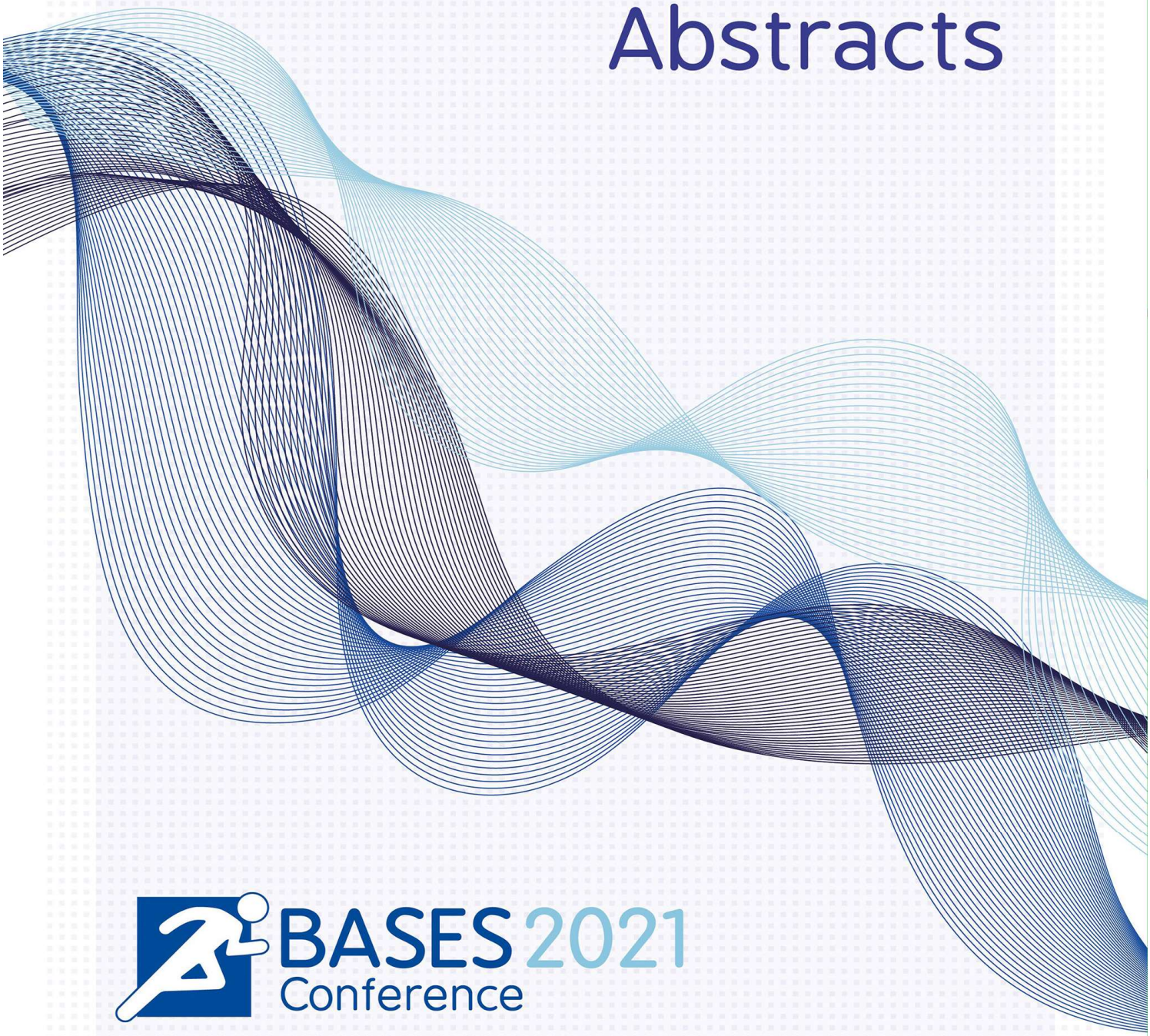
Abstracts



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ABSTRACTS

The British Association of Sport and Exercise Sciences Expert Statements

D1.S2.1(1) The BASES Expert Statement on Conducting and Implementing Female Athlete- Based Research

Produced on behalf of the British Association of Sport and Exercise Sciences by Drs Kirsty Elliott-Sale, Emma Ross FBASES, Richard Burden and Kirsty Hicks.

The Tokyo Olympics will be the first Games where there are as many medals available for females as for males and reflects a rise in female participation from 2.2% in Paris 1900 to ~48.8% in Tokyo. The Tokyo Paralympics will feature more female athletes than any previous Games, 4,400 athletes will compete in 537 medal events, with 1,756 places available for women, which is a 17% increase on London 2012. This coupled with increasing global investment, development and media coverage of women's sport, indicates an increased appetite for female sport. Moreover, the unique hormonal fluctuations encountered by female athletes, as a result of the eumenorrheic menstrual cycle (MC) and its perturbations, could significantly impact upon performance and health, showing the clear necessity for high-quality female athlete- focused research.

Although research into female-specific performance started in 1876, surprisingly little is known about the direction or magnitude of the effects of ovarian hormones on performance. There is a dearth of female athlete-specific research (Costello et al., 2014) and poor methodological quality has further compounded our ability to draw evidence-based conclusions/recommendations. To overcome the androcentric (male-centred) physiology research base and to pursue a competitive advantage, more studies are needed that specifically address the performance- and health- related issues associated with the fluctuations in reproductive hormones. Sport scientists can address this by unpicking the combined/individual effects of oestrogen and progesterone on physiological processes, performance and health. This expert statement outlines good practice to follow when conducting and implementing female athlete-based research. We hope that it will reduce some of the poorer practice previously seen in laboratory and applied settings and will allow female athletes to receive the same quality and quantity of research informed practice, to allow them to reach their full potential.

Background and evidence

The MC is a repeating pattern of sex hormone production and secretion, which is subject to large inter- and intra-individual variation. A eumenorrheic cycle lasts 21-35 days. Assuming a 28-day cycle, day one is characterised by a bloody discharge known as menstruation/menses, or colloquially as "a period." In the simplest terms, the MC can be divided into two phases: the follicular phase, occurring before ovulation; and the luteal phase, occurring after ovulation. It is worth considering the MC as (at least) three phases with significantly/meaningfully different hormonal profiles: 1) The early follicular days 1-5 (low oestrogen and progesterone); 2) The ovulatory days 14-15 (medium oestrogen, low progesterone); and 3) mid-luteal days 20-22 (high progesterone, high oestrogen).

These phases can be established by (i) asking athletes to indicate when their period starts; (ii) using a urinary ovulation kit; and (iii) adding 7 days from when ovulation occurs; and confirmed by blood samples that are retrospectively analysed for 17-β-oestradiol (most potent type of oestrogen) and progesterone concentrations. Janse de Jonge et al. (2019) suggest the luteal phase is verified by a progesterone concentration >16 nmol·L-1. We suggest the research community adopts these phases, so we can make direct comparisons between studies.

The late follicular phase has the highest oestrogen levels and would yield the greatest oestrogen to progesterone ratio, but this phase is difficult to determine as there is a lot of variability in the timing of this peak and there are no obvious physical indicators of this phase unlike menstruation and ovulation. As such this phase should be avoided for research purposes in the absence of daily prospective blood sampling.

The MC has many perturbations (i.e. alterations to the usual function). Anovulatory cycles are characterised internally by the absence of an ovulatory peak in 17-β-oestradiol and externally by periods but no ovulation. Amenorrheic cycles are typified internally by downregulated 17-β-oestradiol and progesterone levels and externally by no periods or ovulation. Oligomenorrhea refers to infrequent periods and results in cycles that are >31 days but otherwise follow the same eumenorrheic hormonal patterns just extended over a longer timeframe. Polymenorrhea refers to frequent periods and results in cycles that are <21 days but otherwise follow the same eumenorrheic hormonal patterns just truncated over a shorter timeframe.

In an applied setting the MC can easily be tracked using a calendar and ovulation kits; we suggest annotating the start and end of menstruation and when ovulation occurs. If ovulation kits are not available then athletes should look out for another physical signs of ovulation, such as a rise in basal body temperature (taken every morning upon wakening) or a white vaginal discharge that is stretchy and slippery and looks like egg whites. Athletes should note any physical/emotional changes as they occur, allowing them to produce their own personalised MC profiles. This is a straightforward concept but collecting data in this way can be a powerful tool; empowering each athlete to understand her cycle and how it relates to any physical and emotional symptoms she may experience. To get

the best data, rather than simply instructing athletes to monitor their cycle, athletes need to be invested in these activities, using a system that suits them. They should monitor for >3 months to allow meaningful conclusions about their cycle patterns to be made.

For coaches, monitoring MCs offers the opportunity to understand individual athletes, and their lived experience of the MC. At the very least it can help explain why some days feel better than others; at best it can produce patterns that can be anticipated, exploited or overcome. Coaches must create a space where athletes feel safe and confident to share their cycle details. Safe, in that they will neither be judged on what they report, nor will it be used against them; this information will be treated confidentially. Confident, in that their coaches are comfortable discussing MCs and have good enough knowledge of female physiology to be able to use the data impactfully and without risk. The goal is to ensure that all athletes can overcome any cycle-related symptoms, such that their ability to fulfil their potential on any given day is not compromised.

"Hormonal contraceptives" is an umbrella term, which describes a variety of medications that obfuscate the MC, by altering the endogenous hormonal milieu (Elliott-Sale & Hicks, 2018). Nearly half of elite UK-based female athletes use a hormonal contraceptive (Martin et al., 2018) therefore, it is not ecologically valid to only consider eumenorrheic athletes either in research or practice. Most (68%) hormonal contraceptive users take the combined oral contraceptive pill (OCP), which follows a two-phase, 28-day regimen: pill consumption (low endogenous oestrogen and progesterone plus exogenous oestrogen and progestin) for 21 days and pill withdrawal (slight rise in endogenous oestrogen and progesterone and no exogenous oestrogen and progestin) for 7 days. Therefore, there are significantly/meaningfully different ovarian hormonal profiles between OCP users and non-users, making them two distinct groups. OCP use has been associated with less physical/emotional side-effects than non-use (Martin et al., 2018), although this warrants further investigation. As the long-term health implications of chronic hormonal contraceptive use are unknown, female athletes need to receive informed medical advice on contraceptive choices. We need to educate OCP takers about their withdrawal bleed, dispelling the myth that this is a period and a marker of reproductive health. Low energy availability is masked by OCP use because a breakthrough bleed can still occur, even if an athlete is under-fuelling.

There is no consensus on the effects of the ovarian hormones on performance. Such inconsistencies might arise from differences in the definition and quantification of reproductive status and the type of outcome measured. Future research should focus on measuring the concentration of reproductive hormones at the time of performance assessment. Studies on OCPs should employ a homogenous design, studying one type of OCP per group as large variation in endogenous sex hormone concentration were observed when multiple brands were analysed together (Elliott- Sale et al., 2013).

At present there are no fit for purpose, evidence-based guidelines from high quality peer-reviewed papers for practitioners to apply. Practitioners should develop their own bespoke athlete guidelines based on the data collected from their athletes until such point that the scientific community endorses a substantial body of work, which can be used to inform practice.

As every woman's cycle is different and can change across her lifespan, there might never be a universal blueprint that practitioners can exclusively use to direct training and performance.

D1.S2.1(2) The BASES Expert Statement on the Use of Music for Movement among People with Parkinson's

Produced on behalf of the British Association of Sport and Exercise Sciences by Prof Costas I. Karageorghis FBASES, Dr Dawn Rose, Dr Lucy E. Annett, Dr Judith Bek, Dr Lindsay Bottoms, Dr Peter J. Lovatt, Dr Ellen Poliakoff, Dr Benjamin G. Schultz, Dr Caroline P. Whyatt, Dr William R. Young and Prof Yvonne N. Delevoye-Turrell.

"Music makes me feel free; it makes me feel normal, like I was a puppet with my strings messed-up, and suddenly they've all been untangled."
Anon. person with Parkinson's

Music is an artistic auditory stimulus that unfolds over time. It can prime specific actions and prompt engagement in physical activity as well as heighten motivation during motor tasks (Karageorghis, 2020). Contrastingly, it can be used to down-regulate arousal to facilitate the transition from an active to a sedentary state or to ameliorate anxiety. In therapeutic applications, musical features such as rhythm, melody and harmony have been shown to elicit psychological and physiological changes (Thaut & Hoemberg, 2014).

Parkinson's is a degenerative neurological condition in which the loss of dopamine neurons results in impaired initiation and control of movement, with common symptoms including tremor, postural instability and gait disturbance. There are also non-motor effects that include apathy, anxiety and depression. Medication does not alleviate all manifestations of the condition and there is presently no known cure (Obeso et al., 2017). It is notable that people with Parkinson's are estimated to be 30% less active than age- matched peers (Ramaswamy et al., 2018). Nonetheless, evidence is emerging that a range of exercise-based and social activities that involve musical engagement can serve to address the common symptoms and enhance quality of life (Thaut & Hoemberg, 2014).

This statement brings together an international interdisciplinary team to outline what is known about music-related applications for people with Parkinson's, and to provide recommendations for exercise and health practitioners.

Background and evidence

Auditory and motor areas in the brain are closely linked. Notably, rhythm and tempo provide "temporal scaffolding" to help guide when, how far and how fast to move (Dalla Bella et al., 2015, p.78). The sustained interest in how the rhythmic components of music can help to regulate

movement in Parkinson's has led to a therapeutic strategy known as rhythmic auditory stimulation. Findings from related work indicate that rhythmic auditory stimulation training has a regulatory effect on walking (Dalla Bella et al., 2015). This "entrainment effect" can also direct several of the body's pulses, such as breathing rate, heart rate and brain waves. Nonetheless, if people find it difficult to extract a beat or need to adapt their walking pattern to certain situations (e.g. rough ground), rhythmic auditory stimulation training can have limited applicability.

Researchers in Parkinson's have suggested that musical stimuli provide more effective auditory cueing than simple metronomic (tick-tock) stimuli. A recent study illustrated that the capacity to synchronise accurately depends not only on the speed (tempo) and type of auditory cue (metronome, music), but also on the type of movement being coordinated (Rose et al., 2019; see Figure 1). Moreover, music can facilitate action production, leading to greater automaticity and fluency in sequential motor tasks (Karageorghis, 2020). Accordingly, people with Parkinson's have a means by which to engage in purposeful motor behaviours with less cognitive effort. Music has "groove", lyrics and affective qualities that come to the fore in social situations such as dancing. Thus, music has the potential to facilitate expressive and communicative actions as well as functional ones. Nonetheless, care must be taken when using music with lyrical content that requires semantic processing, as dual-tasking can be challenging for people with Parkinson's.

The effects of music are nuanced and multifaceted. Music triggers memories that can transport individuals back in time and connect them with significant others in a meaningful way. The familiarity of personally meaningful music may assist in the internal generation (i.e. imagination) of cues to motivate, initiate and regulate movement. Research has shown that auditory and motor imagery ("internal rehearsal") can facilitate movement production and fluency, in motor tasks such as gait (Young et al., 2016) and hand movements (Bek et al., 2019). As well as using pre-recorded music, the ability to deploy an "inner jukebox" could be promoted as a therapeutic strategy for Parkinson's (Rose et al., 2019).

Recommendations

- Select music tracks that have a clearly extractible metre (strong beat) and avoid altering the tempi of tracks.
- Incorporate music making as well as music listening into therapeutic programmes.
- Music is a socialising force that can be used to encourage people to move together in time and space, with concomitant benefits for quality of life.
- Within group settings, consider participants' age and preferences in the formation of music programmes in order to accommodate individual needs (e.g. varying levels of movement complexity).
- Employ modern digital technologies, such as those that generate motion sensor-mediated music programmes, to facilitate the autonomous selection of music based on movement rate (i.e. passive synchronisation).

Future directions

- The use of digital technologies to identify and codify individuals' spontaneous motor tempo should be explored in order that this can be incorporated into therapeutic music applications.
- There is a need to examine how music can help people with Parkinson's to divert attention (i.e. facilitate dissociation) from overwhelming sensory inputs that are both external (e.g. noise, social chattering) and internal (e.g. tremor, muscle pain).
- The use of music to evoke motor imagery that facilitates movement should be explored.
- The influence of group dynamics on responsiveness to music warrants further investigation.
- Going beyond measuring single-limb body movements (e.g. finger tapping) would serve to elucidate the therapeutic benefits of music-related interventions.

Conclusions

Music for movement can be used in Parkinson's to facilitate the guidance of voluntary actions, improve engagement in physical activity, elevate motivation and enhance affective states. We hope that the detail provided herein will encourage practitioners to optimise the way in which music is integrated into their therapeutic approaches and to create a soundscape that will enable people with Parkinson's to "untangle the puppet strings."

D2.S2.1(2) The BASES Expert Statement on Eligibility for Sex Categories in Sport: Trans Athletes

Produced on behalf of the British Association of Sport and Exercise Sciences by Dr Georgina Stebbings, Dr Adam Herbert, Dr Shane Heffernan, Prof Roger Pielke Jr., Prof Ross Tucker and Dr Alun Williams.

Physiological differences between men and women have led to the segregation of sport according to biological sex. Without this segregation, women would disappear from most elite and matched levels of sport, as greater physical capacity in men, developed particularly in response to androgens during and after puberty, confers insurmountable advantages in speed, strength, endurance, and other variables. To allow fair competition, and regulate safety of combat and collision sports, a protected female category in sport exists.

In most individuals, biological sex aligns to gender identity (cis men/women), whereas in trans people, biological sex differs from gender identity. Thus, if permitted to compete in the sporting category aligned to their gender identity, trans women (assigned male sex at birth) may retain a performance advantage and reduce safety of other women in certain sports, while trans men (assigned female sex at birth) may be at increased risk of injury.

To facilitate inclusion while balancing fairness of competition and athlete safety, several sport organisations developed guidelines for the inclusion of trans athletes. Both World

Table 1. Extent of male advantage in selected physiological characteristics relevant for athletic performance. Adapted from Hilton & Lundberg (2020).

Characteristic	Approximate male advantage
Limb length	~12%
Muscle mass	~37%
Muscle strength	~55%
Cardiovascular function	~27%

Athletics and the International Olympic Committee (IOC) permit trans men to compete without restriction in the male category. Trans women may compete in the female category, if they maintain serum testosterone <5 or 10 nmol/L (depending on sport/organisation) for 12 months before competition. Contrastingly, World Rugby exclude trans women from competing with elite women and require trans men to confirm physical ability before competing against elite men for safety reasons - a policy based on current evidence in non-athletic trans women and men.

Through this expert statement, we provide recommendations for practitioners, researchers and policymakers working in this area.

Sexual dimorphism-linked performance differences

Sexual dimorphism is the development of divergent secondary sex characteristics between males and females during puberty due to androgenisation and a resulting ~15-fold higher serum testosterone in most cis men. As testosterone is primarily responsible for initiating positive changes in many anthropometric and physiological variables (Table 1), there is a corresponding divergence in athletic performance between biological males and females following puberty. Indeed, cis male performance advantages in elite sport range from ~12% in swimming, rowing, and running, to ~20% in sports more reliant on upper body strength (Hilton & Lundberg, 2020) and ~30% in combat sports (Busko et al., 2016). Comparable differences also exist between untrained cis men and women. Accordingly, concerns have been raised regarding how well eligibility regulations introduced by sport organisations balance fairness and safety of competition with inclusion of trans athletes, particularly trans women, in categories aligned to their gender identity. While research on the physiological effects of hormones on trans athletes is lacking, emerging evidence suggests 12 months of testosterone suppression does not remove the physiological advantage of untrained trans women (Wilk et al., 2020; Hilton & Lundberg, 2020; Harper et al., 2021).

Effect of hormone therapy

When transitioning, trans people often undergo hormone therapy, which for trans women typically involves administration of oestrogen, and testosterone suppression via androgen blockers. While muscle mass (~5%) and strength (~4%) reduce in trans women following 12 months of testosterone suppression below 5 nmol/L, these reductions are much less than typical advantages in muscle mass (~37%) and strength (~55%) of cis men. Extending testosterone suppression >12 months produced no further substantial reductions, which appear to plateau within 2 years.

While assessments of muscle mass and strength are often used for athlete selection and to monitor training, these may not reflect sport-specific actions that ultimately determine fairness and safety. Indeed, comparisons between cis men and women suggest differences in sport-specific actions are larger than observed for the individual phenotypes that combine to determine them. The force generated during maximal arm cranking, for example, was 162% greater in cis men than cis women despite typical sex differences in muscle mass, strength, and speed each not exceeding 60% (Morris et al., 2020; Hilton & Lundberg, 2020). Thus, for sports where muscle mass and strength are important, data suggest including trans women in the female category, even after 12 months testosterone suppression, would be unfair and (in some circumstances) unsafe, though research on sport-specific actions using athletic participants would provide clarification.

Similarly, testosterone suppression appears to have no effect on skeletal anatomy and trans women who experienced androgenisation, are likely to be taller, with ~12% longer limbs and a ~6% narrower pelvis than cis women (Hilton & Lundberg, 2020).

All else being equal, longer limbs produce greater torque, which is advantageous in jumping, throwing or other sports requiring explosive actions and/or reach. Based on current evidence that trans women retain advantages in skeletal anatomy, muscle mass and strength compared to cis women, fair and safe competition in female sports where these phenotypes are important is not preserved under current World Athletics and IOC eligibility regulations.

In comparison to strength/speed sports, sex differences in endurance performance are notably smaller (≤13%; Hilton & Lundberg, 2020), although no controlled investigations on the long-term effects of testosterone suppression on elite endurance performance exist. In trans women soldiers, 2.4 km run performance after 2.5 years of hormone therapy was ~8% slower than pre-therapy but remained ~11% faster than cis women (Roberts et al., 2020). Reductions in serum haemoglobin following testosterone suppression (~14%; Gooren & Bunck, 2004) are similar to the difference between cis men and women (~12%; Murphy, 2014), and probably contribute to this impaired running performance. Endurance performance is multifactorial, however, and effects of testosterone suppression on blood volume, cardiac output and lactate metabolism require further investigation.

Ultimately, regulation of trans women's eligibility in female sport cannot be universal, so organisations governing multiple sports/ events should assess eligibility for each sport separately.

For trans men, hormone therapy typically involves administration of testosterone, so a therapeutic use exemption is required to avoid an anti-doping violation. Many governing bodies require a signed declaration of an athlete's gender identity, and some require additional confirmation of performance capability, or annual verification of hormone therapy and serum testosterone. In general, these requirements do not restrict trans men from participating in male sport but

practitioners working with trans men should assess whether they are physically able to compete against cis men, particularly in contact or collision sports, and are aware of potential injury risks. Testosterone administration in trans men improves strength and endurance, with evidence in soldiers of trans men outperforming cis men in 2.4 km run, and push-ups and sit-ups completed in 1 min, following 2.5 years of hormone therapy (Roberts et al., 2020). The shorter limbs and wider pelvis of trans men (disadvantages in many sports) are, however, unaffected by post-pubertal testosterone administration. Thus, the magnitude of any retained disadvantage or risk of injury will differ between sports/events, particularly contact vs non-contact, and requires more research involving athletes and sport-specific actions.

Conclusions and recommendations

- Recent data suggest testosterone suppression probably cannot negate the effects of prior androgenisation sufficiently to enable fair and safe participation of trans women in the female category of those sports heavily influenced by physiological capacity, so current regulations for such participation (e.g. IOC and World Athletics) should be reviewed and updated.
- Further research investigating the impact of hormone therapy on performance of sport-specific actions in trans athletes is required.
- Practitioners supporting trans men athletes should assess whether they are physically able to compete against cis men, particularly in sports that present significant injury risks.
- Awareness of current trans athlete eligibility regulations and the likely extent of physiological adaptations following transition should be raised among athletes and practitioners, to develop broader scientific and ethical understanding.

