMS values, the hormonal changes were attributable to the intense physical stress of the simulated intervention. Further research is needed during real firefighting activities, where high emotional stress may also be present.

- **Keywords:** anxiety; blood lactate; heart rate; hormonal responses; profile of mood states

J. L. White; J. C. Scurr; N. A. Smith. *The effect of breast support on kinetics during overground running performance.* S. 492–498.

Changes in ground reaction forces that result from different breast support conditions may have implications for sports performance and transmission of forces through the skeleton. The aim of this investigation was to compare kinetic variables and breast motion in a no-bra, everyday-bra and two sports-bra conditions. Following ethical approval, eight female participants with D-cup breasts had retro-reflective markers placed on the left and right nipples, anterior superior iliac spines and clavicles. Five calibrated ProReflex infra-red cameras (100 Hz; Qualisys) measured 3-D displacement of markers and synchronised kinetic data were collected using a force platform (500 Hz, Kistler 9281CA). A repeated measures one-way ANOVA revealed a significantly higher medial impact force in the no-bra condition (0.15 times body weight) compared with the compression sports-bra condition (0.12 times body weight) ($F = 3.64_{3,21}$, $p = 0.03$). Findings suggest that inadequate breast support affects a female's running kinetics, which may have negative physiological consequences on sports performance.

- **Keywords:** bra; kinetics; running; 3D analysis