D2.S4.1(1) The BASES Expert Statement on psychological considerations for injury risk reduction in competitive sport

Produced on behalf of the British Association of Sport and Exercise Sciences by Dr Adam Gledhill FBASES, Dr Andreas Ivarsson, Professor Urban Johnson, Dr Ulrika Tranaeus, Dr Denise Hill and Claire Louise Davidson.

Sports injuries can have serious, long-term health implications for athletes (Putukian, 2016) and is a leading cause of athletes' retirement (Ristolainen et al., 2012). Injury occurrence is associated with less successful team performance can have a significant impact on business and asset management. Hence, whether you are most concerned with the health, performance, or financial implications, reducing the risk of sports injuries is pertinent for sports organisations.

Given these considerations, practitioners should try to reduce the risk of injury (Gledhill et al., 2018). Yet, despite the robust evidence demonstrating that psychological factors can increase the risk of acute (e.g., Ivarsson et al., 2017) and overuse (e.g., Tranaeus et al., 2014) injuries, psychological factors are not as well-recognised or planned for as physical factors. This lack of recognition of, or planning for, psychological considerations may be due to potential concerns surrounding uncertainty about the evidence-base regarding psychological factors, a lack of awareness of the benefits of psychological strategies, or resource constraints (e.g., finances). To address these concerns, the purpose of the expert statement is to outline the prominent psychological risk factors for sports injury and provide real-world suggestions which can help sport and exercise scientists reduce sports injury risk.

Which psychological factors increase injury risk?

Personality factors, psychosocial stress, the stress response, and poorer coping resources are related to increased acute sports injury risk (Johnson, 2021). Of these, psychosocial stress - which might be organisational stressors or factors beyond competition stressors - and the magnitude of the stress response have the largest and most consistently reported links with sports injury risk (Ivarsson et al., 2017). There are several mechanisms which can explain the acute injury risk. First, neurocognitive changes can create neuromuscular changes that reduce movement control, thus increasing the risk of acute non-contact injuries. Similarly, neurocognitive changes associated with stress response can increase reaction time in response to environmental injury risk factors (e.g., avoiding collisions). Furthermore, negative life event stress is associated with peripheral narrowing which can increase injury risk through reduced situational awareness, whereas chronic daily hassles can reduce an athlete's capacity to effectively concentrate during training and competition (see Johnson, 2021 for further insight).

The mechanisms for overuse injury risks are different and, whilst growing, the evidence-base regarding psychological risk factors is smaller (Tranaeus et al., 2014). Typically, athletes could be at a higher risk of overuse injury in instances where they experience organisational stressors and cultures that impact on decisions and behaviour (e.g., poor coach-athlete relationships; poor communication between coach, medical, support staff, and the athlete; environments which emphasize negative sporting social comparisons). These manifest unrealistic training and performance demands for athletes and have the potential to heighten psychosocial stress. Without the opportunity or resource to manage that stress, or in instances where athletes demonstrate poor lifestyle choices and behaviours (e.g., insufficient recovery, poor sleep planning, over-training, general poor self-care), athletes become more susceptible to injury. It is likely that the risk of overuse injury in such instances is the product of complex interactions between these different factors that influence stress hormone perturbation, immunosuppression and/or impair soft tissue repair (Johnson, 2021; Tranaeus et al., 2014).

Table 1. Psychological interventions to reduce sport injury risk (experimental trials with control groups).

Study	Participants	N	Intervention	Results
Naderi *et al.* (2020)	Elite male soccer players	168	Mindfulness (MAC approach)	Number of injuries, average injuries per team and days lost due to injury lower in mindfulness group than control group
Zadeh *et al.* (2019)	Male soccer players	45	Mindfulness (MAC approach)	Reduced injury rates in mindfulness group
Olmedilla-Zafra *et al*. (2017)	Male soccer players	74	Stress Inoculation Therapy (PMR, breathing, imagery, self-instructional and attention-focus training)	Decrease in average number of injuries in treatment group
Tranaeus *et al.* (2015a)	Male and female elite floorball players	346	Stress management, relaxation, goal setting skills and emotional control	Both genders suffered fewer injuries in the treatment group
Tranaeus *et al.* (2015b)	Male and female elite floorball players	401	Stress management, relaxation, goal setting skills and emotional control	Both genders suffered fewer injuries in the treatment group
Ivarsson *et al.* (2015)	Male and female junior elite soccer players	41	Mindfulness (MAC approach)	Greater proportion of intervention group players remained injury free
Edvarsson *et al*. (2012)	Male and female high school soccer players	29	Cognitive behavioural feedback (self-regulation techniques of thought stopping, relaxation and breathing; stress management; video clips	Fewer injuries in the intervention group
Noh *et al*. (2007)	Female ballet dancers	35	Autogenic training, broad-based coping skills (AT, imagery, self-talk).	Overall reduction in injury burden in intervention group
Johnson *et al.* (2005)	Male and female soccer players	235	(a) somatic and cognitive relaxation, (b) stress management skills, (c) goal setting skills, (a) attribution and self-confidence training, and, (b) identification and discussion about critical incidents related to their football participation and situations in everyday life. (PST).	Broad-based coping skills most effective at reducing injury risk
Kolt *et al*. (2004)	Male and female gymnasts	20	Cognitive-behavioural stress management	Fewer injuries in treatment than control group

[1]MAC = Mindfulness, Acceptance and Commitment Approach; PMR = Progressive Muscular Relaxation; AT = Autogenic Training; PST = Psychological Skills Training

Reducing uncertainty: which psychological strategies can reduce injury risk?

Given the prominence of psychosocial stress and stress responses for acute and overuse injury risk, most intervention studies have investigated the role of various stress-management-based interventions (Gledhill et al., 2018; Ivarsson et al., 2017). Table 1 outlines key studies, demonstrating their intervention approach and outcomes (references available from the lead author).

Whilst demonstrating promise, this body of research has quite a narrow focus of mainly investigating intra-individual interventions. This is an important consideration, given that many stressors contributing to injury risk might be more a product of organisational stressors or cultures. Future research should examine the impact of interventions that includes the athlete's environment, organisation, or culture, and how such interventions might reduce injury risk.

Applied recommendations

To support sport and exercise scientists in integrating psychological considerations into their injury prevention planning, we offer the following suggestions:

- Screen athletes daily for psychosocial stress indices, sleep quality, and perceived recovery (e.g., by. using the Acute Recovery Stress Scale or the Short Recovery and Stress Scale; see Kölling et al., 2020 for English language validation).
- Offer stakeholder education around organisational injury risk factors. This could include organisational culture, psychosocial stressors and relational issues. Such education could contribute to reducing athlete stressors and mitigating against poor behavioural choices, thus reducing overuse injury risk.
- From the outset, facilitate open communication between athletes, coaches, and medical/support staff, to understand and ensure appropriate demands on the athlete.
- Create psychologically safe (e.g., Edmondson & Lei, 2014) sporting environments as this type of environment can encourage athletes to discuss and raise concerns about stressors, demands and potential injuries.
- As a sport and exercise scientist, form strong relationships with your athletes. Common factors such as shared goal consensus/collaboration, empathy, working alliance, and positive regard are all important for open dialogue regarding injury and injury risk factors.
- Adopt psychological intervention strategies. Of those in table 1, mindfulness and acceptance-based practice and stress management interventions (e.g., cognitive-behavioural stress management) demonstrate promise for injury risk reduction.
- Consider athlete (and coach/other stakeholder) education, so that they understand the performance-related benefits of engaging with mindfulness and acceptance-based strategies. This increases the likelihood of athletes engaging and maximise potential benefits.

Concluding thoughts

The evidence behind psychological strategies for sports injury risk reduction provides largely consistent, clinically meaningful results: athletes with higher psychosocial risk indices for sports injury suffer more sports injuries, and injury risk is lower in groups exposed to psychological interventions aimed at injury prevention. Sport and exercise scientists have an important role to play in facilitating the adoption of psychological strategies into sports injury prevention programmes for competitive athletes.

D3.S2.1(1) The BASES Expert Statement on Eligibility for Sex Categories in Sport: DSD Athletes

Produced on behalf of the British Association of Sport and Exercise Sciences by Dr Georgina Stebbings, Dr Adam Herbert, Dr Shane Heffernan, Prof Roger Pielke Jr. and Dr Alun Williams.

In 2019, the Court of Arbitration for Sport ruled against Caster Semenya, and in favour of World Athletics (formerly IAAF), to uphold their 'Eligibility Regulations for the Female Classification (Athletes with Differences of Sex Development). Consequently, 'relevant athletes' (specifically XY sex chromosome women with naturally occurring serum testosterone ≤5 nmol/L) cannot compete in international races between 400 m and 1 mile, unless they reduce serum testosterone below 5 nmol/L for at least 6 months.

Some consider this decision a victory for female athletes in maintaining a protected category in elite sport, to others it permits unnecessary discrimination. Nonetheless, the ramifications of this decision, and those of possible future challenges, are substantial for all female athletes. Through this expert statement, we provide recommendations for practitioners, researchers and policymakers working in this area.

Background and evidence

Conventionally, biological sex is binary, with differences in sex chromosomes, anatomy, hormone levels and secondary sex characteristics aligning as either male or female. Men typically have greater muscle mass (~37%), strength (~55%), and maximal rate of oxygen consumption (~25%) (Hilton & Lundberg, 2020). Thus, open sport competition between men and women would be unfair and, in some circumstances, unsafe.

Several genetic conditions collectively referred to as differences in sex development (DSDs), however, can lead to atypical development of binary sex phenotypes. Of concern in sport is that unusual genetic variations in some women DSD athletes may confer performance advantages that are ordinarily excluded from the women's category. However, World Athletics' regulations are based on insufficient and flawed empirical evidence.

According to the World Health Organization (WHO), sex refers to multiple biological factors including genetics, hormone levels and anatomy, and while males typically possess XY sex chromosomes and females are typically XX, there are XY females and XX males. Thus, no single factor or formula exists that neatly determines whether an individual is male or female. Yet in establishing their Eligibility Regulations, World Athletics overlooked this reality in favour of using mainly sex chromosomes and serum testosterone levels to differentiate between men and women1.

Serum testosterone is a strong candidate to differentiate between men and women, with 8-30 nmol/L typical in XY men substantially greater than 0.1-2 nmol/L typical in XX women (Handelsman et al., 2018). Testosterone, and its often more potent metabolite dihydrotestosterone (DHT), increase muscle mass, strength, and other aspects of physical performance. In DSD women, however, due to rare genetic mutations, considerable variability exists in the synthesis of, and response to, circulating testosterone (Table 1).

In DSDs affecting androgen synthesis/action, circulating testosterone is often within the typical male range, yet the ability to process this testosterone is compromised. While women with these DSDs might have natural testosterone levels exceeding the typical female range, and some degree of androgenisation during puberty, the extent of any performance advantage conferred by these biological changes remains unclear. Any advantage may be negligible, but the implicit assumption made in the regulations is that the advantage is similar in magnitude to what typical XY males enjoy over typical XX females. In the absence of evidence to this effect, the existing evidence is insufficient to justify exclusion of these athletes.

Nonetheless, if future research demonstrates conclusively women DSD athletes are advantaged because of their genetics, should this be considered differently to other genetic advantages experienced by most/all elite athletes? The R577X polymorphism on the actinin alpha 3 gene (ACTN3) is a common genetic variant known to convey ~1% advantage in elite sprint running (Papadimitriou et al., 2016). A rare mutation to the erythropoietin receptor (EPOR) gene enhances red blood cell

Table 1. Categories of DSDs affected by the World Athletics Eligibility Regulations

DSD	Gene	Consequence of mutation	Likely degree of androgenisation
17β-hydroxysteroid dehydrogenase type 3 deficiency	*HSD17B3*	Reduced conversion of androstenedione to testosterone	Partial
5α-reductase type 2 deficiency	*SRD5A2*	Reduced conversion of testosterone to DHT	Partial
Partial androgen insensitivity syndrome	*AR*	Reduced androgen receptor binding to testosterone and DHT	Partial
Ovotesticular DSD	*SRY, DMRT1 or SOX9*	Both ovarian and testicular tissue present	Partial

1Women with XY chromosomes deemed adequately sensitive to testosterone via controversial invasive clinical assessment.

synthesis by ~60% (de la Chapelle et al., 1993). Yet for athletes possessing either advantageous variant, there are no eligibility regulations – nor do we believe there should be.

Importantly, advantages conferred by variants in ACTN3, EPOR and thousands of other genes, influence athletic performance of both men and women, whereas variants involved in DSDs being regulated by World Athletics affect women only. As the affected DSD women have female gender identity and biological characteristics compatible with the broad WHO definition of female sex, then we do not accept the unscientific recategorisation of these athletes by World Athletics and subsequent use of that recategorisation to justify discrimination against them.

Regardless of whether one accepts discrimination against women DSD athletes is justified, the application of regulations to five middle-distance running events only, and not all athletic events, is paradoxical. It is based primarily on one controversial study, funded by World Athletics (Bermon & Garnier, 2017), which contained extensive data errors leading to calls for retraction (Pielke et al., 2019). The study reported elite women athletes with higher testosterone levels (not a subset of 46 XY women) performed ~2- 5% better than those with lower testosterone in five of 22 athletic events. The authors could have concluded there was no overall competitive advantage of higher testosterone within the women's category. Instead, they concluded that in five athletic events only (<25% of events), higher testosterone gives women a competitive advantage. In doing so, the authors incorrectly imply that higher testosterone, and subsequent potential for increased muscle mass and strength, is not advantageous for sprinting, jumping, or throwing events. Similarly, they imply the potential for elevated haemoglobin or reduced fat mass is not advantageous for long-distance events.

If this were accurate, we might expect the largest performance differences between XY men and XX women in these same five events, but that is not the case, with men outperforming women by ~12% in running events, regardless of distance, and by ~20% for most field events (Hilton & Ljundberg, 2020). Furthermore, the five events were running 400-800 m and two field events, whereas the restricted events under World Athletics' regulations are running 400 m to 1 mile.

Finally, the regulations require affected athletes to lower their natural circulating testosterone to <5 nmol/L for at least 6 months to compete in the restricted events. Testosterone is lowered via hormone administration or surgery; the unsolicited implementation of which for non-pathological conditions violates established medical ethics, may result in harmful side effects, and led the World Medical Association (2019) to advise physicians against administering treatment solely to alter sport performance. Compounding these major ethical concerns, there is poor evidence of 6 months testosterone suppression nullifying any/all competitive performance advantage in women DSD athletes who experienced higher natural testosterone since puberty.

Conclusions and recommendations

- Exclusion of women DSD athletes from participating in the female category in the five currently restricted running events, or any other event/sport, is not scientifically or ethically justified.
- Before pursuing such restriction, further independent research comparing biochemical, physiological and performance differences between women athletes with and without DSDs is required, and longitudinally in women DSD athletes who voluntarily reduce serum testosterone.
- Medical practitioners should follow World Medical Association guidance and refuse to administer medication or surgery to reduce natural levels of testosterone unless based on medical need.
- Sport and exercise scientists supporting women athletes should familiarise themselves with the regulations and encourage DSD athletes to train for sports/events not currently restricted.

Day 1. Free Communications - Biomechanics and Motor Behaviour

D1.S2.1(3) Wearable technology as an objective tool for measuring running gait: a validation and reliability protocol

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Objective measurement of running gait is an important clinical tool for injury assessment and provides metrics that can be used to enhance performance. Running gait assessment has traditionally been performed using subjective observation or expensive laboratory-based objective technologies, such as 3D motion capture or force plates. However, recent developments in wearable technology allow for continuous monitoring and analysis of running mechanics in any environment, but technologies used for assessment must be valid and reliable. The objective of this pilot study was to investigate the validity and reliability of a commercial wearable technology (DANU Sports System) for running gait assessment. With institutional ethics approval, healthy young adult athletes (aged 18-40 years) wore a commercial wearable technology (DANU Sports System) and were tracked with laboratory reference systems (OptoGait, 3D motion capture and force plates) during running. Participants completed two testing sessions, one week apart in the biomechanics laboratory at Northumbria University. Testing consisted of treadmill running (5-minute trials at 3 controlled speeds) and intermittent overground running (10 trials per foot at controlled speeds), completed in a standardised shoe. Running gait outcomes included ground reaction forces, ground contact time, flight time, cadence, stride length, stride time and stride velocity. Wearable system validity and reliability were examined using intra-class correlation coefficients and Bland-Altman plots to compare to laboratory reference standards. Preliminary results examining the DANU Sports Socks against the OptoGait system during gait, running and jumping tasks suggest that the devices are well matched. The DANU system had slightly shorter ground contact times and longer flight times than the OptoGait, which may represent greater accuracy due to the direct measurement of the foot when in contact with the ground. Overall, wearable technology is rapidly becoming a feasible means to quantify running biomechanics in a more ecologically valid manner, with applications in sports medicine and performance. Regardless, practitioners should ensure that the use of wearable technology is evidence-based and fully investigate the accuracy, reliability, and value of any wearable device prior to incorporating them into practice. Preliminary findings suggest that the DANU multi-modal wearable system may be an accurate tool for objectively measuring running gait, but further work is required to definitely establish in a larger cohort its validity and reliability, as well as potential for clinical or sports performance applications.

Day 1. Free Communications - Physical Activity for Health

D1.S5.1(1) Educators perspectives on the value of physical education, physical activity and fundamental movement skills for early years foundation stage children in England

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A lack of information is available for physical education (PE) provision in the early years foundation stage (EYFS), prompting concern about school delivery and the values behind the approaches being taken. Increasing physical activity (PA) levels and fundamental movement skill (FMS) tuition are of particular importance. With institutional ethics approval, semi-structured interviews of 20-40 minutes in length were used to investigate educators' (headteachers (n=2), EYFS teachers(n=7), and external PE coaches (n=3)) perspectives on the value of PE and PA for EYFS children across England. Subsequently, interviews were recorded and transcribed verbatim by the lead researcher. Using Braun and Clarke's six stages of thematic analysis (Braun and Clarke, 2006, Qualitative Research in Psychology, 3, 77–101), the resulting themes were identified via repetition in topics and answers; similarities and differences in answers to the same question; reflection of the missing data within this research area; theory relating to the scientific underpinning of the questions; and, finally, the metaphors and analogies interviewees used within their answers. The five assigned themes were: (1) PA and PE in school settings for the EYFS; (2) benefits of PE and PA for young children; (3) barriers to achieving sufficient PA/PE for children faced by teachers, parents, and children; (4) educator knowledge of FMS and key opportunities for development and (5) intervention experience, needs and training delivery. This study highlights the broad and complex factors that educators face when aiding children to perform adequate PA, which include a lack of confidence to teach PE and FMS and reduced parental involvement. These results show that to improve PA, increase the quality of PE and FMS tuition, greater intervention, and training for educators, along with more PA and FMS resources are required. This study collected important stakeholder views and dialogue, and this information can help shape the impact and implementation of both FMS interventions and PA policy at the EYFS.

D1.S5.1(2) Examining the relationship between physical activity level and menopausal symptoms

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Physical activity is a non-hormonal intervention recommended for women managing perimenopausal and postmenopausal symptoms. The type of exercise includes practices such as yoga and Thai chi, as well as sports and gym sessions. However, the frequency and intensity of exercise required for symptom reduction remains unclear. Therefore, a cross-sectional study was designed to compare the level of self-reported menopausal symptoms and anxiety and depression, in active and inactive, peri- and postmenopausal women. Institutional Ethical approval was granted. Social media was used for recruitment and 123 women aged between 40 and 65 years (mean51.3, SD4.9), completed the study. Anonymous data was collected through an online management service. Socio-demographic data included ethnicity (white British 91.1%, white other 5.7%, Asian 2.4%, mixed white & Asian 0.8%), education level (postgraduate or higher 17.9%, undergraduate degree 19.5%, A-level or equivalent 20.3% GCSE or equivalent 37.4%, not stated 4.9%), work (retired 9,8%, full-time 52.0%, part-time 29.3%, unemployed 3.3%, unable 1.6%, not stated 4.1%) and relationship status (partner 84.6%, separated 8.1 single 6.5%). The menopause stage was reported post-menopause 39%, perimenopause 53.7% and not known/stated 7.3%. Participant reported physical activity was categorised as active or inactive using the UK Chief Medical Officer (CMO) recommendations for exercise for healthy adults. The active group included women who reported at least 150 minutes of moderate activity or 75 minutes of vigorous activity per week in the preceding six months. Menopausal symptoms and symptoms of anxiety and depression were assessed using the Menopausal Rating Scale (MRS) and the Hospital Anxiety and Depression Scale (HADS-A and D) respectively. Data for the MRS and the HADS-A and D subscales was not normally distributed, so Kruskal-Wallis tests were used for group differences. The alpha for all tests was $P<0.05$. Active women (n=92) reported significantly less physical and mental exhaustion ($P<0.001$), hot flushes ($P<0.001$), sleep disturbances ($P<0.01$), joint and muscle complaints ($P<0.001$), bladder problems ($P<0.01$) and irritability ($P<0.05$) compared to inactive women. There were no differences for heart discomfort, dryness or sexual problems. Active women reported less anxiety HADS-A ($P<0.001$) and depression HADS-D ($P<0.001$). The analysis and conclusions are limited by the small group of inactive women. Study design for confirmation and comparison of different types of exercise will ensure sufficient numbers in each group. However, the results of this study suggest that women fulfilling CMO physical activity recommendations for the UK will on average experience lower levels of symptoms than those who do not.

Day 1. Free Communications - Physiology and Nutrition (Session 1)

D1.S2.2(1) Branched-chain amino acids supplementation does not attenuate muscle damage and soreness after change-of-direction exercise in male collegiate basketball players

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The effects of branched-chain amino acids (BCAAs) supplementation on the attenuation of exercise-induced muscle damage and soreness have been widely investigated considering several exercise protocols, in particular with an unaccustomed eccentric action (Khemtong et al., 2021, Nutrients, 13, 1880). Change-of-direction (COD) ability is characterized by an eccentric muscle action required to decelerate the body (Chaabene et al., 2018, Sports Medicine, 48(8), 1773-1779), potentially causing an excessive muscle damage if several COD actions are repeated over a prolonged time. Therefore, the aim of this study was to investigate the effects of BCAAs supplementation on muscle damage and soreness and performance outcome after a COD exercise protocol. With institutional ethical approval (IRB-2018-079), a double-blind, randomized, controlled, crossover study design was conducted. Nineteen male collegiate basketball players (age: 19.8 ± 1.3 years; stature: 182.5 ± 7.0 cm; body mass: 75.9 ± 7.8 kg) were assigned to a BCAAs or placebo condition with a 2-week washout period. A BCAAs (SUP: 0.17 g/kg BCAAs + 0.17 g/kg glucose, 4:1:1 ratio for leucine, isoleucine, and valine) or an isocaloric placebo (PLA: 0.34 g/kg glucose) supplement was ingested 30 min before and after the termination of the exercise protocol. The COD exercise protocol consisted of 11 consecutive 10-m shuttle sprints for 5 sets for 3 blocks, with a 1- and 3-min rest interval between sets and blocks, respectively. Creatine kinase (CK), interleukin-6 (IL-6), muscle soreness (VAS) and performance outcome (505 test) were measured at baseline, POST, 24, 48, 72 h after exercise protocol. Repeated measure ANOVAs (condition: SUP, PLA; time: baseline, POST, 24h, 48h, 72h) and effect sizes (Cohen's d) were applied. Only time effect emerged for all variables, therefore data are combined for both conditions. Compared with baseline levels (CK: 197.2 ± 133.7 IU/L, IL-6: 3.4 ± 4.3 pg/ml), CK remained elevated until 24h (266.3 ± 186.8 IU/L, $P = 0.003$, $d = 0.52$), whilst IL-6 peaked at POST (3.9 ± 4 pg/mL, $P = 0.001$, $d = 0.43$) and returned to baseline level at 24h. Compared with baseline (0.3 ± 0.7 AU), VAS peaked at POST (5.2 ± 2.4 AU, $P < 0.01$, $d = 2.85$) and remained elevated until 72h (2.2 ± 1.8 AU, $P < 0.01$, $d = 1.45$). Performance outcome was impaired at POST and returned to baseline level thereafter. This study demonstrated the pattern of muscle damage and soreness after a COD exercise protocol, without any beneficial effect of BCAAs supplementation.

D1.S2.2(2) The Effects of High Adiposity on Concentric and Eccentric Muscle Performance of Upper and Lower Limb Musculature in Young and Old Adults

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Evidence demonstrates obesity is detrimental to skeletal muscle health and may evoke a negative obesity cycle (Tallis, et al., 2021, Biomolecules, 11, 372). Previous research examining effects of obesity on skeletal muscle function typically focus on a single muscle group and/or mode of contractility, with limited assessment of muscular fatigue or direct comparisons between age groups. More specifically, there is a dearth of studies examining effects of obesity on eccentric muscle performance and the concomitant effects of old age and obesity (Tallis, et al., 2018, Journal of Experimental Biology, 221, jeb163840). This study uniquely examined the influence of adiposity on maximal concentric and eccentric torque and fatigue of elbow (EF, EE) and knee (KF, KE) flexors and extensors, in young and older adults. Following institutional ethics approval, 40 males were categorised into young (n=21, 23±3) and old (n=19, 68±6) and further by body fat percentage, into normal (young = 16.9±2.5%, old = 20.6±3.1%) and high adiposity (young = 28.9±5.0%, old = 31.3±4.2%) groups, using multi-frequency bioelectrical impedance analysis (Tanita MC-780, Japan). Handgrip strength, sit-to-stand performance, and isokinetic assessments (Cybex NORM, Humac2009, USA) of peak torque at 60°, 120° and 180° s^{-1} were measured. Comparisons of muscle performance were measured using a 2-way (age and adiposity) ANOVA, or in the case of fatigue resistance, a 3-factor (age, adiposity and set) ANOVA. Results indicated older men produced significantly lower handgrip strength and concentric and eccentric peak torque and had significantly slower rate of force development and time to stabilisation during sit-to-stands ($P<0.037$). However, these measures of muscle performance were not influenced by adiposity ($P>0.055$). For KE and KF, high adiposity and older groups demonstrated reduced peak concentric and eccentric torque normalised to body mass ($P<0.021$) and muscle and contractile mode specific reductions in torque normalised to segmental lean mass, indicative of reductions in muscle quality. Eccentric fatigue resistance was unaffected ($P>0.30$) and perceived muscle soreness, measured up to 72 hours post, was only enhanced in the upper body of young groups following eccentric fatigue ($P=0.009$). Despite impacts of adiposity on skeletal muscle function being comparable between ages, the consequences for older adults during activities of daily living is likely more substantial given that muscular strength is already compromised by age. Furthermore, reductions in muscle quality are likely an

important contributor to reduced functional performance in obese individuals, given that larger muscles of poorer quality will contribute to an already elevated bodily inertia.

D1.S2.2(3) The impact of sodium bicarbonate fluid ingestion approach on blinding efficacy and treatment palatability

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Extracellular buffers such as sodium bicarbonate ($NaHCO_3$) have been well-established as nutritional ergogenic aids (Peeling et al. 2018, International Journal of Sport Nutrition and Exercise Metabolism, 28(2), 178-187). It is common during randomised placebo-controlled trials to prepare $NaHCO_3$ in solutions of water and flavoured squash (Higgins et al. 2013, Journal of Sport Sciences, 31(9), 972-981), however research is yet to compare fluid ingestion strategies for protecting blinding. If study blinding is not effective, then participant perceptions of what they have received could influence treatment outcomes. The aim of our study was to assess participant perceptions of blinding efficacy for 4 × $NaHCO_3$ (0.3 g/kg BM) and 4 × placebo (0.03 g/kg BM sodium chloride) treatments. Following institutional ethics approval, 16 participants (age, 38.5 ± 10.4 years) visited the laboratory on 4 separate occasions in a randomised, counterbalanced, double-blind design to taste 8 different treatments (i.e., 2 treatments per visit). Treatments were dissolved in 4 ml/kg BM solutions of water, before 1 ml/kg BM solutions of either orange or blackcurrant squash were added. The treatments were then chilled for 1 h or left at room temperature. Participants were required to guess which treatment they had received ("$NaHCO_3$, "placebo", "not sure") and palatability scores were assessed using 9-point Likert type scales anchored by "1" (extremely disliked) and "9" (extremely liked). Ratings of treatment assignment (correct, incorrect) were analysed using 2 x 2 Chi-square tests (χ^2) with Cramer's V (V) statistic reported as the effect size. Palatability scores were analysed using a one-way repeated measures ANOVA. Blinding was best protected by administering treatments in chilled orange squash + water ($\chi^2 = 0.13$; $p = 0.723$; $V = 0.06$), whereby 7 out of 16 (44%) participants correctly identified $NaHCO_3$. Giving treatments as a chilled solution of blackcurrant squash + water was the least efficacious $NaHCO_3$ blind (69% correct; $\chi^2 = 4.50$; $p = 0.034$; $V = 0.38$). Palatability scores were more favourable when $NaHCO_3$ was administered in chilled orange squash + water compared to room temperature blackcurrant squash + water (+1.4 units; $p = 0.021$; 95% CI: 0.2, 2.6). Our results indicate that preparing $NaHCO_3$ in a chilled solution of orange squash and water is the best fluid ingestion approach for protecting blinding and improving palatability. These findings have important implications for the design of $NaHCO_3$ randomised placebo-controlled trials and suggest that researchers should consider the flavouring and temperature of treatments to maintain blinding.

Day 1. Free Communications - Physiology and Nutrition (Session 2)

D1.S5.2(1) Assessing the prevalence of low energy availability, disordered eating and eating disorders in female endurance runners

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Low energy availability (LEA) occurs when energy intake does not meet the demand of normal physiological functioning and the demands of exercise, resulting in negative physiological adaptations which can have long term health and performance consequences (Logue et al., 2020, Nutrients, 12(3)). LEA may arise from an unintentional calorie deficit, or an intentional deficit due to disordered eating behaviours or an eating disorder. There is currently a paucity of research investigating prevalence of LEA in female endurance runners, and the interrelationship with disordered eating and eating disorders. The primary aim of this study was to identify the risk of LEA in recreational and competitive female endurance runners, a secondary aim was to identify prevalence of risk of disordered eating and eating disorders and investigate associations with risk of LEA. Following institutional ethical approval, a total of 524 female endurance runners completed an online questionnaire that included the validated Low Energy Availability in Females Questionnaire (LEAF-Q) (Melin et al., 2014, British Journal of Sports Medicine, 48(7), 540-545) and Female Athlete Screening Tool (FAST) (McNulty et al., 2001, Journal of the American Dietetic Association, 101(8), 886-892). The Shapiro-Wilk test of normality, Kruskal Wallis, chi-square cross tabulation and stepwise logistic regression analyses were used to explore differences and associations between those at risk or not at risk of LEA, disordered eating and eating disorders. Data were examined in relation to age and competitive standard. Key findings of the study were 47.3% of the total cohort were identified as at risk of LEA, 29.2% at risk of disordered eating and 8.8% at risk of a clinical eating disorder. Competitive runners were found to be at statistically higher risk of LEA than recreational runners (H (1) = 7.0, P = 0.008). LEAF-Q and FAST scores were significantly different in age categories (18-24, 25-30, 31-40 and 40+ years) with increasing age associated with decreasing risk, (H (3) = 24.4, p = <0.001, H (3) = 13.1, P = 0.004), respectively. The 18-24 age group had the highest prevalence of LEA and clinical eating disorders. A significant association was identified between LEAF-Q score and FAST score, (χ^2 (2, N= 524) = 18.525, P = <0.001). The current study identified high prevalence rates of LEA, and risk of both disordered eating and eating disorders in recreational and competitive runners, highlighting the need for early identification, screening methods and educational intervention programmes aimed at all levels of female runners.

D1.S5.2(2) A 3-week supplementation period of MCT's with a C8:C10 ratio of 30:70 offsets the cognitive decline caused by a prolonged bout of exercise

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Prolonged exercise (≥1 hour) has been shown to decrease cognitive performance in young adults (Moore et al., 2012, Journal of Sports Sciences, 30, 841-850). Medium chain triglycerides (MCTs) provide the brain with an alternative and more efficient fuel source than glucose via direct and indirect energy pathways. Previous research has demonstrated that MCTs improve cognitive performance in a wide range of populations, including young, healthy adults (Ashton et al., 2021, Physiology & Behaviour, 229, 113252). The aim of the present study was to determine if MCT supplementation can reduce the extent of the cognitive decline caused by a bout of prolonged exercise in young, healthy adults. Following institutional ethical approval, participants (age: 20 ± 2 yrs; height: 1.75 ± 0.08 m; body mass: 72.4 ± 16.1 kg) were randomly assigned into two groups of 10 (placebo (0 g) and experimental (MCT) (12 g) MCT/day) and were supplemented for 3 weeks. Participants performed a VO_2max ramp test to establish individual gas exchange thresholds (visit 1). In visits 2 and 3, participants cycled on a stationary ergometer at 90% gas exchange threshold for one hour either side of the 3-week supplementation period. Participants underwent a battery of cognitive tests pre and post exercise. These tests included Trail Making (TM), Digit Span (DS) and Spatial Span (SS). We carried out statistical analysis using a mixed model ANOVA and this showed that the MCT group exhibited significantly increased pre-exercise cognitive performance post supplementation period in TM A (18.9%), TM B (21.6%), DS Forwards (16.2%) and DS Backwards (24.1%) ($P < 0.05$). Cognitive performance declined significantly post exercise in each condition for all cognitive measures from pre-exercise scores ($P < 0.05$), apart from SS Backwards ($P > 0.05$). This was with the exception of the post supplementation period for the MCT group, who maintained their pre-exercise cognitive performance ($P > 0.05$). In conclusion, the results suggest that not only did cognitive performance improve after the 3-week MCT supplementation period in young, healthy adults, MCTs facilitated this improvement to be maintained after a prolonged bout of exercise, which otherwise caused cognitive decline in the pre-supplementation tests and placebo group. This is because MCTs are a very efficient fuel source for the brain as they can directly cross the blood-brain -barrier due to their relatively shorter carbon chain length. They also provide an indirect additional fuel source for the brain via ketone bodies, such as βHB.

Day 1. Free Communications - Sport and Performance (Session 1)

D1.S2.3(1) The effect of repetitive whole body cryotherapy treatment on adaptations to a strength and endurance training programme

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Despite its potential merit in sport and exercise recovery, the implications of repetitive Whole Body Cryotherapy (WBC) treatment during training programmes require further review due to the possibility of repetitive cold interfering with long term adaptations. This study investigated the impact of two weekly WBC sessions (3 minutes, -120°C) on adaptations to a 6 week strength and endurance training programme. Following institutional ethical approval, sixteen male participants (mean ± SD age 33.4 ± 9.8 years, height 1.79 ± 0.05m, body mass 82.3 ± 9.8 kg) were randomly allocated into WBC (n=7) and non-cryotherapy control (CON, n=9) groups. A programme was performed which consisted of two weekly lower body strength and plyometric training sessions and two weekly 30 minute runs at 70% VO_2 max. Participants were assessed for body fat, VO_2 max, isometric leg muscle torque, three repetition maximum barbell squat and countermovement jump height before and after the programme. Resistance and running intensities were progressed after 3 weeks. Participants in both groups significantly improved muscle torque (WBC: 277.1 ± 63.2 Nm vs. 318.1 ± 83.4 Nm, p=0.00; CON: 244.6 ± 50.6 Nm vs. 268.0 ± 71.8 Nm, p=0.05) and barbell squat (WBC: 86.4 ± 19.5 kg vs. 98.9 ± 15.2 kg, p=0.03; CON: 91.1 ± 28.7 kg vs. 106.1 ± 30.0 kg, p=0.00) following the 6 week programme. For the CON group, there was also a significant reduction in body fat percentage (19.4 ± 5.3 % vs. 18.6 ± 5.1 %, p=0.01) and significant increase in jump height (293.3 ± 45.2 mm vs. 328.1 ± 69.2 mm, p=0.01). There was no significant increase in VO_2 max for either group (both p>0.2). There was no difference between WBC and CON for responses in muscle torque, 3RM barbell squat and body fat, however WBC participants did not increase their jump height (302.3 ± 44.0 mm vs. 312.3 ± 47.8 mm, p=0.23). Repetitive WBC does not appear to blunt adaptations to a concurrent training programme, although there may be an interference effect in the development of explosive power. Sports practitioners can cautiously apply repetitive WBC to support recovery post-exercise without undue concern on athletes' fitness gains or long term performance, particularly throughout training phases focused more on general strength development than explosive power.

D1.S2.3(2) Relative age effect in the elite player pathway of Connacht Rugby

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Background: Relative age effect (RAE) is a concept that causes birthdate distribution to influence participation in elite sport, with those born earlier in the selection year more likely to reach elite level than those born later in the year, due to inadequacies in physical maturation in childhood and adolescence. Success in rugby union is largely determined by an array of physical qualities, and with elite player pathways selecting players as adolescents, there is a concern that RAE is influencing selection and de-selection in the pathway. Previous research has outlined that RAE's presence in rugby union is largely dependent on the nation at hand, but that playing position and age group play a role in the phenomenon's presence. No previous research has examined RAE's presence in Connacht Rugby's elite player pathway.

Methods: Male rugby players (N = 220) from Connacht Rugby's elite player pathway were included in this study, including players from the entry point of the pathway through to senior level. Players were categorised into quartiles and halves based on their birthdate distribution, while their age group and playing position was also considered. Birthdate distribution was analysed in comparison to national population birthdate distribution in order to determine if RAE existed in the pathway. Ethical approval for these methods was granted by the Taught Programme Research Ethics Committee of Galway-Mayo Institute of Technology.

Results: The results highlighted an under-representation of players born in the last quarter of the year across the whole pathway, while RAE was most significant at entry point (P = 0.003) and Academy (P = 0.034) levels with regard to half-year data. Positionally, significant RAE was seen in forwards (P = 0.024), and in back row (P = 0.017) players in particular. Altogether, RAE increased as the pathway progressed.

Conclusion: Observed data differed to previous research that highlighted a decreasing RAE as pathways progressed. Positionally, there were similarities with some nations, but the effects are largely dependent on the nation at hand.

D1.S2.3(3) Collateral damage after coaching turnovers: side effects on high-performance improvement and professional development

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Football coaches are often replaced given the absence of results or performance. Albeit scholars have identified the consequences of turnovers on team performance using quantitative data, relatively little is known about the spill-over effects absorbed by the sport structure during transitions of coaches. Therefore, this research aims to explore the potential collateral damage on athlete development and coaching staff members after head coaches are changed. The study presents two research questions: (1) how do coaching turnovers affect athletic development in practice? And (2) as turnovers occur, what are the side effects for sport science professionals? Qualitative, semi-structured interviews were conducted with 59 elite practitioners from Brazil (29 football coaches and 30 coaching staff members), who voluntarily consented to the institutional ethics procedure. While the group of coaches participated in 47.6% of all league games in the Brazilian first tier from 2003 to 2020, the group of staff members outlined 7 assistant coaches, 5 goalkeeping coaches, 10 fitness trainers, 5 physical therapists, 2 physiologists, and 1 medical doctor. The final list gathers participants and even winners at the national, international, continental, Olympic, and World Cup stages. First, interviewees were asked how changing coaches affects football development in practice. And secondly, how coaching volatility spills over them from a professional and personal perspective. According to the preliminary findings based on a deductive-inductive content analysis, the key factors jeopardizing high-performance improvement emerged in three themes: (1) performance goals, (2) team building, and (3) training methodology. Sport science practitioners emphasized how changes of routines between coaching transitions affect training plans and load monitoring, while also worrying about the injury risks during the season. In terms of side effects, recurring perceptions were captured among the following themes: (1) personal life, (2) job security, and (3) interdisciplinary relations. Personal life includes three subthemes: health, family, and self-doubt. Job security encompasses the subthemes of pressure, risk, and workflow. Last, the category of interdisciplinary relations involves the subthemes environment, behavior, and trust. Overall, the preliminary analysis suggests that within-season coaching turnovers are perceived as a damaging phenomenon across the sport structure in Brazil, which might resonate the level of football development and the constraints for professional growth witnessed in the domestic territory. This research documents the relevance of expanding football performance analyses beyond quantitative data by gaining in-depth knowledge from elite practitioners for the improvement of sport operations and management through qualitative studies.

Day 1. Free Communications - Sport and Performance (Session 2)

D1.S5.3(1) A reliable and practical cycling heat stress test for quantifying changes in heat adaptation following acute and chronic heat-alleviating strategies

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Purpose: Large-scale sporting events such as the Tokyo 2020 summer Olympic and Paralympic games are due to be held under hot (ambient temperature >30□) and humid (±70% relative humidity [RH]) environmental conditions. A new cycling heat stress test (HST) which mimics the anticipated conditions of events such as Tokyo can be used to understand the extent to which heat adaptation can enhance performance and alleviate thermal strain in a hot-humid environment, allowing the personalisation of heat-alleviating countermeasures (i.e., heat acclimation (HA), cooling interventions, rehydration plan). Therefore, the aim of the present study was to establish the reliability of a novel cycling HST which fixes the work intensity relative to body mass. Method: Fourteen male endurance trained cyclists/triathletes completed the cycling HST (45-mins, 2.5 W.kg-1) on two separate occasions, separated by 5-7 days, in a hot-humid environment (32□ and 70% RH). The study was approved by the institutes ethics committee. Results: All physiological and perceptual variables displayed good test-retest reliability (Intra-class correlation coefficient [ICC] range: 0.78-0.95) and acceptable within-participant variation (coefficient of variation [CV] range: 0.5-12.8%). None of the physiological and perceptual measures, except thermal comfort ($p = 0.03$), demonstrated a significant difference between repeat trials of the HST. Conclusion: The HST offers a reliable method to accurately quantify changes in heat adaptation following acute and chronic heat-alleviating strategies; designed to improve performance and protect athlete health in a hot-humid environment. The prescription of exercise intensity at a fixed workload relative to body mass, thus not requiring access to specialist equipment or need for prior testing, may support athlete engagement and facilitate multiple assessment times across a season.

D1.S5.3(2) Effect of changing match format from halves to quarters on match activity and heart rate responses of male university field hockey players

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The study examined whether match activity and heart rate responses of male university field hockey players differed when match format was 2 x 35 min halves compared to 4 x 17.5 min quarters. Thirty-five male university field hockey players (age 21.2 ± 3.0 years, height 1.81 ± 0.07 m, body mass 75.1 ± 8.9 kg), competing at national level in the UK, were monitored over 52 matches played across the 2018 – 19 (2 x 35 min halves, 28 matches) and 2019 – 20 (4 x 17.5 min quarters, 24 matches) seasons using 15 Hz Global Positioning System units and heart rate monitors. Ethical approval was granted by institutional university ethics. Total distance, high-speed running distance (≥ 15.5 km.h□[1]), number of accelerations (≥ 2 m.s□[1]), number of decelerations (≤ -2 m.s□[1]), average heart rate and percentage time spent at > 85% of maximum heart rate were recorded during both match formats. Two-level random intercept hierarchal models (Match – level 1, Player – level 2) suggested that the change in format from 35 min halves to 17.5 min quarters resulted in a reduction in total distance and high-speed running distance completed during a match (by 221 m and 120 m respectively, both $P < 0.001$). The percentage time spent at > 85% of maximum heart rate during a match was also reduced (by 3.1%, $P = 0.045$). The change in format had no influence on the number of accelerations or number of decelerations completed during a match (halves vs. quarters: 45 vs. 44 accelerations, $P = 0.177$; 46 vs. 45 decelerations, $P = 0.280$). Match activity and heart rate responses decreased during the second half of matches in both formats, and this decrease was not found to be reduced with the change in match format as no significant cross-level interactions were observed within the models (between season and half, $P \geq 0.339$). Overall, the findings suggest that the change in match format did alter match activity and heart rate responses of male university field hockey players, but the quarter format actually reduced the total distance and high-speed running distance completed during matches and did not attenuate the decrease in activity seen during the second half of matches. The data presented may guide the effective prescription of training programmes that reflect match activity profiles following the rule change at national level.

D1.S5.3(3) Identifying a relationship between teamwork and team perfectionism, with the mediating effect of team cohesion, in competitive team sports

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The importance of teamwork has been established in a range of contexts, but it has received little attention in sport. Previous research has established cohesion as an emergent state of

teamwork (McEwan & Beauchamp, 2014), and a relationship between cohesion and perfectionism has also been identified (Junior et al., 2017). However, no research has linked all three constructs together. The current study aimed to investigate whether or not a relationship between teamwork and team perfectionism exists, and whether team cohesion acts as a mediator of any relationship between the two. With research into teamwork in sport emerging and perfectionism still causing fervent debate within sports literature, research into whether the variables are related is essential. Ethical approval was obtained from the Sport and Exercise Science Research Ethical Approval Committee for Health (REACH, BSc/SES/HES/BMS), School for Health, University of Bath, Bath, U.K.One-hundred and sixty-two athletes from a range of competitive sports teams participated. All participants completed a short version of the Multidimensional Assessment of Teamwork in Sports (MATS; McEwan et al., 2018), which assessed the levels of teamwork, along with measures for team cohesion (Carron et al., 1985) and team perfectionism (Hewitt et al., 2008). Correlational analysis found that teamwork was significantly ($p < .01$) correlated with self-oriented perfectionism and significantly ($p < .05$) correlated with team-oriented perfectionism. However, there was no significant correlation between teamwork and team prescribed perfectionism. Mediation analyses further found that only social cohesion had a significant ($p < .05$) mediating effect on the relationship between teamwork and team-oriented perfectionism. These findings suggest that a relationship between teamwork and team perfectionism exists, specifically dimensions of perfectionistic striving. A lack of significant correlation between team prescribed perfectionism and teamwork indicates that the perception of high perfectionistic standards from others was detrimental to teamwork behaviours. Thus, teams should aim to set high standards but must be cautious of how their expectations are perceived within the team.

Day 1. Posters - Physical Activity for Health

D1.S4 The Effect of a Games-Based Physical Activity Intervention on Wellbeing in Adolescent Females

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While there is conclusive evidence that the physical health of adolescents is enhanced by frequent physical activity, there is also a widespread belief that physical activity is inherently good for young people in respect of varied psychosocial outcomes (Biddle & Asare, 2011. British journal of sports medicine, 45, 886-895). Elevated symptoms of depression and anxiety were reported by 40% of adolescents in Ireland. Females were found to have higher symptoms of depression and anxiety and lower levels of mental wellbeing than males of the same age. Meeting physical activity guidelines on a higher number of days was associated with increased levels of mental health in adolescents (Murphy, Sweeney & McGrane. 2020. Physical Activity and Health, 4, 1). The aim of this study was to examine the effects of a school-based lunchtime games programme on mental wellbeing and symptoms of depression and anxiety in adolescent females. This study was a non-randomised, exploratory, controlled before-and-after design. Having obtained ethical approval the study took place from September 2019 to December 2019. The intervention consisted of lunchtime games 3 days per week for 40 minutes over a 10-week period. Symptoms of depression were measured using the Beck Depression Inventory (BDI). Symptoms of anxiety were measured using the Beck Anxiety Inventory (BAI). Wellbeing was measured via the Warwick-Edinburgh Mental Wellbeing Scale (WEWMS). Self-efficacy was measured using the General Self-Efficacy Scale (GSES). After a one week 'sampling' period, students self-selected to either 0 (n = 21), 1 (n = 24), 2 (n = 22) or 3 (n = 18) days of lunchtime games. Those who self-selected to 0 acted as the control group. Intervention and control groups were compared through pre- and post-testing of physical fitness and psychosocial outcomes. Participants were included in the intervention design via a survey to ascertain the most popular activities at the outset. Paired t-tests found no significant differences in any of the physical fitness measures. Participating in games twice a week led to significant decreases ($p < 0.01$) in symptoms of anxiety and depression while the control group had significant increases ($p < 0.01$) in symptoms of anxiety and depression. Mental wellbeing ($p < 0.01$, $d = 0.67$) and self-efficacy ($p < 0.01$, $d = 0.76$) significantly increased in those who participated two and three times a week with similar effect sizes suggesting increased self-efficacy may be a key mechanism for increasing wellbeing through physical activity.

D1.S4 Establishing the test-retest reliability of the 'delta' (Δ) method of exercise prescription for high intensity interval training (HIIT) in overweight and obese adult males

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High-intensity interval training (HIIT) is a safe and effective exercise intervention used by overweight and obese individuals to ameliorate or diminish obesity-related health factors. However, the intensity of exercise is often prescribed using a percentage of one's maximal oxygen consumption (VO_2max) which can produce wide inter-individual differences in the relative exercise intensity (internal physiological load) achieved. The delta (Δ) method involves prescribing exercise intensity using the difference in workload at an individual's ventilatory threshold (WVT) and at peak oxygen consumption (Wpeak), which is proposed to normalise exercise intensity (Lansley et al, 2011, International Journal of Sports Medicine, 32(7): 535-41). The test-retest reliability of the exercise intensity prescribed via the Δ method, and measures of enjoyment in an overweight and obese cohort is yet to be established. We aimed to determine the reliability of completing HIIT using the Δ method of intensity prescription in the aforementioned cohort. After gaining ethical approval from the University of Sunderland, ten sedentary overweight or obese adult males (36.1 ± 9.6 years, 32.4 ± 5.5 kg.m^2, 29.7 ± 6.3 ml. kg-1min-1) completed two identical HIIT protocols (10 x 60 s at Δ 80, 60 s rest), one week apart. Test-retest reliability via intraclass correlation coefficient (ICC 3,1) and typical error was quantified for heart rate (HR), oxygen consumption (VO_2), ratings of perceived exertion (RPE), as well as total session enjoyment. RPE was assessed via the CR100 scale, and enjoyment via the physical activity enjoyment scale (PACES). Each participant completed all intervals in both workouts with no reported adverse effects. The mean intensity equated to vigorous-intensity exercise with regard to conventional maximal anchors (~67% VO_2max and ~81% HRpeak). VO_2 demonstrated trivial to moderate typical error (≤ 2.3%) and good to excellent reliability (ICC 3,1: 0.968) between visits. HR maintained moderate to excellent reliability, though there was a high typical error for HR reserve between-protocols (6.0%) and moderate typical error for RPE (9.1%). Enjoyment between-protocols was high (98.2 ± 11.2, 95.7 ± 11.6 average PACES) and maintained good to excellent reliability (ICC 3,1: 0.954). A 10 x 60 s HIIT protocol at an intensity of Δ 80 corresponded to vigorous intensity exercise and was feasible and enjoyable for overweight and obese male adults. All variables demonstrated moderate to excellent reliability, with internal physiological load the most

consistent. These findings provide the basis for further use of the delta concept to prescribe intermittent exercise protocols in overweight and obese individuals.

D1.S4 An observational study of the cardiovascular health risk factors of school age children with autism

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Cardiovascular disease (CVD) is a leading cause of death in the autistic community (Heffernan et al., 2018, Journal of autism and developmental disorders, 48(2), 625-631). The purpose of this study was to capture parental views on the cardiovascular health (CVH) risk factors of their child with autism. With institutional ethics approval, a questionnaire was administered to 122 parents of school-aged children with autism living in Ireland, the UK, and the USA to capture the parents' observations of their child's CVH risk factors. The questionnaire incorporated sections of previously published questionnaires examining the areas of interest (Bond et al., 2013, Surgery for Obesity and Related Diseases 9(1), pp.123-128: Osler, & Heitmann, 1996, International journal of epidemiology, 25(5), pp.1023-1029: Healy & Garcia 2019, Journal of Developmental and Physical Disabilities, 31(3), pp.313-328). Parents reported on their child's physical activity (PA), screen time, eating, and sleeping habits, and cognitive distress. In a typical week only 29% of children met the PA guideline of at least 60 minutes of moderate/vigorous PA per day. Children spend on average 6 hours participating in screen time activities daily, with only 9% of children meeting the guidelines of no more than 2 hrs screen time per day. In 21% of cases parents reported that their child's diet was unhealthy and 34% perceived that their child had poor sleep quality. Finally, more than 40% of parents reported that their child experienced one or more of the following cognitive distress conditions daily: mood swings; difficulty making decisions; easily irritated, difficulty with concentration, and outbursts of anger/frustration. No significant correlations occurred between walking activity, moderate PA, vigorous PA and the amount of time spent watching TV, playing computer games/video games and siting while using a phone/laptop/ tablet, $p>0.05$. The overall results suggest that several CVH risk factors are prevalent among children with autism, with a large proportion of the sample not meeting the PA or screen time guidelines and experiencing frequent occurrences of cognitive distress. Sleep quality and eating habits were also frequently reported as being poor. These factors are modifiable risk factors for poor CVH among children with autism and therefore should be key targets for future study and intervention to reduce CVD risk among this population.

D1.S4 Comparing a technology-supported exercise intervention to partly-supervised exercise in breast cancer survivors: a randomised-controlled trial

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Studies show supervised exercise improves health among breast cancer survivors but is less enjoyable than unsupervised exercise (Phillips et al., 1999, Support Cancer Care, 25, 3243-3252). This study examined the effects that 8-weeks of unsupervised technology-supported exercise had on aspects of health compared to partly-supervised exercise (NHS ethical approval 18/WA/0314). Data are presented as means ± SD. Thirty women (age 57 ± 6 years, 25.3 ± 3.3 BMI kg.m2, VO2max 28.9 ± 6.1 ml.kg-1.min-1) who had received breast cancer treatment within 2-48 months, were randomised into 2 groups. A partly-supervised (n=15) group undertook 2 supervised and 1 unsupervised session weekly for 8 weeks. Supervised sessions included treadmill walking (intensity and duration increasing fortnightly by 5% VO2max (55-70%) and by 5-min (35-50-min)). Unsupervised sessions (similar duration/intensity) were recorded with HR (heart rate) monitors. A technology-supported unsupervised group (n=15) were set weekly exercise goals (increasing fortnightly by 15-min; 105-150-min, and 5% of HRmax; 55-70%) recorded with an activity tracker with weekly telephone support. VO2max, blood pressure (BP), body fat % (DXA) and 6-min walk distance were assessed pre- and post-intervention. Data were analysed using repeated measures ANOVAs (SPSS v22, significance accepted at $P<0.05$). Adherence was higher in the partly-supervised group (87 ± 7% sessions, versus 64 ± 25% sessions; $P=0.01$). VO2max was unchanged (partly-supervised; 28.2 ± 4.2 to 28.7 ± 3.9 ml.kg-1.min-1; $P=0.707$ technology-supported; 28.9 ± 6.8 to 28.2 ± 7.1 ml.kg.min-1; $P=0.215$, change 1.08 ml.kg-1.min-1, 95% CI −1.34 to 2.58 ml.kg-1.min-1). Systolic BP decreased in the partly-supervised group (135 ± 22 to 126 ± 22 mmHg; $P=0.001$, versus 125 ± 21 mmHg to 121 ± 19 mmHg, $P=0.145$; change 5 mmHg, 95% CI −0.56 to 3.36 mmHg). Body fat was unchanged (partly-supervised; 37.0 ± 3.9 to 37.0 ± 3.6%; $P=0.381$, technology-supported; 35.2 ± 7.3 to 34.6 ± 7.6%; $P=0.115$; change 0.0%, 95% CI −1.96 to 1.97%). 6-min walk distance improved in the partly-supervised group (475 ± 43 to 518 ± 35 m, $P=0.001$, versus 493 ± 72 to 509 ± 76 m, $P=0.111$; change 27 m, 95% CI 2.8 to 6.8 m). Non-inferiority analyses showed that unsupervised technology-supported exercise was inferior to partly-supervised in improving VO2max, 6-minute walk distance and systolic BP. Partly-supervised exercise might be a feasible intervention for improving health among breast cancer survivors.

D1.S4 Systematic review of effects and parameters of plyometric training on the power of legs in prepubescent footballers

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Actions such as jumps, accelerations, crashes, kicks, rejections, regattas are determinants in the optimal performance in football for adults, youth and children, as determined above (Castagna, 2003 and Meylan and Malatesta, 2009). These movements are based on the power strength generated in the neuromuscular structure. Although several authors have investigated the application of plyometric training on prepubertal footballers (Faigenbaum et al, 2007; Sáenz Villarreal, 2012; Ramírez-Campillo, 2015 however, the collection of research findings from 2015 - 2020 on effects on leg power and plyometric training parameters are not specific in this population. This systematic review submitted to the university's ethics committee sought to contribute descriptively to the theory of matter and set as objectives 1) To carry out a systematic review of the studies that examine the effects and parameters of the plyometric training on the leg power in prepubertal footballers between 2015 - 2020, and 2) make recommendations based on the classification of scientific evidence. The search for information was carried out during the months of January and February 2021 in the databases Pubmed, Medline, Spordiscus, Science Direct and Dialnet, setting as eligibility criteria: the publication period, age limit for intervention, type of training programmes, power or explosive force measurements on legs. As a search strategy we used the English keywords plyometric training, jump, youth soccer, prepubertal, explosive strength, from which we obtained a total of 465 studies and 21 of them met the eligibility criteria to be analyzed. The studies were classified into two levels of evidence and two levels of strength of recommendation. The categories of analysis studied were the effects found and the intervention parameters of the training programs. The studies of this revision corresponding to 17 randomized trials, 2 systematic reviews and 2 meta-analyses indicated the importance of plyometric training for the increase leg power in prepubertal football players, measured by the researchers in small to moderate rating ranges on the Cohen rating scale for jump, sprint, kick and agility tests. These improvements are closely related to parameters for program design and intervention, such as: duration (6-8 weeks), weekly frequency (2 times), session type (integrated), break between sessions (48-72 hours), volume per session (40-120 contacts), exercise intensity (maximum), series (1-3), repetitions (6-15), pause between series (90 seconds), load progression (increasing), total volume (400-900 contacts). It is necessary to continue investigating in greater depth on the effects and parameters of pliometric training in this population.

D1.S4 Preliminary data to explore different boundaries of enjoyment using the Physical Activity Enjoyment Scale during home-based exercise and running outdoors

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Enjoyment of exercise is critical for adherence to exercise interventions for both healthy and clinical populations. Considering that affective responses may be a predictor for exercise adherence, it is important to prescribe exercise which result in positive responses (Oliveira et al., 2018, PLoS One, 13, e0197124). Research which explores these affective responses often utilise the Physical Activity Enjoyment Scale (PACES) which is a validated scale from 18-126 (Kendzierski and DeCarlo, 1991, Journal of Sport and Exercise Psychology, 13, 50-64). However, the validation study does not present boundaries to determine whether it is high, moderate or low level of enjoyment and it is unclear what the numerical scores obtained from PACES represents. Therefore, the aim of the current study was to establish ranges of values to pertain to different levels of enjoyment on the PACES scale.

Following ethical approval, 48 participants (36 ± 8 years, 33 women) were recruited and randomly completed 4 x 30 min exercise conditions. One session was a self-paced outdoor run, the other 3 sessions were home-based exercise videos. Two of these videos were selected by the researchers with one described as high intensity interval training and the other as resistance training. The 4th home-based exercise session was a video of their choice. Following the completion of each exercise session the participants completed a 6-point Likert scale (1 very unenjoyable to 6 very enjoyable) and the PACES scale. Mean PACES scores and 95% confidence intervals were determined for each level of the Likert scale as well as frequency of results. Data was not normally distributed therefore, a Kruskall-Wallis test was performed with pairwise comparisons to determine differences in PACES scores with the rated Likert point.

Twenty-six (14%) exercise sessions were found to be 'very unenjoyable' with PACES being 94 (83,105), 14 (7%) 'moderately unenjoyable' with PACES being 64 (54,72), 22 (12%) 'slightly unenjoyable' with PACES being 65 (60,71), 32 (17%) 'slightly enjoyable' with PACES being 78 (72,84), 69 (36%) 'moderately enjoyable' with PACES being 99 (96,102) and finally 27 (14%) 'very enjoyable' with PACES being 115 (111,118). The median PACES scores were found to be significantly different between Likert scale points $H(5)=96.0$, $p<0.001$, however pairwise comparisons did not match the increasing order of the Likert scale (e.g. PACES scores for very unenjoyable were significantly greater than slightly unenjoyable). The preliminary results suggest that the PACES scale may not be able to distinguish between different levels of enjoyment.

D1.S4 Isokinetic force values at 60 ° per second of the knee in an adult population of Bogotá

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Knee injuries have become one of the most frequent affectations in the adult population. Therefore, it is necessary to identify risk factors for skeletal muscle injury, to subsequently diagnose and create prevention mechanisms. This study sought to identify the level of imbalances and asymmetries in the legs from the evaluation of the isokinetic force levels of quadriceps and hamstrings in the sedentary and active population between 30-50 years of age belonging to the city of Bogotá.

With the authorization of the institutional ethics committee and the signature of the informed consent, the sample was selected by simple random probabilistic sampling, through a call to users of a sports center and interested people captured by social networks. A descriptive analysis with measures of central tendency and dispersion. The alpha value was a priori set at p 0.05 for all tests. The sample consisted of 50 physically active and 50 sedentary persons, 56 women, 44 men with an average age (years) of 38.23±7.02, with mass of 66.52±11.7 for active and 71.67±14.7 for sedentary, height 1.67±0.1 for active and 1.65±0.1 sedentary, BMI 23.89±3.2 and 26.31±4.5 respectively. Torque levels of flexors and knee extensors were determined at 60° per second in both extremities, identifying that the active population has higher peak torque values in front of the sedentary population, with predominance of the right leg (RL) muscle strength index with respect to the left leg (LL). In the study of balance and leg symmetry using peak torque and ratio calculation (peak torque ratio between the force produced by hamstrings and quadriceps); the active population shows a ratio of 50.2% in (RL) and 49.5% in (LL), while the sedentary population shows a ratio of 48.5% in (RL) and 48.2% in (LL) evidencing that both sedentary and active present high risk indices of knee injury as proposed by Soderman, 2001, who establishes that indices less than 0.55 (55%) increases risk of anterior cruciate ligament injury. On the other hand, the analysis of asymmetries showed that the active population had higher percentages of asymmetries in flexor (11.6% vs 13.4%) knee, while sedentary population presented in the knee extensors (13.2% vs 11.8%). The assessment of balances and symmetries of knee, allow to identify muscle deficits becoming a fundamental component for the protection and prevention of musculoskeletal injuries.

D1.S4 Examining the mediating roles of muscular strength and perceived motor competence in the relationship between fundamental movement skills, physical activity and weight status in British children

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Fundamental movement skills (FMS) are an important antecedent of children's physical activity (PA) and weight status (Robinson, et al., 2017, Medicine and Science in Sports and Exercise, 49, 2234-2239). Conceptual models suggest that the association between PA, FMS and weight status are mediated by perceived motor competence (PMC) and physical fitness (Stodden, et al., 2008, Quest, 60, 290-306). Research supports this model (Burns & Fu, 2018, Journal of Functional Morphology and Kinesiology, 3, 61) but there remains a dearth of data testing the model in children, and few studies have considered muscular strength within their conceptualisation of 'physical fitness'. This study examined the mediating roles of strength and PMC in the relationship between FMS, PA and body mass index (BMI) in British children. Following institutional ethics approval and parental informed consent, 180 children (98 boys, 82 girls), aged 8-11 years took part in this study. Stature and body mass were assessed using a Seca Stadiometre and scales (Seca instruments, Hamburg, Germany), from which BMI (kg/m2) was calculated. PA data was collected using accelerometry worn over four days (ActiGraph-wGT3X-BT, USA). FMS was assessed using The Test of Gross Motor Development-2, and PMC was evaluated using The Pictorial Scale of Perceived Movement Skills Competence (Barnett, et al., 2015, Journal of Physical Activity and Health, 12, 1045-1051). Strength was assessed using a composite z-score comprising of handgrip strength (dominant hand) and the seated 1kg medicine ball throw. Non-parametric mediation analysis, controlling for sex, examined direct effects of FMS and mediating effects of muscular strength and PMC on both PA and BMI. Results indicated no significant effect of PMC or strength on PA (both P>.05), although there were direct effects of FMS on PMC (P =.028) and strength (P=.001). Although FMS had a significant, direct effect on BMI (P=.002), there was a significant mediating effect of strength on the relationship between FMS and BMI (P=.0001). The results of this study suggest that the proposed mediating role of PMC between FMS and PA or FMS and BMI is not evident in British children aged 8-11 years. Likewise, while strength did not mediate the effect of FMS on PA, it did significantly influence the effect of FMS on BMI. Consequently, facilitating interventions that promote the development of both FMS and strength in 8–11-year-olds, may have additional benefit for children's healthy weight, rather than focusing on FMS and/or strength in isolation.

D1.S4 Associations between handgrip strength and Body Mass Index in Emirati adolescents and young adults: A pilot study

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Muscle weakness is associated with sarcopenia, dynapenia, malnutrition, stroke, and type 2 diabetes (e.g., Bohannon and Magasi, 2015, Muscle & Nerve, 51, 102-105). Grip strength measurements using handgrip dynamometers are easy, efficient, non-invasive, and reliable measure of the maximum voluntary force of the hand for assessing muscle weakness. When applied correctly, handgrip strength (HGS) has demonstrated associations with all-cause mortality including cardiovascular and non-cardiovascular mortality, and cancer (e.g., Celis-Morales et al., 2018, The BMJ, 361, k1651). Given the health consequences associated with low HGS, many countries have developed reference values for their populations. Presently, this data does not exist for Middle Eastern regions. The primary purpose of this pilot study was to establish procedures for collecting large population-based data that will allow HGS normative data to be determined in a follow-up investigation. In addition, correlates (i.e. BMI & Sex) known to affect the predictive nature of HGS, were explored to allow the researchers an appreciation of their role in determining reference values for the Emirati population. With institutional ethics approval, 471 participants (n males = 395, mean age: 17.80 + 0.87 years, mean BMI = 32.05 + 8.32 kg.m2; n females = 76, mean age = 17.96 + 3.54 years, mean BMI = 24.48 + 3.56 kg.m2) had body composition measurements (e.g., height, weight, waist circumference) and HGS (e.g., CAMRY Electronic Handheld Dynamometer) assessed. The American Society of Hand Therapists protocol was used with a mean score of three trials per hand representing total HGS. Participants were divided into four groups based on their BMI (underweight = 47, healthy = 101, overweight = 95, obese = 228). Data were analyzed using descriptive and inferential statistics at $P < 0.05$. The results indicated that there were significant differences in HGS (25.41 ± 6.58 kg, 29.98 ± 9.92 kg, 31.61 ± 5.35 kg, and 35.93 ± 6.21 kg; $P < 0.001$) among underweight, healthy, overweight, and obese BMI groups, respectively. Regression analysis indicated that when using sex and BMI as independent variables for predicting HGS, the coefficient of the determinant R2 was 0.739 ($P < 0.001$). The results demonstrate a positive relationship between HGS and BMI, with sex being a significant predictor of performance. These findings support those noted elsewhere (Liao, 2016, Middle Eastern Journal of Rehabilitation & Health Studies, 3, e53229) and go some way towards addressing gaps in the Middle Eastern literature that may support clinicians' diagnoses and treatments decisions.

D1.S4 Correlation of the prehensile force with isokinetic knee force at 60 degrees per second in sedentary and active population between 30-50 years

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The identification of muscle strength levels becomes a variable of intervention and assessment of physical performance. A quantitative approach study of non-experimental design and descriptive scope was developing with the objective of identifying the correlation between bilateral prehensile force and isokinetic force of knee flexion-extensors at 60 degrees per second in the adult population of Bogota. The population sample was selected by simple random probability sampling and consisted of 100 adults (56 women and 44 men) between 30 and 50 years of age in Bogotá, Colombia. The population was convening voluntarily in a sports center by exposing the project through social networks. Subsequently, the study population was included according to inclusion and exclusion criteria, after which the informed consent was requested to be signed and endorsed by the Ethics Committee of the Manuela Beltran University. Within the methodological process, the characterization of the sedentary and active population was carried out by means of the IPAQ tool, and then prehensile force tests were performed by executing three attempts applying the greatest possible force and isokinetic force of lower limbs. SPSS statistical software was used to analyze the population with the Kolmogorov-Smirnov normality test, then the variables were correlated using Pearson's test establishing a significance of $p < 0.05$. The study population had an average age of 38.23 ± 7.02 years, mass of 66.52 ± 11.7 kg, for active and 71.67 ± 14.7 kg for sedentary; height 1.67 ± 0.1 meters active and 1.65 ± 0.1 meters sedentary and BMI 23.89 ± 3.2 and 26.31 ± 4.5 respectively. Within the results, significant correlations of prehensile force (PF) with isokinetic force (IF) of lower limbs, identifying high correlation between right PF with IF (ICC (intraclass correlation coefficient) = 0.756-0.791) ($p < 0.05$) and high correlation between left PF with IF (ICC = 0.659-0.738). Similarly, the correlations of PF with IF at 60 degrees per second recognizing high-very-high correlations between right PF with IF (ICC = 0.732-0.830) ($p < 0.05$), showing that adults who perform more physical activity have higher levels of global strength, being an important indicator of performance and physical health. Likewise, the correlations of PF and IF in sedentary population, presented high correlations between right PF with IF (ICC = 0.677-0.734) ($p < 0.05$). In conclusion, high levels of correlation between upper and lower limb strength were evidenced, being an important reference in the recognition of levels of physical activity and global muscle strength.

Day 2. Free Communications - Biomechanics and Motor Behaviour

D2.S2.2(1) A tool for teaching biomechanics at undergraduate and Masters level

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Biomechanics is a beguiling subject; it merges physics and biology, it contains muscles and forces and is dynamics and moving. But too often this fascination is not conveyed to students who find it confusing, inaccessible and, in the extreme, boring. Partially to blame for this situation is the availability of only out-dated teaching material including text books and videos at best. This presentation will introduce the next level of teaching material which contains a musculoskeletal model and a number of pre-recorded trials which illustrate many biomechanical principles and can be loaded onto every students' PC and Mac. These trials include statically supporting a weight, moving a weight in the hand, inverse dynamics, gait, running, climbing stairs, a rowing machine, ballet choreography, manual handling, tennis serve and cycling with EMG signals. The teaching package also contains a 3-dimensional graphics engine which enables the display in interrogation of anatomical trajectories, joint angles, joint ranges of motion, muscle forces, joint contact forces, ground reaction forces, joint torques, muscle lengths, muscle forces, muscle energy expenditure, muscle power, visualization bars and local coordinate systems. Output can be in the form of csv files for post-processing, graphs in many styles, images and videos. The package also contains example worksheets which can be used "straight from the box" or edited to suit individual teaching styles. This teaching tool has been successfully used in universities from Lithuanian to Brazil via the UK and has been demonstrated to bring the subject of biomechanics to life. Further information at www.BoB-Biomechanics.com.

D2.S2.2(2) Segmental contribution to whole spine kinematic reveals multi-segmental interaction

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The spine is a multi-segmental structure with an important role in anatomical and physiological functions. It is a primary concern in the sport, occupational and clinical environments; however, the majority of our knowledge has been acquired from non-multisegmental models and limited information is available about segmental interactions. Stepwise segmentation is a novel approach to characterize the contribution of each part in the range of motion and pattern. The aim of this study was to examine the stepwise segmentation to characterize multi-segmental interaction during the lifting and lowering tasks. Ten men (mean ± SD; age of 22.82 ± 2.27 years, height 1.70 ± 0.04 m and weight 67.97 ± 6.41 kg) participated in the experiment. They performed lifting and lowering a box by two techniques (stoop and squat) with two different loads (i.e., 10% & 20% of body weight) that was approved by the department's ethical committee. The thoracic and lumbar segments were divided into five segments by six cluster markers (C7, T3, T6, T9, T12, and L5). A motion capture system was used to measure kinematic data, at 120 Hz frame rate. Stepwise segmentation is an iterative procedure for stepwise aggregation of segmental effects or for excluding a segment to calculate a relative angle from upper (e.g., C7 to L5) or lower (e.g., L5 to C7) segments. Statistical Parametric Mapping (SPM) was used to assess the effects of the stepwise segmentation. It revealed the contribution of all defined segments to the spine range of motion: lifting ($p<0.0010$) and lowering ($p=0.0010$); however, the cervico-thoracic segment attenuated the real contribution of the other thoracic parts when including to the kinematic model. The stepwise segmentation showed patterns when was considered a point in first derivative's graph. Timing of the minimum of first derivative showed an increasing trend (slope= 0.085, intercept=30) in lifting; while maximum of the first derivative exhibited decreasing trend (slope= -0.022, intercept= 47) for lowering (standing to flexion). The first and second derivatives of the relative angle exhibited potential to describe movement patterns. With respect to the phase of the tasks, changes in the first derivative implicitly demonstrated the contribution of the different parts in the magnitude and pattern. Segmentation analyses revealed a cephalad-to-caudad motion pattern during lifting and a caudad-to-cephalad pattern during lowering.

D2.S2.2(3) The gait profile score characterises walking performance impairments in highly functional amputees

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Understanding how an amputation(s) affects the ability to walk is a key determinant of rehabilitation. The Gait Profile Score (GPS) provides a measure of walking quality in degrees, with healthy controls scoring around 5^0 to 6^0, with higher GPS scores indicating a poor quality of walking. Recent military conflicts have resulted traumatic amputation of lower limbs in young military personnel. With intensive rehabilitation, many can walk efficiently. Understanding the "quality" of their gait may help deduce the reasons for why they are highly functional. Therefore, the aims of this study were to: a. Compare the GPS

of the intact and prosthetic legs of unilateral transtibial (UTT), unilateral trans-femoral (UTF), and bilateral trans-femoral (BTF) amputees to healthy controls and, b. Determine the relationship between GPS, oxygen cost, temporal and spatial parameters in UTT, UTF and BTF amputees. With institutional ethical approval, thirty amputees (UTT: n = 10, UTF: n = 10, and BTF: n = 10) were recruited and underwent a rehabilitation program at the Defence Medical Rehabilitation Centre, Headley Court, and ten healthy controls. Joint range motion was measured at the pelvis, hip, knee, and ankle during walking using a Vicon motion capture system on level ground at self-selected speed to calculate GPS. Metabolic energy consumption was measured via in-direct calorimetry. GPS was significantly higher when comparing GPS of prosthetic leg between BTF (6.92° (5.81 – 8.03)) versus UTT (5.55° (4.46 – 6.63), P = 0.001) and UTF (5.36° (4.63 – 6.09), P < 0.0001), but no significant difference between UTT against UTF (P = 0.764). GPS overall correlated significantly with walking speed (r = -0.403, n = 40, P = 0.010), stride length (r = -0.344, n = 39, P = 0.032), stride width (r = 0.690, n = 39, P < 0.001), oxygen consumption (r = 0.443, n = 37, P = 0.006), and oxygen cost (r = 0.671, n = 37, P < 0.001). These results indicate that with a higher GPS, walking speed will decrease, stride length shortens, stride width widens, oxygen consumption and cost increases. As the first study to report a GPS in highly functional amputees, differences in the quality of walking, as well as temporal and spatial parameters, are visible dependant on amputation level. Amputees who are more efficient at walking have a better quality of gait and therefore improving this should be prioritised in rehabilitation to optimise function, specific to amputation level.

D2.S2.2(4) Effects of a proprioceptive program on postural control and joint stability of lower limbs in skaters of Bogotá

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This study aimed to determine the effects of a 12-week proprioceptive program on postural control and joint stability of lower limbs in in-line roller skates. With the authorization of the institutional ethics committee and the signature of the informed consent of the parents, participating were 8 athletes belonging to the MSC Bogotá club, aged between 7 and 12 years, who by random selection were divided into control group and experimental group, (CG) n = 4 with age 10.5 years + 1.29 and (EG) n = 4 with age 10.3 + 2.06. The experimental group participated in a program of proprioceptive exercises, applied three times a week in the first 20 minutes of their regular training, the control group continued participating in their regular training. Before and after the program a stabilometry test was carried out in positions of skating with bipodal and unipodal support on BTS force platform P-6000 to evaluate the postural control and skip test with unipodal support in skating position, using the protocol of marking for Davis body segments and Smart DX 6000 optoelectronic cameras to assess the stability of lower limbs. The data were collected through the Smart Analyzer software, and later analyzed under statistical tests for independent and related samples in statistical software SPSS and G*Power. The results showed statistically that the proprioceptive program produces significant improvements in (EG), in the transverse displacement variables of the COP with closed eyes in bipodal support (p=.004), and in the transverse displacement variables of the COP with open eyes ES (effect size) = 0.999 with SP (statistical power) = 22%. With eyes closed in bipodal support ES = 1.386 with SP = 38%, likewise a medial displacement of the angle of the left ankle in unipodal fall (p=0.013) in addition to generating a moderate to high effect on the variables of postural control and joint stability of the lower limbs in skaters from 7 to 12 years of age.

Day 2. Free Communications - Physical Activity for Health (Session 1)

D2.S2.1(1) The impact of a resistance training intervention on strength and physical self-perceptions of youth who are inactive and/or have overweight/obesity

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Regular participation in physical activity (PA) has the potential to improve a child's emotional, social and cognitive well-being (Faigenbaum et al., 2014, Res Q Exerc Sport. 85(3), 297-307). While the UK PA guidelines recommend 'activity to develop movement skills, muscular fitness and bone strength', there has been limited research on the impact of resistance training (RT) on psychological outcomes in youth. Evidence supports an association between muscular fitness and physical self-perceptions (PSPs) in youth (Lubans and Cliff. 2014, J Sci Med Sport, 14(3),216-21). However, further research would substantiate a possible effect of RT on strength and PSPs of youth who are inactive and/or with overweight/obesity, which was the aim of this study. Following ethics approval, 12 participants were quasi-randomly assigned to an experimental (EG; n=6, age 8.7 ±1years, BMI z-score=2.54±0.61) or control group (CG; n=6, age 9.2±1years, BMI z-score=1.50±0.93). All data are expressed as mean±SD. Pre- and post-intervention assessments for strength (isometric mid-thigh pull) and PSPs (CY-PSPP questionnaire) were completed. The EG participated in a 10-week RT programme (45minutes, twice weekly). The CG refrained from RT but maintained their normal PA. A mixed ANOVA with repeated measures was conducted and Hedges' g was calculated to assess change scores between the groups. There was 93% attendance and positive feedback from participants. There were no statistically significant changes in strength or CY-PSPP score in the EG, in comparison to the CG. Although not significant (P>0.05), there was a large effect size evident for relative strength (g=0.825), small positive effect sizes for perceived physical condition (g=0.275) and global self-worth (g=0.367), and small negative effect sizes for perceived strength (g=-0.214), sport competence (g=-0.345) and physical self-worth (g=- 0.201). The findings suggest that a RT intervention had a positive impact on strength and PSPs in some part, in this population. However, with negligible to small effect sizes, these findings are unlikely to represent an important change. Comments from participants did not align with the quantitative analysis. This might be due to limitations of conducting the CY-PSPP with this age group, however this tool has been previously validated with this age group. The excellent attendance supports the feasibility of the intervention and overall the study provides evidence to support an effective mode of PA for this population. Future research should include a larger sample size, a robust assessment of PSPs, and the intervention should be delivered over a longer duration.

D2.S4.1(2) Exploring the experiences of Grandparents who spend leisure time with their Grandchildren: An Interpretative Phenomenological Analysis

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Grandparents play an important function in the lives of their grandchildren. Age UK (2019) estimates that 5 million grandparents are taking on childcare responsibilities, with 40% providing regular care 4-6 times per week for up to 5 years. There are bidirectional benefits of spending time together, including increased child well-being (Buchannan & Rotkirch, 2018) and keeping older adults more mental and physically active with an increased sense of purpose and closeness, reducing social isolation (Age UK, 2019). Despite this, there is a dearth of intergenerational research, which often focuses on children, using quantitative measures. Where qualitative research has been used, focus groups have been the main method, then only regarding feasibility or post intervention evaluation. To date, the grandparents' experiences have been unexplored. The aim was to gain insight into the experiences of grandparents spending active leisure time with their grandchildren, the types of activities, duration, benefits, barriers and how this may shape the relationship of the intergenerational dyad. This is important to advise in the formation of the research and gain insight into an important and under-researched area. The study had full ethical approval and used semi-structured interviews, recorded and transcribed verbatim with 10 participants, 7 females and 3 males, aged between 57-73 years old. The analysis utilised Interpretative Phenomenological Analysis (IPA) following methods proposed by Smith, Flowers, and Larkin (2009) and coded using Nvivo. Both positive and negative experiences were described by grandparents with a sense of joy, but also evolving roles from carer/surrogate parents to friend being expressed. There were expectations, a sense of duty felt by participants but also descriptions of feeling useful with limited time that needed to be utilised fully. Financial implications were highlighted, not always considered or respected by family members. Proximity and frequency were described in relation to aiding the bond formation between the intergenerational dyad. Findings suggest that grandparents' experiences are varied and unique, depending on morals, upbringing and values. It could be dependent on their financial situation, which guided feelings of guilt and ability to regularly

devise and conduct activities. Despite this individuality, common themes and concerns were identified, with many converging to provide an overall picture of how grandparents feel when spending time with their grandchildren as well as the challenges and issues they face in facilitating, maintaining and embedding physical activity into leisure time. Future directions will seek to inform intergenerational physical activity interventions.

D2.S4.1(3) The Effects of Static versus Dynamic Resistance Exercise on Post Exercise Hypotension

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According to Public Health England (2018) an estimated 5.6 million people in the U.K are living with undiagnosed hypertension. North American and European guidelines for the prevention of hypertension include lifestyle adjustments, such as exercise. However, studies report conflicting effects of PEH in resistance exercise, since intensities are variable, and evidence for acute static resistance exercise (SRE) studies are minimal. To date optimal training prescription during resistance training that cause PEH are still unclear. Therefore, the aim of this study was to compare the magnitude of the PEH response between SRE and dynamic resistance exercise (DRE). With institutional ethics approval, ten healthy, normotensive adults (aged 27±8 years), with 12 months regular resistance training experience, volunteered to participate in the study. Following an initial strength assessment to determine participants' ten repetition maximum (10RM), each participant completed an acute bout of DRE and SRE one week apart. The order of sessions was randomised and counterbalanced but timings remained consistent to minimise circadian variation. The dynamic condition consisted of 3 sets of 10 repetitions of the back squat, using 10RM weight, with a 1-second concentric and 1-second eccentric phase. Whilst the static protocol required participants to perform 3 sets of a -twenty second isometric hold in the back squat position, with their same 10RM weight. Following each bout of exercise, participants took up a seated position and both systolic blood pressure (sBP), diastolic blood pressure (dBP) and heart rate (HR) were measured every 5 minutes using a Honsun sphygmomanometer cuff and stethoscope for 60 minutes post exercise. The results suggest a sustained decrease in sBP (P=<0.001, 95% Confidence Interval (C.I.) ranging from 2.92-7.18) and HR (P=0.007, C.I 1.98-11.12) below baseline for 60 minutes, although, dBP failed to show a significant decrease (P=0.42) and mean arterial pressure (MAP) significantly decreasing only for the first 15 minutes (P=0.03, C.I 0.40-5.23). However, there was no statistically significant difference in PEH between SRE and DRE for sBP (P= 0.64), dBP (P=0.81), MAP (P=0.72), and HR (P=0.88), therefore PEH occurs irrespective of the mode of resistance exercise. Thus, an acute bout of resistance exercise is associated with evidence of PEH for up to 60 minutes post exercise, mediated by significant reductions in sBP. However, the type of resistance exercise appears to have no impact upon the magnitude of the reduction in blood pressure observed. Future studies should consider comparing this response in trained vs untrained individuals.

D2.S4.1(4) The association between 24-Hour movement behaviours and clustered cardiometabolic disease risk among adolescents from Saudi Arabia: a cross-sectional study

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Physical activity (PA), sedentary behaviour (SB) in the form of recreational screen time, and sleep time (ST), are associated with cardiometabolic disease risk in adolescents. The Canadian 24-Hour Movement Guidelines for children and youth has emphasised the integration of these three movement behaviours rather than in isolation (PA ≥60 min/day, SB ≤2 hours/day, and ST 8–10 hours/day) in a daily 24-hour assessment of optimal health. However, this 24-hour concept has not been investigated in the Gulf Cooperation Council countries. Therefore, we examined the association between meeting the 24-hour movement behaviour and clustered cardiometabolic risk score (CMRS) in adolescents from Saudi Arabia. Ethics approval was obtained from the College of Medicine Institutional Review Board, King Saud University. A random sample of 120 participants (50% female) were selected from eight schools in Riyadh city, stratified for location (mean age 13.6 ± 1.1 years, stature 154.5 ± 7.5 cm, body mass 53.9 ± 14.9 kg). A wrist-worn accelerometer (GENEActive) measured moderate to vigorous PA (≥60 min/day) and ST (≥8 hours/day), and the Global School-Based Student Health Survey assessed SB (≤2 hours/day). CMRS was calculated using sex-specific z-scores summed from waist circumference, mean arterial blood pressure, fasting HDL cholesterol, LDL cholesterol, triglycerides, and glucose. Participants were also categorised at risk if their CMRS was >1 SD. Statistical analysis was conducted using linear and logistic regression, and general linear model with adjustment of covariates (sex, age, region, stature, and diet score of fruit, vegetables, drink milk or eat milk products, and carbonated soft drinks). No sex differences were observed for meeting any of the guidelines. Of the 120 participants, 47 met zero, 58 met one, 12 met two and 3 met three of the 24-hour guidelines. General linear models and logistic regression indicated that meeting any or none of the 24-hour guidelines on a daily basis were not associated with CMRS (β= 0.24, P= 0.55) or participants classified at risk (OR= 1.12, P= 0.78). In conclusion, few adolescents from Saudi Arabia are meeting the 24-hour movement behaviours, which are not associated with CMRS. Further prospective studies to understand the long term health impact of these relationships are required.

Day 2. Free Communications - Physical Activity for Health (Session 2)

D2.S4.3(1) Explosive resistance training for older adults: a survey of applied practitioners

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The ability to produce force rapidly is important for many activities of daily living (ADL's), for example, the ability to recover from a trip, to avoid a fall or rise from a chair unaided. Explosive strength training (EST) is recognised as a safe and effective means to improve rapid force production. However, very little is known about the application of EST for older adults in real-world settings and whether there are any barriers to implementing it. Therefore, the aim of this study was to investigate current practices in the use of EST for older adults by applied practitioners. Following institutional ethics approval, applied practitioners involved in prescribing exercise for older adults were invited to complete a self-administered online questionnaire containing multiple-choice and open-ended questions in five sections: 1) demographics, 2) education and qualifications, 3) the current application of EST, 4) concerns with promoting EST and 5) training needs. The questionnaire was distributed online and advertised through social media platforms as well as by email. Closed-ended and multiple-choice answers were analysed using descriptive statistics, using absolute and relative frequency counts. Responses were obtained from 199 participants (138 female, 58 male, 1 non-binary) aged between 20 and 79 years and based in 15 countries. Participants were predominantly working as fitness instructors, personal trainers, and physiotherapists. All respondents (100%) indicated that they prescribed resistance training for older adults, whereas only 84/199 (42%) prescribed EST. The most prescribed repetition scheme for both upper and lower body EST was 3 sets of 4-6 reps with 1-2 minutes rest between sets. The most common training frequency was 1 or 2 days per week and body weight was the most frequent form of resistance used followed by resistance bands. Supervision of EST was provided 'always' by 66% of respondents (42/64). All participants were asked whether they had ever received specific information about the prescription of EST and whether they would benefit from training in the prescription of EST for older adults. Of the 152 respondents, 33.6% (n=51) indicated that they had previously received training and 76.3% (n=116) felt that they would benefit from training. These findings suggest that EST may not be a predominant training type prescribed by applied practitioners working with older adults. This is despite its potential to improve rapid force production and impact ADL's and therefore, practitioners may benefit from training opportunities in EST for older adults.

D2.S4.3(2) Clinical exercise provision in the UK: A comparison of job titles, roles and qualifications across five specialised exercise services

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In the UK, the NHS long-term plan advocates exercise as a key component of clinical care but there is currently no defined workforce to deliver the plan. In reality, exercise provision as part of clinical care pathways across medical conditions is highly inconsistent and piecemeal, i.e., it has emerged separately for different conditions and varies across geographical areas within the UK. Our aim was to map current (pre-COVID-19) UK clinical exercise provision with specific focus on exercise staff job titles, role and qualifications across cardiovascular, respiratory, stroke, falls and cancer services. Clinical exercise services were identified electronically between May 2020 and September 2020 using publicly available information (no institutional ethical requirement needed) from clinical commissioning groups (CCG), national health boards and published audit data. Data relating to staff titles, roles, qualifications and exercise delivery were collected via electronic records and telephone/e-mail contact with service providers. Data were obtained for 731 of 890 eligible clinical services (216 cardiac, 162 respiratory, 129 stroke, 117 falls, 107 cancer). Cardiac rehabilitation services provided both clinical (phase III) and community (phase IV) exercise interventions delivered by physiotherapists, exercise physiologists (exercise specific undergraduate (BSc)/postgraduate (MSc)) and exercise instructors (vocationally qualified with or without BSc/MSc). Respiratory, stroke and falls services provided a clinical exercise intervention only, mostly delivered by physiotherapists and occupational therapists. Cancer services provided community exercise, primarily delivered by vocationally qualified exercise instructors without a tertiary degree (88%). MSc qualified exercise physiologists were employed in cardiac (18%), respiratory (8%) and cancer (1%) services but not in falls and stroke exercise delivery. Job titles of "exercise physiologists" bore little alignment to their qualifications, i.e., only 82/115 had MSc level qualifications, further demonstrating a large amount of heterogeneity across services regarding staff titles, roles and qualifications. These results suggest that clinical exercise provision, job titles, roles and qualifications were inconsistent across five key long-term health conditions in the UK. Regulation of exercise job titles and roles is required for more consistent and sustainable provision of exercise in clinical settings.

Research is needed to further understand the role of staff competencies and qualifications in exercise provision and what staff factors are important for optimal service delivery.

D2.S4.3(3) Influence of traumatic lower-limb amputation on physical activity and cardio-metabolic health risks in UK military personnel

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Severe injuries sustained during military combat result in exceptional long-term healthcare and rehabilitation needs. Unfortunately, evidence suggests an increased prevalence of physical inactivity and reduced functional status in this population. It is currently unclear if previously physically active military personnel with lower-limb amputation(s) (LLA) have compromised cardio-metabolic health following prolonged rehabilitation care. Using UK military personnel with traumatic unilateral (UNI) and bilateral (BI) LLA at the end of their rehabilitation care pathway, the aim of this study is to, 1) determine the impact of free-living environment (rehabilitation vs. home) on physical activity energy expenditure (PAEE); and 2) assess the within and between group differences in biomarkers of cardio-metabolic health compared to non-injured controls (CON). Sixteen LLA (8 unilateral (UNI), 30±5 years; 8 bilateral (BI), 29±3 years), attended two 4-week residential rehabilitation admissions, separated by two 6-week recovery periods at home. Thirteen active, non-injured, age-matched males (28±5 years) represent CON. Following UK Ministry of Defence ethics approval, estimated daily ambulatory PA was recorded using a triaxial accelerometer for 7-days during residential rehabilitation and 7-days whilst at home using validated population specific prediction algorithms. Fasted blood samples (lipid profile) were taken prior to determining the insulin and glucose response to a 75g oral glucose load at baseline and 20 weeks. Data were analysed using 2-way mixed model ANOVA (group x time). Whilst at home, mean PA counts.day-1 reduced by 17% (P=0.018) and 42% (P=0.001) in the UNI and BI group, respectively. UNI group demonstrated a similar capacity for PAEE to CON, both of which were greater (P<0.05) than BI LLA. No significant interactions were observed for any biomarkers of cardio metabolic health. Cardiovascular and metabolic health markers were comparable between UNI LLA and CON (P>0.05). BI LLA demonstrated significantly elevated cardiovascular health risk (Total:HDL cholesterol ratio, P<0.001; triglyceride, P=0.001; and CRP, P=0.002), insulin resistance (HOMA2-β (P=0.030), and reduced insulin sensitivity (P=0.005) compared to CON. Metabolic syndrome was identified in 63% of BI LLA. Despite extensive residential rehabilitation following injury (39±15 months), cardio-metabolic component risks are already elevated in BI LLA, but are comparable between UNI LLA (14±8 months following injury) and active non-injured CON. The adverse outcomes in BI LLA appear to be associated with a loss of metabolically active tissue and lower reported PA levels. Innovative strategies that improve and/or support the long-term cardio-metabolic health and PA of severely injured BI LLA while at home are warranted.

D2.S4.3(4) Effects of breaking up sitting time on postprandial cardiometabolic disease risk markers in South Asian adults with overweight or obesity

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South Asians have the highest risk of developing cardiometabolic diseases of any ethnicity in the UK (Gholap et al., 2011, Primary Care Diabetes, 5(1), 45-56). Breaking up sitting time with 2 to 5-min bouts of light or moderate-intensity walking every 20-30-min can improve postprandial glycaemia and insulinaemia in Caucasians (Dunstan et al., 2012, Diabetes Care, 35(5), 976-983; Henson et al., 2016, Diabetes Care, 39(1), 130-138). However, data on the effects of breaking up sitting on cardiometabolic disease risk markers in South Asians is lacking. The study aimed to establish whether breaking up sitting with light-intensity walking could improve postprandial cardiometabolic risk markers in South Asians with overweight or obesity. With institutional ethical approval, 19 (14 female) South Asians classified as overweight or obese (age: 50 ± 14 years; body mass index: 26.4 ± 2.5 kg.m-2, body fat: 34.3 ± 7.4%) completed two 5-h experimental conditions in a counter-balanced order: prolonged sitting (SIT) and breaking up sitting with 5-min bouts of light-intensity walking every 30-min (INT-SIT). Two standardised test meals (58% carbohydrate, 28% fat, and 13% protein) were provided at 0 and 3 h. Blood samples (to analyse blood glucose, triglyceride, and plasma insulin concentrations) and resting expired air samples (to estimate carbohydrate and fat oxidation, and resting energy expenditure) were taken at regular intervals throughout. Statistical analyses were completed using linear mixed models. Cohens d effect sizes were calculated to describe the magnitude of the between-condition differences; 0.2, 0.5, and 0.8 indicated a small, medium, or large effect, respectively. Compared with SIT [1.73 (95% CI 1.40, 2.06) mmol.L-1·5h-1], INT-SIT [1.52 (95% CI 1.21, 1.85) mmol·L-1.5h-1] attenuated postprandial glycaemia incremental area under the curve (iAUC) (P = 0.08; small-medium effect: d = 0.36). Compared with SIT [0.17 (95% CI 0.13, 0.22) kcal.5h-1], INT-SIT [0.22 (95% CI 0.17, 0.27) kcal·5h-1] significantly increased postprandial resting energy expenditure iAUC (P = 0.04; medium effect: d = 0.53). There was no significant difference in postprandial iAUC between SIT and INT-SIT for all other variables (P > 0.05). These results suggest that breaking up sitting with 5-min bouts of light-intensity walking every 30-min acutely improved postprandial glycaemia and resting energy expenditure in South Asians with overweight or obesity. Thus, breaking up sitting time will play a crucial part in improving cardiometabolic health in the South Asian community if these novel findings are confirmed in future research with larger samples.

Day 2. Free Communications – Psychology

D2.S2.3(1) Abuse in gymnastics: Delivery of online group therapy using Focused Acceptance and Commitment Therapy

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In the summer of 2020, the world of gymnastics was rocked by the release of the documentary Athlete A. It quickly became apparent that gymnasts in the UK had also experienced similar abuse at the hands of their coaches and that their allegations had equally been ignored by British Gymnastics. Many elite gymnasts broke their silence and openly discussed the emotional and physical abuse that they had experienced. Consequently, The British Athlete Commission (BAC) with the NSPCC launched an independent helpline for gymnasts to report the abuse that they had received after it became apparent that British Gymnastics had been woefully inadequate in acting upon the complaints received, and they were no longer trusted.

It became evident that these gymnasts needed psychological support. This paper details the applied work with BAC to deliver online group therapy sessions for those gymnasts who could benefit from psychological support. The therapy sessions were designed in line with the principles of Focused Acceptance and Commitment Therapy (FACT), a brief intervention. The aim of FACT is to focus on fusion, experiential avoidance and unworkable action, leaving behind the more traditional DSM diagnostic approach. Thus, the primary aim was to focus on active intervention with the principle that one small change can create a domino effect and be the catalyst for meaningful psychological transformation.

This method ensured we could work with as many people as possible, and FACT facilitated designing a programme based on delivering three sessions to each group. In order to be able to participate in a group, each participant was identified by BAC as being someone who may benefit from the group sessions. Each group's membership was carefully considered to ensure a degree of homogeneity. Each group had a maximum of eight participants and was facilitated by two psychologists. Since November 2020, 74 people have attended the groups.

Overall, the programme has been extremely successful, and endorses the effectiveness of FACT as an efficacious method of delivering meaningful psychological support for abused gymnasts evidenced by participant and psychologist evaluations. The sessions helped participants to understand that they are not alone, and that they were not responsible for the abuse they received. Moreover, the online delivery increased the accessibility of the psychological support. Given the prevalence of damaging behaviour in sport this programme has extensive relevance to practitioners supporting abused athletes.

D2.S2.3(2) Stress-related growth in elite sport performers: qualitative differentiators in psychosocial mechanisms

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Research into growth following stressful life experiences has gained increasing attention within sport, particularly considering the array of negative experiences elite athletes often need to confront to succeed. Understanding more about the psychosocial mechanisms underpinning how athletes experience growth can help us better support athletes through these times. The purpose of this study was to explore growth following stress related experiences, comparing elite athletes who exhibit higher and lower levels of growth. Following institutional ethical approval, 75 current or retired elite athletes received the Stress-Related Growth Scale-Revised (SRGS-R). The SRGS-R was used to obtain participants who had reported experiencing growth, with all participants having competed at international events, from World Championships to Olympic Games. To compare the experiences of those higher and lower in growth, extremities at the top and bottom 10 percent of the SRGS-R participated in one semi-structured interview. The sample comprised six elite athletes (five females and one male), from sports including rowing, triathlon, and gymnastics. Within this sample, three athletes reported experiencing higher levels and three lower levels of growth. The type of stressor was not used as a criterion given it is the subjective evaluation of the event demands and their impact on one's life which ultimately determines the event severity. The stressors experienced include, divorce, chronic injury, underperformance, a career jeopardising error, deselection from a National Team, and the significant breach of trust. Interpretative phenomenological analysis revealed three themes as key differentiators through which psychological mechanisms influence growth. The themes include (a) understanding of self, (b) development in athletic identity, and (c) social support. These mechanisms were found to be pivotal aspects of the transitional process that facilitate growth in elite performers. Athletes higher in reported growth showed greater association with meaningful behavioural actions, reflecting the modification of previously held beliefs into a new worldview. Athletes lower in reported growth reflected an attempt to maintain beliefs into an already existing worldview, thus hindering growth. The journey towards growth is a dynamic process, with the potential to result in an array of positive benefits if accompanied with appropriate psychological underpinnings. Practical implications to support the experience of growth in similar sporting environments are suggested, with specific reference to which psychological mechanisms important to enhance. This research offers ideas of pre-

stressor, proactive approaches to building psychological skills which may support individuals to better cope with future stressful experiences, and thus, help facilitate growth from their experience.

D2.S2.3(3) Helping soccer players help themselves: Effectiveness of a psychoeducational book in reducing perfectionism

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Both trait perfectionism and perfectionistic cognitions are associated with a range of negative outcomes such as anxiety, anger, and dejection in football players (e.g., Donachie, Hill, & Madigan, 2019; Journal of Sport and Exercise Psychology, 41(5), 309-319.). These are outcomes that if unchecked have a negative impact on wellbeing and performance. In regards to helping managing perfectionism, research outside of sport has shown psychoeducational or self-help books can be effective (e.g., Steele & Wade, 2008; Behaviour Research and Therapy, 46(12), 1316-1323). As a self-help intervention is non-invasive, accessible, inexpensive, low intensity, and easy to implement, it may be a good resource for football players who have busy schedules, usually managing training and competition commitments alongside personal commitments. The current study is the first to examine the effectiveness of a self-help book ("When Perfect Isn't Good Enough"; Antony & Swinson, 2009; New Harbinger Publications) in reducing perfectionism among in the context of sport. With institutional ethical approval, one hundred and fifteen soccer players (male = 44, female = 71, M age = 21.62 years, SD = 5.03) were randomly allocated using block randomization to a self-help intervention group (n = 55) or a control group (n = 60). Participants completed the Multidimensional Perfectionism Scale, Perfectionistic Cognitions Inventory-10, Attitudes Toward Seeking Professional Psychological Help-Short Form and Sport Emotion Questionnaire pre-intervention, post-intervention (8-weeks later) and at follow-up (5-weeks later). The intervention group were given the Cognitive Behavioural Therapy based self-help book and asked to read it independently and complete any tasks or activities in the book. The book is 280 pages in length and consists of 16 chapters and 53 exercises. It is comprised of four sections addressing the following topics: identifying perfectionism and the way it manifests; changing perfectionistic thoughts; changing perfectionistic behaviours; and strategies to manage perfectionism. A 2 (group) × 3 (time) factorial ANOVA revealed a significant group × time interaction for socially prescribed perfectionism, perfectionistic cognitions, and negative pre-competition emotions (anxiety, anger, and dejection). Post-intervention, moderate-to-large between-group differences were evident for perfectionistic cognitions and anxiety (d = 0.75 and 0.59). At follow-up, moderate-to-large between-group differences were evident for socially prescribed perfectionism, perfectionistic cognitions, and anxiety (d = 0.51, 1.15, and 0.70). As the self-help book was effective at reducing some aspects of perfectionism and negative pre-competition emotions, self-help books are therefore worth considering when developing strategies to support perfectionistic football players.

D2.S2.3(4) Contributing Factors to the Development of Shared Understanding within Football Teams

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Shared understanding is defined as two or more people thinking similarly in specific situations (Blickensderfer et al., [2010]. Journal of Applied Sport Psychology, 22, 486-499). Existing literature suggests that shared understanding can be developed by various factors including experience performing together, and effective methods of communication to enhance prediction of actions and team performance. The aim of the research was to establish contributing factors to the development of shared understanding within football teams. With ethical approval being granted, the below methodology was followed. A 17 question, semi-structured interview schedule was used to guide the discussion and was split into three separate sections, recorded with the participant's permission and transcribed afterwards. This included gathering demographic information, outlining the participant's relationship within their current team member(s) and sharing perspectives of how shared understanding develops and the influence on team performance. The participant's data then underwent a six-stage thematic analysis as outlined by Braun and Clarke (2006, Qualitative research in psychology, 3, 77-101), where similarities and differences were between the data were outlined, coded, categorized and compared to produce key themes between participants. Within the analysis, themes were also reviewed by the broader research team as part of a reflexive analysis process (Sparkes & Smith, [2014] Qualitative research methods in sport, exercise and health: From process to product). The results of the research highlighted different contributing factors which combine to develop shared understanding between team members. Participants suggested that a combination of experience performing together, possessing an effective relationship with team members and effective methods of communication between each other were fundamental to the development shared understanding. This combination of factors facilitated the accurate prediction of the actions of others, based on an effective shared mental model, leading to an effective team performance. Therefore, the combination of the above factors is fundamental to developing shared understanding between football teams, facilitating an effective team performance. The research provides support for the combination of the factors to develop shared understanding between team members in football and how they can positively impact team performance. Further research is required to determine if these factors are comparable across specific roles in the team, different team sports or different performance levels. It would also be beneficial to outline if there are other contributing factors to the development of shared understanding between football teams.

Day 2. Free Communications - Sport and Performance (Session 1)

D2.S2.1(4) The effect of cold-water swimming on driving performance

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Exposure to cold-water has detrimental effects on physiological (manual dexterity, muscle force generation) and psychological (cognitive) functioning that extends to the recovery period. At this stage, swimmers may drive their cars despite still presenting with cognitive and physical performance decrements. This study investigated the effect cold-water swimming has on subsequent driving performance. Three outdoor swimmers gave their written informed consent to participate in the ethically approved study and completed a 60-min self-paced wetsuited swim in a 15°C temperature controlled flume followed by a 60-min rewarm period in 15°C air. To assess car driving performance (speed and number of infractions) participants drove a car simulator four times, once before and three times after swimming (immediately, 30-min and 60-min afterwards). Rectal thermistors and gastrointestinal pills measured deep body temperature throughout. Thermal sensation and thermal comfort votes were collected and maximal voluntary grip strength (MVGS) was measured before each driving task. Eye movements were recorded during the driving tasks using a head mounted eye-tracker. There was no change in deep body temperature, whole body thermal comfort or thermal sensation following the swim. However, participants reported cold extremities 30-min post swim and MVGS was reduced by 6, 5 and 23% compared to pre-swim measurements. All participants showed an increase of 1 or 2 driving infractions post swim and one participant was unable to maintain the required speed. When driving 30-min post swim, this participant spent 53% of the drive time outside the speed zone compared to only 19% pre swim. Additionally, changes in gaze behaviour occurred with changes in driving performance post swim. For participants who controlled their speed there was an increase in the number of visual fixations towards the speedometer 30-min post swim (21%) compared to driving pre swim (5%). Despite no deep body cooling, participants reported having cold extremities with reduced MVGS, which may explain changes in muscle function and consequently the decrements in driving performance. Feelings of cold and discomfort may have also distracted participants from the driving task as suggested by the distraction hypothesis (Teichner, 1957, Journal of Applied Physiology 11(3):333–38). Coping with cold requires attentional resources. Participants' cold perception may result in less attentional resources to maintain driving performance (speed and infractions). Although limited in sample size, the results suggest that driving performance may be reduced after cold-water swimming and that it is potentially unsafe for a swimmer to drive within 60-min after exiting the water.

Day 2. Free Communications - Sport and Performance (Session 2)

D2.S4.2(1) Injury epidemiology in professional ballet: a five-season prospective study of 1596 medical attention injuries and 543 time-loss injuries

Mr Adam Mattiussi[1,2], Joseph Shaw[1,2], Sean Williams[3], Phil Price[2], Derrick Brown[4], Daniel Cohen[5,6], Richard Clark[1], Shane Kelly[1], Greg Retter[7], Charles Pedlar[2,8], Jamie Tallent[2]

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The aim of this study was to describe the incidence rate, severity, burden, and aetiology of medical attention and time-loss injuries across five consecutive seasons at a professional ballet company. Medical attention injuries, time-loss injuries, and dance exposure hours of 123 professional ballet dancers (female: n = 66, age: 28.0 ± 8.3 y; male: n = 57, age: 27.9 ± 8.5 y) were prospectively recorded between the 2015/16 and 2019/20 seasons. The incidence rate (per 1000 h) of medical attention injury was 3.9 (95% CI: 3.3–4.4) for women and 3.1 (95% CI: 2.6–3.5) for men. The incidence rate (per 1000 h) of time-loss injury was 1.2 (95% CI: 1.0–1.5) for women and 1.1 (95% CI: 0.9–1.3) for men. First Soloists and Principals experienced between 2.0–2.2 additional medical attention injuries per 1000 hours and 0.9–1.1 additional time-loss injuries per 1000 hours compared with Apprentices ($p \leq .025$). Further, intra-season differences were observed in medical attention, but not time-loss, injury incidence rates with the highest incidence rates in early (August and September) and late (June) season months. Thirty-five percent of time-loss injuries resulted in over 28 days of modified dance training. A greater percentage of time-loss injuries were classified as overuse (female: 50%; male: 51%) compared with traumatic (female: 40%; male: 41%). This is the first study to report the incidence rate of medical attention and time-loss injuries in professional ballet dancers. Incidence rates differed across company ranks and months, which may inform targeted injury prevention strategies.

D2.S4.2(2) Influence of scheduling on objective sleep metrics in professional U18 footballers: a longitudinal observational study

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Sleep duration and quality are widely thought to be a driver of physiological and psychological recovery and performance. Sleep is sensitive to behavioural factors, however, the full effect of competitive scheduling and the start time (the time players are scheduled to arrive at training/matches) is unknown. The purpose of this study was to assess the influence of scheduling on objective sleep quality in U18 professional footballers from a category one English academy. After ethical approval and informed consent, wrist-actigraphy data from 11 (age: 17.3 ± 0.7years) U18 professional footballers were collected over a 10-week in-season period. A total of 402 individual data points were collated by training day (TD, n=265), matchday (MD, n=33), MD-1 (n=52), and MD+1 (n=52). Data was further collated by start time. Differences between day type were analysed using a within-subject mixed linear model ANOVA and the influence of start time on objective sleep variables were assessed separately using a linear mixed model multiple regression. Sleep duration on MD+1 (mean ± SD) (410 ± 42 mins) was significantly less compared to all other days (TD: 433 ± 67, p=0.004; MD: 462 ± 84, p<0.001; MD-1: 435 ± 67, p=0.005). Time in bed after MD (577 ± 103) was significantly greater (p=0.012) compared to MD+1 (511 ± 98). Players sleep onset time on MD (00:33 ± 00:42) was significantly later compared to MD-1 (23:44 ± 00:38, p<0.001) and TD (00:00 ± 00:47, p<0.001). Compared to a 09:00 start, players achieved significantly greater sleep duration when start time was scheduled at 09:30 (Estimate, 95% CI) (31.74mins, 9.51 – 53.96, p=0.005), 10:00 (17.70mins, 2.72 – 32.67, p=0.021) and when no activity was scheduled (36.98mins, 18.09 – 55.86, p<0.001). This was primarily driven by significantly later wake times (p<0.05). There was no significant influence of day type or start time on sleep latency, wake after sleep onset, sleep quality, or sleep efficiency after the model was adjusted to account for within-subject variation (p>0.05). Both day type and start time appear to significantly modify sleep behaviour in U18 professional footballers. In part, this could be due to players electing to sleep earlier on MD-1, sleep later on MD, and wake later on MD+1, where no training/competition is scheduled. Results suggest that sleep duration can be maximised through scheduling, though it is not clear if this affects performance.

D2.S4.2(3) The structure of a professional ballet season: a five-year analysis of 121 dancers

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Excessive week-to-week progressions in dance exposure are an injury risk factor in professional ballet (Shaw et al., 2021, Medicine & Science in Sports & Exercise). However, periodizing rehearsal and performance schedules in professional ballet companies is difficult given the lack of longitudinal data published on the structure of a ballet season. The aim of this study was to explore the structure of a professional ballet season and identify factors which may influence dance exposure. With institutional ethical approval, scheduling data were collected from 121 dancers over five seasons at The Royal Ballet. Linear mixed effects models were used to evaluate differences in weekly exposure time and performance count across sexes, company ranks, and months. Random forest regression was used to investigate factors associated with the variation in rehearsal time for individual productions. Differences in weekly exposure time were observed between company ranks ($p < .001$); the largest exposure was seen in first artists (27.5 h·week^{-1}, 95% CI [26.5, 28.5]). The count of shows performed per season varied widely across company ranks ($p < .001$), ranging from 28, 95% CI [22, 35] in principals, to 113, 95% CI [108, 118] in artists. Performance congestion was observed in December, whereas total dance exposure peaked between January and April. Rehearsal durations were greatest in preparation for newly choreographed ballets, and for ballets which were longer in duration. Dancers creating roles in a new ballet completed considerably more rehearsal time than they would in an existing work. The rehearsal and performance schedules of professional ballet dancers vary widely across company ranks, timepoints in the season, and repertoire. This study provides a basis from which ballet companies may periodize their rehearsal and performance schedule.

D2.S4.2(4) Maturity status, not tempo influences training load and neuromuscular performance during an academy soccer season

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Traditionally, adolescent soccer teams are chronologically derived which may result in biologically diverse individuals exposed to the same training loads. Limited evidence exists surrounding age-related load prescription and the interaction of maturation (tempo and status) providing an important rationale for this study. Primary aims of this study were to establish how biological maturation impacts load perception and neuromuscular response within an Elite Player Performance Plan (EPPP) environment and, secondly to provide recommendations for practitioners for ongoing prescription. With ethical approval fifty-five male soccer players (age 14.5 ± 1.2 years; stature 172 ± 10 cm; body mass 59.8 ± 10 kg; 94.1 ± 1.8 % predicted adult height) were recruited form one EPPP academy and reported ratings of global (sRPE) and differential perceptions of exertion 15-min following training sessions across a season (40-weeks). Ratings of global (sRPE) and differential (RPE-B, breathlessness; RPE-L, leg muscle; RPE-T, technical/cognitive) perceptions of exertion were provided in arbitrary units (AU) for each training session using the CR-100® scale on a customised application. Neuromuscular performance was measured using countermovement jump (CMJ), reactive strength index (RSI), absolute (ABS) and relative leg (REL) stiffness at three specific timepoints across the season (i.e., start, middle and end). Perceived exertions and neuromuscular performance were examined using linear mixed modelling ($P < 0.05$), supplemented with non-clinical magnitude-based decisions (MBD) used to facilitate practical applications. Analysis indicates that every 5% increase in maturity status (not tempo) results in players rating overall session intensity 6.9 AU lower ($P = 0.002$). Additionally, maturity status (5% increase) substantially influences neuromuscular performance over the course of a season (CMJ, $P = = 0.001$; RSI, $P = 0.038$; ABS, $P = 0.043$). The big picture is, that less biologically advanced players report accumulated loads that far exceed more advanced counterparts (>40% over a 40-week season), despite experiencing the 'same' prescription, likely elevating their risk of non-functional overreaching, injury or possibly 'burnout'. This suggests the need for maturity-specific load prescription (e.g., bio-banding) within academy soccer which may prevent significant within age-group differences in accumulated load, possibly preventing injury and/or burnout around key developmental periods.

Day 2. Posters - Biomechanics and Motor Behaviour

D2.S3 Differences in vertical and braking ground reaction forces between common parkour vaulting techniques with running and precision style landings

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The emerging sport of parkour has developed a landing technique focused on soft, quiet and controlled landings. The performance characteristics of practitioners (traceurs) in two-legged drop landings are becoming increasingly established (Puddle, D. L., and Maulder, P. S., 2013, Journal of Sports Science and Medicine, 12, 122-129), but it is unknown whether the same characteristics will be demonstrated for different movements and with different landing techniques. Therefore, the purpose of this study was to investigate the ground reaction forces (GRFs) produced during three common parkour vaulting techniques utilising two common landing styles, with the aim of understanding how GRFs may change between the different scenarios and the subsequent implications for injury. Following ethical approval, 10 traceurs (age: 29.4 ± 7.18 years, height: 173.81 ± 8.05 cm, mass: 74.22 ± 8.35 kg, experience: 9.7 ± 3.62 years) performed a drop landing, step vault, dash vault, and kong vault onto a force plate with a two-foot precision landing (precision) and a single foot running landing (running). Vertical (vGRF) and braking (bGRF) GRFs per limb were analysed by repeated measures two-way ANOVA. A significant interaction effect between movement choice and landing style was found for both peak vGRF ($P = 0.01$) and peak bGRF ($P > 0.01$). All movements increased in vGRF when using a running landing. The kong vault was found to produce the greatest vGRF and bGRF of all movements in both landing styles, differing significantly from all other vault techniques. The dash vault produced the least vGRF and bGRF of all movements in both landing styles, differing significantly from the step and kong vaults with a running landing but not with a precision landing. The step vault was not found to significantly differ from a drop landing with either landing style. Movement and landing style choice affect landing GRFs for common parkour vaulting techniques. While GRFs increased in running style landings, they still did not exceed those typically experienced in jogging, indicating that traceurs mimic their performance in two-legged drop landings and continue to effectively mitigate landing forces when vaulting.

Day 2. Posters - Physiology and Nutrition

D2.S3 Energy availability, macronutrient intake & performance measures in elite female gaelic games players

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It has been established that male Gaelic games athletes consume inadequate calories and, in particular, insufficient carbohydrates (O'Brien et al. 2019, Sports, 7(3), 62). However, there is currently no research on dietary intake or energy availability (EA) in female Gaelic games athletes. Moreover, there is limited evidence regarding the effects of low energy availability (LEA) on performance, in all populations (Jurov et al. 2021, Journal of the International Society of Sports Nutrition, 18(1), 1-10). The aim of this study is to determine the EA status of elite female Gaelic games players and examine its effect on performance measures. With institutional ethics approval (17/HSES/03/), 56 female elite inter-county Gaelic games athletes (stature 1.65 ± 0.12cm; body mass 65.8 ± 9kg; age 25 ± 6years) completed 3-day (gym, rest and pitch day) food diaries with corresponding training logs within one week during the pre-season stage. Energy availability (EA) was defined as energy intake (EI) minus calories expended during exercise energy expenditure (EEE), adjusted for resting metabolic rate (RMR) and normalised to lean body mass (LBM) (Nativv, 2007, Medicine & Science in Sports & Exercise, 39, 1867-1882). EA= EI - EEE/(LBM), with a unit of kcals/ kg FFM

Resting metabolic rate (RMR) was estimated using the Cunningham equation. LBM was calculated using skinfold measurements. Counter movement jump height, 10m and 20m sprint times and the Yo-Yo Level 1 test were assessed during the same week. Carbohydrate intakes (3.25 ± 0.69g/kg) were below current guidelines for team sport athletes (6-10 g/kg) (Thomas, Erdman & Burke, 2016, Journal of the Academy of Nutrition and Dietetics, 116(3), 501–528) with protein and fat intake within the recommended ranges of 1.4-1.7g/kg (Tarnopolsky, 2010, Clinical Sports Nutrition, 3rd Edition. 90-123) and 0.5 – 1g/kg (Kerksick et al. 2018, Journal of the International Society of Sports Nutrition, 15(1), 1–57), respectively. Mean EA was 28 ± 5.2 kcal.kg LBM.day), with 71% of participants reporting LEA (<30 kcal.kg LBM.day). Significant correlations were found between energy availability and carbohydrate ($r = 0.744$; $P = 0.001$), protein ($r = 0.666$; $P = 0.001$); fat ($r = 0.761$; $P = 0.001$) intake. 20m sprint time had a significant relationship to EA ($r= 0.273$; $P < 0.05$). This sub-optimal dietary intake and risk of LEA may have negative implications on training and performance for female Gaelic games athletes. To minimise these issues, practitioners should consider individualised athletic nutritional support and education around EA.

D2.S3 "Every athlete has a weird relationship with food": A qualitative exploration of retired athletes' experiences with food across sport types

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Existing research has provided insight into the occurrence of disordered eating behaviours during athletic retirement. However, current qualitative research has repeatedly explored this finding within a limited selection of leanness-focused sport samples. Subsequently, little is known about the eating behaviours of retired athletes from non-leanness-focused sports (Buckley et al., 2019, Nutrients, 11, 1395). The aim of this study was to explore the experiences of both previously studied and under-studied sport types to expand upon the current understanding of eating patterns in athletic retirement. With institutional ethics approval, seven females and five males participated in semi-structured interviews representing seven sports. Leanness-focused sports: swimming (n = 4), cheerleading (n = 1), and gymnastics (n = 1). Non-leanness-focused sports: track sprinting (n = 2), tennis (n = 2), football (n = 1), and field hockey (n = 1). Braun and colleagues' (2016, Routledge Handbook of Qualitative Research in Sport and Exercise, pp. 191-205), six-phase model of thematic analysis was employed. The results were organised into three overarching themes, which represented the temporal trajectory of athletic eating: (a) pre-retirement eating, (b) transition eating, and (c) retirement eating. Within each overarching theme, several unique themes emerged. During pre-retirement eating, participants retrospectively described eating to perform, dichotomous food perceptions, and rigid eating environments. As participants transitioned into retirement, they recounted an average two-year period of recalibration, increased food awareness, and challenges adapting to eating outside of the sport environment. As current retired athletes, participants noted a more relaxed eating environment and progressive journeys with food; however, strategic eating habits persisted. Consistent with previous research, body image concerns and disordered eating behaviours such as restrictive dieting, specific food avoidance, and overcompensation through exercise were identified throughout the transition out of sport and into retirement. Notably, these behaviours were documented in participants from both leanness-focused and non-leanness-focused sport types. Thus, the results provide novel contributions regarding how post-retirement eating behaviours are conceptualised across various sports and highlight the occurrence of disordered eating behaviours and body image issues irrespective of a sport's emphasis on leanness. Furthermore, consideration should be given to when athlete duty of care ends. From a multidisciplinary team approach, sport

psychologists and nutritionists can play an important role in supporting retiring athletes as they adapt to physique changes and new eating patterns. Specifically, nutrition education and psychological support should be extended to help facilitate healthy relationships with food among athletes as they transition out of sport.

D2.S3 The Effects of Compression Tights and Socks on Muscle Oxygenation

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Compression garments and their influence on muscle oxygenation remains unclear due to poor garment fitting and assessment methods. The aim of this study was to assess the effects of compression socks and tights on muscle oxygenation during a variety of recovery based activities. Ethical approval was granted via Nottingham Trent University Ethics Committee. Sixteen healthy males, (mean ± SD: age 23.5±2.9 years, body mass 85.1±10.4 kg) completed 3 experimental trials in a randomised order: control; compression socks; and compression tights. During each trial participants completed 20 minutes each of laying supine, sitting, walking (4km.h-1), recovery jogging and sitting activities. Bespoke garments were manufactured for each individual based on their specific leg geometry. A Near-Infrared Spectroscopy (NIRS) device was attached to the right gastrocnemius and vastus lateralis and measured muscle oxygenation, deoxygenation and Tissue Saturation Index (TSI %) responses. Muscle oxygenation and deoxygenation are expressed as % of the baseline, and the baseline was set at 100%. Compression was assessed using a Kikuhime pressure monitor across 6 landmarks across the limb. A one-way ANOVA was used to determine any differences in TSI, oxygenation and deoxygenation for each activity in each trial (SPSS version 24). Data are presented as mean ± SD. Pressure exerted by the compression garments was highest at the gastrocnemius (socks:20.2±6.3; tights: 12.1±5.3; mmHg). TSI at the gastrocnemius was lower when wearing compression garments compared with control. Specifically, during supine, sitting and walking activities, compression socks and tights reduced TSI (all $P<0.001$; Walking: control: 77.0±5.8; socks: 69.9±5.4; tights: 71.1±6.8; %). TSI at the vastus lateralis was not different between trials. At the gastrocnemius, muscle oxygenation was greater during the supine activity with compression ($P<0.001$; Supine: control: 90.7±19.8; socks: 103.6±19.2; tights: 101.9±24.4; %). However, muscle oxygenation was not different during the sitting activity. At the vastus lateralis, during the supine and sitting activities, muscle oxygenation was greatest when wearing compression tights ($P<0.01$), whereas during walking and jogging muscle oxygenation was lowest when wearing compression socks ($P<0.05$; walking: control 114.2 ±19.9; socks: 103.7±16.2; tights: 108.5±34.5; %). In conclusion, oxygenated haemoglobin as indicated by TSI is lower at the gastrocnemius when wearing compression garments, perhaps suggesting a greater utilisation of oxygen. Oxy-haemoglobin concentrations at the capillary level differ depending upon the type of activity and the type of compression garment worn. Initial findings suggest further research is warranted to determine how compression pressures and garment types alter muscle oxygenation.

D2.S3 Engagement in familiarisation sessions of the 15-m multi-stage fitness test on estimated maximal oxygen consumption scores in professional policing students

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The introduction of the professional policing undergraduate degree was introduced in 2019 which aims to standardise entry to the police for new recruit's aswell as to allow serving officers to gain accreditation from previous experience and training (Williams et al., 2019, Police Practice and Research, 20, 259-272). For professional policing university students to join the special constabulary, they must achieve a level 5.4 on the 15-m multi-stage fitness test (MSFT) equivalent to a maximal oxygen consumption (VO_2max) of 35ml·kg^{-1}·min^{-1} as part of the personal safety training (PST) entry process (Morris et al., 2019, Occupational Medicine, 69, 133-138). However, opportunities for students to develop familiarity of the 15-m MSFT to help support them successfully through the PST is lacking in the curriculum of the professional policing degree. Therefore, the aim of this study was to evaluate if participation and engagement in familiarisation sessions of the 15-m MSFT resulted in higher estimated VO_2max levels. Following institutional ethical approval, 28 students, 16 female and 12 male (mean age: 20.2 ± 3.6 years; stature: 1.7 ± 0 m; body mass: 69.9 ± 15.9 kg; body mass index (BMI): 24.6 ± 4.9 kg/m^2 were recruited to the study. Students were provided with 3 familiarisation sessions of the 15-m MSFT each separated by a 16-week period prior to the PST entry process. Estimated VO_2max levels and 15-m MSFT levels were calculated. Attendance rates reached 86%, 61% and 32% for the first, second and third familiarisation sessions respectively. Just 29% attended all three sessions. There was no difference in estimated VO_2max and 15-m MSFT levels for all students between the three familiarisation sessions with the average estimated VO_2max of the group being 37.8 ± 8.4 ml·kg^{-1}·min^{-1} range (26.5 – 52.1 ml·kg^{-1}·min^{-1}). The 29% of students that attended all three sessions had an estimated VO2max of 41.2 ± 7.8 ml·kg^{-1}·min^{-1} range (32.7 – 52.1 ml·kg^{-1}·min^{-1}) which was higher than those who only attended one session ($P = 0.034$). A moderate correlation was identified between session engagement and estimated VO_2max scores ($r = 0.4$, $P = 0.22$). Only 46% of students have passed their PST and 21% have yet to engage in the PST process. Engagement in the sessions declined over time and no improvements in VO_2max were observed thus, further research is needed to a) explore why students may not want to engage fully and b) explore other means of improving VO_2max in students entering the special constabulary.

D2.S3 Musculoskeletal health in active ambulatory men with cerebral palsy and the impact of vitamin D

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Individuals with Cerebral Palsy (CP) show impairments in muscle strength and power. Impairments in strength, in controls low levels of force production and poor bone health are associated with low levels of vitamin D prevalence. It is possible that the severity of musculoskeletal impairments in individuals with CP is exacerbated by living in northern latitudes such as the UK.

A cross-sectional comparison study conducted according to the guidelines of the Declaration of Helsinki, where 24 active, ambulant men with CP aged 21.0 ± 1.4 years (Gross Motor Function Classification Score (I–II) and 24 healthy controls aged 25.3 ± 3.1 years completed in vivo assessment of musculoskeletal health, including:, vastus lateralis anatomical cross-sectional area (VL ACSA), isometric knee extension maximal voluntary contraction (KE iMVC), 10 m sprint, vertical jumps (VJ), and radius and tibia bone ultrasound (US) Tus and Zus scores to assess bone dimensions. Assessments of body mass and body fat (BF)% was used to determine lean body mass (LBM),vitamin D status was measured through venous samples of serum 25-hydroxyvitamin D (25(OH)D) and parathyroid hormone, dietary vitamin D intake from food diary, and total sun exposure via questionnaire were also taken.

The results showed that men with CP had 40.5% weaker KE iMVC, 23.7% smaller VL ACSA, 22.2% lower VJ, 14.6% lower KE iMVC/VL ACSA ratio, 22.4% lower KE iMVC/body mass (BM) ratio, and 25.1% lower KE iMVC/LBM ratio (all $p < 0.05$). There were no differences in hand grip strength or 10 m sprint time between CP and controls. Radius Tus and Zus scores were 1.75 and 1.57 standard deviations lower than controls, respectively ($p < 0.05$), whereas neither tibia Tus nor Zus scores showed any difference compared to controls ($p > 0.05$). The 25(OH)D was not different between groups, and 90.9% of men with CP and 91.7% of controls had low 25(OH)D levels when compared to current UK recommendations. The 25(OH)D was positively associated with KE iMVC/LBM ratio in men with CP ($r = 0.500$, $p = 0.020$) but not in controls ($r = 0.281$, $p = 0.104$).

Overall this study shows that musculoskeletal outcomes in men with CP were lower than controls, and despite there being no difference in levels of 25(OH)D between the groups, 25 (OH) D was associated with strength (KE iMVC/LBM) in the CP group but not controls. The findings suggest that vitamin D deficiency can accentuate some of the condition-specific impairments to musculoskeletal out-comes.

D2.S3 Barriers and enablers in young male soccer players' adherence to nutritional guidance: player, coach and sport nutritionist perspectives

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Nutritional intake is particularly important for young soccer players (Smith, Holmes and McAllister, 2015). However, adolescent professional soccer players have inadequate dietary practices to sustain the demands of training and competition (Russell & Pennock, 2011; Briggs et al., 2015; Granja et al., 2017). Little is known about soccer players' barriers and enablers to adhering to nutritional guidance. Therefore, the aim of this study was to investigate players', sports nutritionists' and coaches' perspectives of the barriers and enablers to adhering to nutritional guidance within a professional soccer club.

Following institutional ethical approval, individual interviews were conducted with 13 players (18 ± 1.3 years), 12 sports nutritionists, and 10 coaches from 12 professional soccer clubs. The Capability, Opportunity, Motivation – Behaviour (COM-B) model and the Theoretical Domains Framework (TDF) were applied to explore the barriers and enablers to nutritional adherence. Thematic analysis was used to interpret the data, and themes were mapped to the COM-B and TDF. Seven key themes were generated relating to the players' barriers and enablers to nutritional adherence: (1) Capability: (a) Nutritional Knowledge; (b) Cooking Skills; (2) Opportunity: (c) Training Venue Food Provision; (d) Nutritionist Accessibility and Approachability; (e) Living Status: (3) Motivation: (f) Performance Implications; and (g) Role Modelling. Good sports nutrition knowledge enables players to make the right food choices and be more independent. Educating players from a young age was highlighted as key. Possessing cooking skills enabled players to adhere to nutritional recommendations, however limited cooking skills was highlighted as a barrier. The food provided by the club was perceived to be an enabler to nutritional adherence, as it was "easy" for players. However, inadequate food provision i.e. no food provision, or limited portion size/food choices, were viewed as a barrier. A supportive, approachable, accessible sports nutritionist who is embedded within the training environment positively influences players' nutritional intake. Insufficient time spent between the player and sports nutritionist was a barrier. Full-time sports nutritionist roles were perceived as more effective. Players food provision outside the club was both an enabler and barrier, some expressed living with parents/ host families made it easier, others expressed having limited freedom of choice and independence, therefore preferring to live independently. The positive impact of a good diet on performance, and role models within the sport motivates players. Soccer clubs and sports nutritionists should develop sound, theory-driven nutrition programmes that target the behaviours of players which influence nutritional intake.

D2.S3 The effects of sodium bicarbonate supplementation at individual time to peak bicarbonate on 4-km cycling time trial performance in the heat

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The use of sodium bicarbonate supplementation has largely been untested in conditions of high ambient heat despite the known ergogenic effects it can provide, albeit in thermoneutral conditions. The purpose of this study therefore, was to explore the effect of individualised sodium bicarbonate ($NaHCO_3$) supplementation according to a pre-established time-to-peak blood bicarbonate (HCO_{3-}) on 4-km cycling time trial (TT) performance in the heat. Following ethical approval from the institution (Gough/3647/Mod/2019/Sep /HELSFAEC), eleven recreationally trained male cyclists (age: 28 ± 6 years, height: 180 ± 6 cm, body mass: 80.5 ± 8.4 kg) volunteered for this study in a randomised, crossover, triple-blind, placebo-controlled design. An initial visit was conducted to determine time to peak (TTP) HCO_{3-} following 0.2 $g.kg^{-1}$ body mass (BM) $NaHCO_3$ ingestion. Subsequently, on three separate occasions, participants completed a 4-km cycling TT in the heat (30 degrees centigrade; °C; relative humidity ~40%) following ingestion of either $NaHCO_3$ (0.2 $g.kg^{-1}$ body mass), a sodium chloride placebo (0.2 $g.kg^{-1}$ BM; PLA) or no supplementation (control; CON) at the predetermined individual TTP HCO_{3-} in vegetarian capsules. Statistical analysis was conducted using either one or two-way repeated measures ANOVA, with confidence intervals stated. Hedges' g (g) effect sizes were also calculated and interpreted using Cohen D thresholds. Absolute peak [HCO_{3-}] prior to the 4-km cycling TT's was elevated for $NaHCO_3$ compared to PLA (+2.8 $mmol.l^{-1}$; $p = 0.002$; $g = 2.2$) and CON (+2.5 $mmol.l^{-1}$; $p < 0.001$; $g = 2.1$). Completion time following $NaHCO_3$ was 5.6 ± 3.2 s faster than PLA (1.6%; CI: 2.8, 8.3; $p = 0.001$; $g = 0.2$) and 4.7 ± 2.8 s faster than CON (1.3%; CI: 2.3, 7.1; $p = 0.001$; $g = 0.2$). These results demonstrate that $NaHCO_3$ ingestion at a pre-established individual TTP HCO_{3-} improves 4-km cycling TT performance in the heat, likely through enhancing buffering capacity.

D2.S3 The effect of a European alpine trek on human energy intake, expenditure and body composition

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Backpacking as a self-sufficient recreational activity can be associated with high daily energy expenditures (Hill et al. 2008, Int. J. Sports Med., 29: 883-887). A more popular activity, hut-to-hut trekking, which negates carrying a tent, sleeping bag and cooking equipment, is enjoyed by many, particularly during the summer months, - although relatively little is known about its energy cost and any associated physiological change. Therefore the aim of the present study was to investigate the effect of a six day alpine trek on energy intake (EI), energy expenditure (EE) and body composition. Between 2008 and 2019 University undergraduates (men, n=134; women n=124) participated in Le Tour du Mont Blanc (~160km) as part of an optional module, which had received approval from the Faculty Ethics Committee. Body mass and %body fat was measured using a segmental body composition analyzer (Tanita, BC-418) before and after the trek. Walking (exercise) heart rate was measured using heart rate telemetry (Polar M400). The individual relationship between heart rate and oxygen uptake (as a proxy measure of energy expenditure) was individually established under standard laboratory conditions. Energy intake was assessed by daily diary records (4-days, 'normal university activity', acting as a control, and 6-days, 'trekking activity'). The raw data for which was analyzed for EI using Nutritcs software upon return to university. The average heart rate for each day was used to estimate walking (exercise) energy expenditure. Differences in body mass and composition (pre- vs. post-trek) were assessed using a paired t-test. During the six days of the trek any difference between energy expenditure and intake was assessed using a 2-way ANOVA with post-hoc Student's t-test. During the trek EI increased significantly above control levels in both men (31.2%) and women (28.3%) ($P<0.001$). Body mass was lower, men 78.7 ± 11.3 vs. 77.6 ± 10.9 and women 63.5 ± 10.3 vs. 62.6 ± 9.5 kg pre- versus post-trek respectively ($P<0.001$). There was also a significant lowering in body fat 14.3 ± 5.1 vs. 12.9 ± 4.8%, men and 26.5 ± 7.0 vs. 25.5 ± 6.7%, women ($P<0.001$). There was a significant main effect for sex with men expending significantly more energy 14.80 ± 0.78 compared with women, 11.83 ± 0.68 MJ during trekking ($P<0.001$). An alpine trek resulted in elevated rates of EI, a significant decrease in body mass and lowered %body fat which was associated with an overall slight negative energy balance.

D2.S3 Physiological characteristics of event riders during the cross-country phase of an affiliated one day event competition

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Cross-country is the most physically demanding phase of the Equestrian discipline of Eventing. Competition levels are classified by fence height (e.g., BE80 is 80cm), technicality and course length. Athletes are required to assume a squat position over the saddle for up to 12 minutes of gallop whilst navigating fixed rustic jumping obstacles. Isometric muscle contractions help stabilise an athlete's body in this position, which in-turn increases metabolic turnover. As exercise duration increases, epidemiological research has shown that injuries are more likely to occur with causation attributed to fatigue (Singer et al., 2003, Equine Veterinary Journal, 35, 139-145). Despite this, little is known about the physiological responses of equestrian athletes during cross-country. Therefore, this descriptive study had two aims. Firstly, to characterise the physiological characteristics of event riders during the cross-country phase of

an affiliated One Day Event (ODE) competition and secondly, to investigate if competition level affected the physiological response of event riders. With institution ethics approval (R19-P089), twenty-four event riders (Mean ± SD age, 28 ± 6 years; stature, 171.1 ± 11.2 cm; body mass, 64.5 ± 9.5 kg) volunteered to participate. In-field data collection took place over two competition dates. Global Positioning System Heart Rate (HR) monitors were fitted to the riders prior to their cross-country round to measure HR (beats.min-1) and speed (km.hr-1), with an immediately pre- and post-competition blood lactate (mmoL.L-1) and Rate of Perceived Exertion (RPE) value recorded. For statistical analysis subjects were separated into three equal competition classification groupings of similar ability (n = 8) BE80 and BE90 (Group 1), BE100 (Group 2) and BE105 and Novice (Group 3) to allow comparison between competition levels. The results showed no difference when comparing competition level (all, $P > 0.05$) suggesting that, irrespective of increasing competition demands across the groups (course length, fence height and number of fences), physiological responses of the event riders did not alter. However, HR was significantly different when analysed at common fence points over the duration of the course (fence 1, 166; fence 2, 183; fence 16, 185 beats.min-1, respectively) ($P < 0.05$), additionally, RPE (8 vs. 13, respectively) and blood lactate (3.14 vs. 5.32 mmoL.L-1, respectively), were all significantly different over time irrespective of competition grouping ($P < 0.05$). In conclusion, this unique descriptive study achieved both aims by characterising the physiological responses of event riders during the cross-country phase of an ODE competition.

Day 3. Free Communications – Physical Activity for Health

D3.S2.1(2) Physical activity and sitting time changes in response to COVID-19 home confinement in England

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England imposed a first national lockdown in March 2020 confining people to their homes in an attempt to reduce COVID-19 transmission. The aim of this study was to evaluate the effects of this lockdown on physical activity and sitting time. With institutional ethical approval, cross-sectional data were collected from 818 adults aged 46 ± 13 years (n=641 females) who responded to an online survey between 29 April and 13 May 2020. The International Physical Activity Questionnaire (IPAQ) Short Form was used for participants to self-report physical activity and sitting time during a typical week before and during the lockdown. Metabolic equivalent minutes per week (MET-min/week) were calculated and participants were classified as engaging in low, moderate or high physical activity according to IPAQ scoring guidelines. Participants were also grouped into low (< 8 hours/day) and high (≥ 8 hours/day) sitting time. Paired samples t-tests compared walking, moderate-intensity, vigorous-intensity and total physical activity MET-min/week before and during lockdown. Chi-squared tests were used to explore differences in the proportion of participants engaging in low, moderate and high physical activity, and high and low sitting before and during lockdown. Walking and total physical activity significantly increased during lockdown by 241 (95% confidence interval: 176, 304) MET-min/week and 302 (155, 457) MET-min/week, respectively ($P < 0.001$). Moderate (16 [-34, 63] MET-min/week, $P = 0.50$) and vigorous physical activity (44 [-49, 139] MET-min/week, $P = 0.35$) during lockdown was not significantly different compared with before lockdown. The proportion of participants in the low (n = 205 and 170), moderate (n = 329 and 335) and high (n = 256 and 285) physical activity categories differed significantly before and during lockdown, respectively ($P < 0.001$). The proportion of participants engaging in high and low sitting on a week day was significantly different during lockdown compared with before ($P < 0.001$); 73% self-reported low sitting both before and during lockdown, whereas 10% reported high sitting at both time points. Fifteen percent changed from low sitting before lockdown to high sitting during lockdown, whereas 2% changed from high sitting to low sitting. These findings suggest that physical activity in England increased as a result of the first COVID-19 lockdown. However, there was a simultaneous increase in sitting time. Intervention strategies to mitigate increases in sitting are needed during situations where people are confined to their homes.

D3.S2.1(3) Identifying Motor Competence Based Profiles in Children: Differences in Physical Activity, and Motivation Towards Physical Activity

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Actual (AMC) and perceived motor competence (PMC) are facilitating mechanisms for physical activity (PA) (Robinson, et al., 2015, Sports Medicine, 45, 1273-1284). Despite the positive association shown between these two constructs, the variation in the strength of the relationship ranges from low to moderate (De Meester, et al., 2020, Sports Medicine, 50, 2001-2049). However, the current research base fails to provide an accurate insight into how different AMC and PMC levels may be combined at an individual level. Therefore, the present study used a person-centred approach to develop motor competence profiles in children and investigated differences in PA behaviour and motivation towards PA between profiles. Following institutional ethics approval two hundred and sixteen British children (7-10 years) took part in this study. AMC was assessed using both process measure, through the Test of Gross Motor Development-2 and -3 (Ulrich, 2000, Test of Gross Motor Development. TX: Pro-Ed) and a product measure through a composite z-score comprising of standing long jump, seated 1kg medicine ball throw and 10-m sprint distance. PMC was evaluated using The Pictorial Scale of Perceived Movement Skills Competence (Barnett, et al., 2015, Journal of Physical Activity and Health, 12, 1045-1051) and motivation towards PA was evaluated using the Behavioural Regulations in Exercise Questionnaire (BREQ) for children (Sebire, et al., 2013, International Journal of Behavioral Nutrition and Physical Activity, 10, 1–9). PA data was collected using accelerometers (ActiGraph-wGT3X, USA). K-means cluster analysis was used to create profiles. Differences in motivation towards PA and PA behaviour were examined using multiple ANCOVAs. Results identified four groups of divergent levels and four groups of convergent levels based on the contribution of either product or process AMC with PMC. Motivation towards PA only differed by profiles that included process and PMC ($p = 0.012$). Children with high actual-process and high PMC had significantly higher levels of autonomous motivation than children with high actual-process but low PMC ($p = 0.009$). No significant differences were found between PA behaviour and profiles ($p = 0.05$). Overall, findings suggest the quality and execution of AMC is key to stimulate motivation towards PA, compared to the outcome of AMC. Furthermore, given that there were no significant differences in PA behaviour at this given time point, this may suggest the effects of AMC and PMC on PA take time to develop. Advocating the development and maintenance of both AMC and PMC is imperative to children's future PA behaviour.

Day 3. Free Communications – Psychology (Session 1)

D2.S2.1(3) The effect of manipulating visual input on perceptions of speed and effort: an online study with implications for exercise interventions

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Episodes of breathlessness ('dyspnoea') are one of the causes of exercise intolerance. The degree of exertional dyspnoea is partly dependent on the underlying pathophysiology, but current opinion considers that it arises from the integration of sensory inputs and prior expectations. There is potential for new therapeutic measures if perceptions can be manipulated using visual input. This study aimed to investigate whether perception of speed and effort can be manipulated using uphill slopes on screen-based stimuli across two experiments. The sample size was calculated using a moderate effect size (f = 0.25), alpha of 0.05, power of 0.95, and moderate correlation among repeated measures (0.3), resulting in a required sample size of 60 participants for each experiment. With institutional ethical approval, participants were recruited via an online recruitment tool (Prolific) and were linked to the online experiment on Gorilla. The task consisted of stimuli developed in Unity 3D where a cart travelled along a straight track with three check points. In experiment one participants viewed trials in three conditions, a flat track, and two where the cart travelled flat first and then uphill on different inclines. All conditions showed a track of the same length and the cart travelling at the same speed (despite going uphill). In experiment two 60 different participants viewed the uphill slopes from experiment one following a new condition where the cart did slow down. Participants were required to press the space bar at the exact moment they passed a check point (to create a temporal error score), completed NASATLX to investigate effort perceptions, and ranked the order of the cart speed across conditions. In experiment one there was no effect of condition on temporal error or NASATLX scores, but uphill slopes were ranked as slower ($\chi^2 = 28.57$; $p < 0.05$). In experiment two there was an effect of condition on error score ($p < 0.05$; $\eta p^2 = 0.98$), post-hoc analysis revealed differences between all conditions ($p < 0.05$). The first condition viewed after the cart slowing was ranked significantly faster than the third condition despite displaying the same speed ($\chi^2 = 17.40$; $p < 0.05$). Results show that it was possible to influence perceptions by manipulating slope and expectations of speed using a simple 2D task. These preliminary findings have implications for developing therapeutic interventions to minimise dyspnoea and exercise intolerance and suggest investigations utilising immersive stimuli with exercise protocols are warranted.

Day 3. Free Communications – Psychology (Session 2)

D3.S2.3(1) Assessing the motivational climates of year 1 physical education curricula underpinned by motor learning theory: SAMPLE-PE

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Traditionally, Physical Education (PE) has adopted a multi-skills approach, where children generally engage in de-contextualised practice of sport techniques to develop specific movement skills and facilitate sports participation. This emphasis on sport technique in PE has been critiqued for a weak conceptual and philosophical justification, and empirical proof of its educational value, and for showing variable effects on motivational climates. The SAMPLE-PE research project set out to change this by creating two PE curricula distinguished by contrasting theories of motor learning: information processing theory and ecological dynamics. While both approaches have shown promise in enhancing children's motor skills, to date there has been little consideration of their impact on motivational climate of primary PE lessons. The aim of this study was to explore to what extent traditional PE (atheoretical), ecological dynamics and information processing theory-based approaches create empowering and disempowering motivational climates when viewed through a self-determination and achievement goal theory lens. This study was approved by the institutional research ethics committee (Reference 17/SPS/031). Forty-four PE lessons were video recorded and coded by two trained researchers using the Multidimensional Motivational Climate Observation System. MANOVA and Bonferroni post-hoc tests were run to explore differences in motivational climate under the three different pedagogical approaches. The group taught with concepts in ecological dynamics displayed a significantly lower disempowering motivational climate in comparison to the group taught with a basis in information processing theory and the traditional PE groups. The ecological group revealed significantly more autonomy support than the traditional PE and the IPT group. The IPT group methods provided significantly more structure than traditional PE and the ecological group. The findings of this study have shown how the approach taken in delivering PE in primary schools may differentially affect empowering and disempowering motivational climates. Results imply that underpinning PE with theories of motor learning is a viable and beneficial alternative to obtain focused outcomes, compared to traditional PE practices.

D3.S2.3(2) From World Champion to long-term injury and chronic illness: an Autoethnography of an international duathlete's journey

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Numerous psychosocial risk factors of sport injury have been identified in the literature (Pensgaard et al., 2018, BJM Open Sport & Exercise Medicine, 4, 1-7), including non-sport-related stressful life events and strong stress responsivity. However, a more holistic approach is needed to better understand the relationship between stress, injury and life experiences such as illness. Furthermore, the relationship between psychosocial risk factors of sport injury and return to sport outcomes requires further investigation. The purpose of this study is to explore the perceived impact of psychosocial risk factors, and their influence on the onset of, of coping with, and returning to sport from injury and illness. This paper meets the recent calls for more autoethnographic accounts of injury within the sport psychology literature (McGannon et al., 2021, International Journal of Sport and Exercise Psychology, 19, 359-379), and provides richly textured and nuanced insights into the author's lived experiences and emotions, situated within a wider cultural context. Following institutional ethical approval, highly personalised, first-person written accounts of a 28-year-old female, international age-group duathlete's life experiences including overuse injury and onset of panic disorder, connecting the personal to the cultural, were recorded. These accounts were narratively analysed using holistic-form structural analysis, focusing on the formal plot and organisation of the story and embracing the complexity and ambiguity of experience. Narrative indwelling precedes identification of narrative types, on which a typology is built, and is followed by interpretation (Smith, 2019, In B. Smith., & A. C. Sparkes (Eds.) Routledge Handbook of Qualitative Research in Sport and Exercise (pp. 260-273). Abingdon, Oxon: Routledge). Ruminations of positional reflexivity increase the rigour of the author's interpretations. Findings identified loss of non-sport-related social support, high athletic identity, and strong stress responsivity as interconnecting psychosocial risk factors of overuse injury and illness. Self-presentational concerns combined with fear of re-injury and perceived recurrence of psychophysiological symptoms of panic disorder, inhibit progress on return to competitive sport. To conclude, athletes' non-sport-related life stress and strong stress responsivity, combined with personality

characteristics influence the occurrence of sport injury and illness, their ability to cope with injury and illness, and self-presentational concerns and recurring symptoms of panic disorder on their return to sport. Thus, it is beneficial for an athlete's social support network to be aware of life stressors outside of sport that influence the occurrence and recovery from sport injury and illness. From a coaching perspective, a holistic approach is advantageous.

Day 3. Free Communications – Sport and Performance

D3.S2.2(1) The reliability and sensitivity of the sub-maximal Yo-Yo Intermittent Recovery (Level 1) test in professional soccer players during a 6-week pre-season

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Physiological testing within soccer provides information about the players, which can subsequently allow coaches to prescribe and monitor training sessions. Additionally, the information gained from physiological testing allows for the evaluation of a players' physical performance (Bradley et al., 2011, European Journal of Applied Physiology, 111, 969-978). The Yo-Yo Intermittent Recovery – Level 1 (IR1) test is frequently used within professional soccer; however, it's exhaustive nature often limits the frequency of testing and the implementation of test results to coaching sessions. In replacement, it is suggested the sub-maximal 6-min Yo-Yo IR1 (Yo-Yo IR1sub) is more appropriate for routine testing, with much less impact on coaching planning and delivery (Bangsbo et al., 2008, Journal of Sports Medicine, 38, 37-51). Before test results can be used by practitioners with confidence, a testing protocol must demonstrate both reliability and sensitivity to change (Hopkins, 2000, Sports Medicine, 30, 1-15). Therefore, this study aimed to determine the reliability and sensitivity of percentage average HR (%Avg. HR) and percentage heart rate max (%HRmax) when undertaking the Yo-Yo IR1sub across a 6-week soccer pre-season. Following institutional ethics approval, fifteen professional male soccer players completed three Yo-Yo IR1sub tests within the first week of pre-season, and one at the beginning of each subsequent week for a total of six weeks. The results of the study suggest that the Yo-Yo IR1sub is reliable for %Avg. HR and %HRmax, with a coefficient of variation of 3.6% and 1.6%, a smallest worthwhile change of 2.1% and 1.6%, and an intraclass correlation coefficient of 0.66 and 0.76, respectively. It is also suggested that both %Avg. HR and %HRmax are sensitive to change during a soccer pre-season, with significant reductions of 9.8% (82 ± 3 vs. 74 ± 4 b·min^{-1}) and 8.8% (91 ± 4 vs. 83 ± 3 b·min^{-1}) ($P < 0.05$), respectively, observed between weeks 1 and 6. In conclusion, these results suggest that sports scientists and coaches evaluating soccer player's levels of aerobic fitness via non-exhaustive procedures can do so using the Yo-Yo IR1sub without any adverse effects on a coach's training session.

D3.S2.2(2) The relationships between external and internal training loads in mixed martial arts

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Effective athlete preparation requires knowledge of the relationship between internal and external training loads (Meeusen et al., 2013, Medicine & Science in Sports & Exercise, 45). This relationship has not previously been described in the multi-discipline combat sport of mixed martial arts (MMA). Therefore, with institutional ethical approval, the training of 20 MMA athletes (age=23.3±5.3, mass=72.1±7.2kg, stature=171.5 ±8.4cm) was observed for two consecutive weeks without intervention. Rating of perceived exertion (RPE, Foster 0-10 scale) and duration were recorded for every training session overall and each of the following training categories when used within sessions: warm up; striking drills; wrestling drills; Brazilian jiujitsu (BJJ) drills; striking sparring; wrestling sparring; BJJ sparring; MMA sparring (Kirk et al., 2021, PLOS One, dx.doi.org/10.1371/journal.pone.0251266). Internal load in arbitrary units (AU) was calculated using sessional RPE (sRPE) for the session overall (Foster et al., 2001, Journal of Strength and Conditioning Research, 15:1) and segmented RPE (segRPE) for each category trained (Haile et al., 2016, Perceived Exertion Laboratory Manual, Springer). External load was measured via Catapult Optimeye S5 accelerometers (Catapult Innovations, Australia) worn on the T3-4 vertebrae for the full duration of each session to record Playerload (PLdACC) in AU (Hurst et al., 2014, Journal of Athletic Enhancement, 5:2). Predictive relationships between internal and external load variables were calculated using Bayesian linear regression (Bayes factor [BF10] ≥ 3) (Wetzels & Wagenmakers, 2012, Psychonomic Bulletin and Review 19:6) using JASP 0.14.1 (JASP Team, Netherlands). Session overall mean sRPE = 448.6±191.1 AU, with mean PLdACC = 310.6±112 AU. Category segRPE range = 33.8±22.6 AU (warm-up) – 122.8±54.6 AU (BJJ drills). Category PLdACC range = 44±36.3 AU (warm up) – 125±58.8 AU (MMA sparring). Regression relationships between internal and external loads: R2 range = .50 - .77 (BF10 range = 4,389 - 7.324e+11), except for warm up (R2=.17, BF10=18), BJJ drills (R2=.27, BF10=7), BJJ sparring (R2=.49, BF10=4,982) and session overall (R2=.13, BF10=67). Most MMA training categories displayed strong predictive relationships between PLdACC and segRPE. BJJ categories displayed moderate only relationships, potentially due to opponent mass bearing and isometric actions not being measured by PLdACC. Relationships for the session overall were small, potentially due to periods of rest and coaching discussions not contributing to external load as measured by PLdACC but still affecting RPE. The strong relationships presented support the in-field use of accelerometry in monitoring external load of MMA training sessions to better manage the training-recovery-adaptation cycle in this population.

D3.S2.2(3) Somatic maturation and performance during parallel back-squat repeated power ability test

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The repeated power ability (RPA) is a suitable method to assess power abilities of basketball athletes (Gonzalo-Skok, Tous-Fajardo, Arjol-Serrano, and Mendez-Villanueva, 2014, Journal of Strength and Conditioning Research, 28(1):126–33) however, the relationship between performance during RPA test and biological maturation need more studies. We aim to examine the relationship between mechanical, cardio-respiratory, and perceptual variables assessed during RPA, and biological maturation. With institutional ethics approval, 16 young male basketball players (chronological age range = 13-17 y) performed the parallel back squat RPA test (3 blocks of 5 sets of 5 repetitions with 30 seconds of passive recovery within sets and 3 minutes between blocks) using maximized propulsive power output. Mean propulsive power (MPP) was recorded with a linear transducer, and percentage of MPP decrement (%Dec), power fluctuation (FLUC), best set, and last set calculated. The acceleration in different axis for overall movement was measured using an inertial measurement unit (WIMU, Realtrack Systems, Almeria, Spain) attached to the barbell. Cardio-respiratory measures were collected continuously with breath-by-breath method using a reliable and valid automated open-circuit gas analysis system (K5, Cosmed Srl, Rome, Italy). Capillary blood samples were obtained at the end of testing protocol using a reliable and valid handheld lactate analyzer (Accutrend Plus; Boehringer; Mannheim, Germany). Perceptual response and muscle soreness were determined using subjective scales. Percentage of predicted adult height (% PAH) was estimated according to non-invasive method (Khamis, and Roche, 1994, Pediatrics, 94(4), 504–507). Multiple regression analysis revealed % PAH as significant predictor of MPP ($P = 0.000$; $R2 = 0.68$), FLUC ($P = 0.036$; $R2 = 0.28$), best set ($P = 0.000$; $R2 = 0.59$), last set ($P = 0.000$; $R2 = 0.67$), pulmonary ventilation ($P = 0.024$; $R2 = 0.32$), oxygen uptake ($P = 0.009$; $R2 = 0.40$), carbon dioxide production ($P = 0.048$; $R2 = 0.25$), rate of perceived exertion ($P = 0.021$; $R2 = 0.33$) and muscle soreness ($P = 0.045$; $R2 = 0.26$), during RPA protocol. The RPA is a training method used to improve high-intensity actions in youth team-sports athletes, however practitioners should be aware that the biological maturation led to different mechanical, cardio-respiratory, and perceptual responses. Thus, the present findings may be useful for effective programming and, consequently, to improve athletic performance, throughout childhood and adolescence. Funding: Foundation for Science and Technology (FCT, Portugal), through a Doctoral grant endorsed to the first author [SFRH/BD/122259/2016] and under project UID04045/2020.

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D3.S3 Perceived psychological challenges impacting upon the performance of para-snowsport athletes

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In para- and disability-sport the ability to cope with pressure while competing has been highlighted by para-athletes (AWPD) and their coaches as a challenge to overcome to perform successfully (Ringland, 2013. Reflective Practice, 14, 680-690). Research refers to disability sport generally but currently very little focuses on elite para-snowsport athletes. Competing in para-snowsports involves unique logistical and environmental challeges for para-athletes'.

Existing research reports similar psychological skills utilized by able-bodied and para-athletes' but differences in the perceived stressors experienced have been reported (Diffenbach & Statler, 2012. Journal of Sport Psychology in Action, 3, 109-118). Existing themes relating to psychological stressors for para-athletes include availability of disability-specific coaching, disability-related organizational stressors (Arnold et al., 2017. Journal of Sport Sciences, 35(12), 1187-1196), athlete and coach access to sport psychology consultants with appropriate expertise (Dieffenbach, et al., 2009. Colorado Springs, CO: USOC and Paralympic Program), injury frequency, access to training and competition facilities, the more complex challenges faced in preparing for practice and competition, and the classification system (Martin, 2015. Kinesiology Review, 4, 91-98). The aim of this study was to explore the specific psychological challenges experienced by para-snowsport athletes.

With institutional ethics granted five elite, male para-snowsport athletes (mean age 34.6 ± 7.6 years), with elite snowsport experience of two to five years and amputation of one or both legs, were interviewed using semi-structured interviews. Data were analysed adopting a reflexive thematic analysis approach. Nine superordinate themes emerged from the data analysis process: Preparation Strategies, Psychological Strategies Used, Stressors, Mindset, Mental Health, Mental Health Strategies, Positive Environment, Physical and Environmental Challenges, and Psychological Challenges. Results highlighted the potential impact of performance factors and stressors on athlete mental health.

The importance of developing positive and supportive practice and performance environments was ultimately highlighted as crucial in enabling para-snowsports athletes to thrive. It was also identified that practitioners working with AWPD seek to understand the lived experience of their athletes to better support their future performance ambitions. This is a theme regularly appearing in research relating to disability-specific coaching (Arnold et al., 2017). It is important future research further explores psychological needs and demands associated with performing in other specific disability sport contexts, to better understand how to support AWPD more effectively.

Day 3. Posters – Sport and Performance

D3.S3 The comparative effect of different timings of whole body cryotherapy treatment with cold water immersion for post-downhill run recovery

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Despite several established benefits of Whole Body Cryotherapy (WBC) for post-exercise recovery, there is a scarcity of research which has identified the optimum WBC protocol for this purpose. This study investigated the influence of WBC treatment timing on responses following a bout of downhill running, an eccentrically biased muscle damaging exercise model. An additional purpose was to compare such responses with those following cold water immersions (CWI), since there is no clear consensus as to which cold modality is more effective for supporting athletic recovery. Following institutional ethical approval, 33 male participants (mean ± SD age 37.0 ± 13.3 years, height 1.76 ± 0.07m, body mass 79.5 ± 13.7kg) were randomly allocated into WBC 1 hour (WBC1, n=9), WBC 4 hour (WBC4, n=8), CWI (n=8) and control (CON, n=8) groups. Participants completed a 30 minute downhill run (15% gradient) at 60% VO_2 max. WBC1 and WBC4 participants underwent cryotherapy (3 minutes, -120°C) 1 hour or 4 hours post-run respectively. CWI participants were immersed in cold water (10 minutes, 15°C) up to the waist 1 hour post-run. CON participants passively recovered in a controlled environment (20°C). Maximal isometric leg muscle torque was assessed pre and 24 hours post-run. Blood creatine kinase (CK), muscle soreness, femoral artery blood flow, plasma IL-6 and sleep were also assessed pre and post-treatment. There were significant decreases in muscle torque for WBC4 (263.5 ± 62.5 Nm vs. 231.0 ± 47.2 Nm, 10.9%, p=0.04) and CON (230.9 ± 53.9 Nm vs. 205.4 ± 52.6 Nm, 11.3%, p=0.00) and no significant decreases for WBC1 (258.2 ± 34.2 Nm vs. 243.8 ± 35.3 Nm, 5.6%, p=0.06) and CWI (245.1 ± 76.8 Nm vs. 229.5 ± 72.7 Nm, 5.1%, p=0.15). There were no significant differences between groups in muscle soreness, CK, IL-6 or sleep. Femoral artery blood flow significantly decreased in CWI (195.0 ± 59.6 ml/min vs. 158.6 ± 80.3 ml/min, p=0.02), but did not differ in the other groups. WBC treatments within an hour may be preferable for muscle strength recovery compared to delayed treatments; however WBC appears to be no more effective than CWI. Neither cold intervention had an impact on inflammation or sleep.

D3.S3 Clustered 10 s sprints enable well-trained runners to maintain speed compared to continuous 30 s sprints

Alan Ruddock[1], Robert Raynor[2], Stephen Thompson[1]

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Sprint-interval training (SIT) is an effective training method, however, evidence is based on cycle ergometry with sedentary populations without reporting physiological or physical demands. This study aimed to; 1) report the internal and external demands of sprint-interval training using a non-motorised treadmill; 2) compare physiological and physical demands of a traditional sprint-interval training session (SIT) with isovolume clusters of 10 s sprints interspersed with 10 s of recovery (CLU) in well-trained athletes. Seven endurance runners (age 32 ± 5 years; body mass 74.5 ± 6.3 kg; stature 182 ± 5 cm; VO_2max 61.2 ± 3.8 $ml{\cdot}kg^{-1}{\cdot}min^{-1}$) provided informed consent to participate in the study that was approved by the local ethics committee and conducted according to the Declaration of Helsinki. SIT consisted of 4 x 30 s maximal effort sprints with 3 minutes passive recovery for a total sprint time of 2 min. CLU consisted of 4 sets of sprints with 3 minutes passive recovery between sets. Each set included 10 s maximal sprints with 10 s of passive recovery repeated 3 times for a sprint duration of 30 s. A Two-Way Repeated-Measures Analysis of Variance (ANOVA) with Bonferroni post-hoc analysis was used to investigate statistically significant differences between variables. A Wilcoxon signed-rank test was used to analyse rating of perceived exertion (RPE). Statistical significance was set at $P < 0.05$, Cohens d and 90% confidence intervals were to analyse effect size. There were no statistically significant differences between groups for peak running speed. Mean speed decreased significantly across repetitions in SIT ($P \leq 0.03$) however, mean speed was maintained in CLU, furthermore mean speed for repetition 4 was faster in CLU than SIT ($P = 0.03$; $d = 1.40$ [CI = 0.59]). There were no significant differences in mean or peak cardiorespiratory variables between groups, however peak %VO_2max for repetition 4 in CLU was significantly greater than repetition 1 ($P = 0.01$; $d = 1.05$ [CI = 0.61]). There were no significant differences between groups for blood lactate ([BLa]) in repetition 1 or 2, however, [BLa] was larger in SIT for repetitions 3 and 4 ($P \leq 0.004$). RPE was significantly greater in SIT for each repetition compared to CLU ($P \leq 0.03$). In conclusion, participants were able to maintain higher running speeds with CLU compared to SIT despite similar physiological demands. Coaches should investigate the use of CLU to optimise mechanical and physiological demands of sprint interval training.

D3.S3 International expert consensus on the development of mental fatigue in orienteering: a Delphi study

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Orienteering is an outdoor sport that requires individuals to navigate and identify the optimal route, in a natural environment, using a compass and map. Mental fatigue (MF) is a performance constraint in both psychological and physiological aspects, affecting orienteers' navigational and visuospatial performance. However, the development of MF is inadequately uniform to develop a clear guideline in addressing MF in orienteering. Therefore, the aim of this research was to seek international orienteering expert consensus regarding the definition, development, cause, influence of and recovery from MF in orienteering based on their practical experience. Following ethics approval, a three-round Delphi survey was conducted online with twenty-four orienteering coaches, athletes and former athletes from 10 different countries with international orienteering competition experience (16.7 ± 7.16 and 16.2 ± 7.27 years respectively). The threshold of consensus in this study was ≥ 70% agreement among respondents. The experts agreed that MF exists in daily life, orienteering training and competition with a substantial negative effect on orienteers conscious decision-making performance and psychological responses. There was an explicit agreement that the form of MF that athletes experienced differs in orienteering training and competition. However, there was no agreement that MF would impact endurance and high-speed running performance during orienteering. The experts also disagree that the extent of MF that orienteers experience is based on the duration of the task. This study highlights issues specific to the development of MF in orienteering for future investigations, and provides consensus-based recommendations for orienteering athletes and coaches to minimise the influence of MF on sports performance.

D3.S3 An insight into short-sprint coaches' knowledge and use of periodisation models and training methods - Evidence from the Sri Lankan context

Jeganenthiran Sellathurai[1,2,3], Nick Draper[1]

[1]*University of Canterbury, New Zealand,* [2]*Sabaragamuwa University of Sri Lanka, Sri Lanka,* [3]*Sri Lanka Track and Field Coaches Association, Sri Lanka*

Recent developments in applied sports coaching that use periodized training strategies to improve athletic performance have become increasingly attractive to coaches, athletes, and strength and conditioning practitioners. Coaches' knowledge and skills are crucial to the successful application of periodisation and training methods for improving performance. Despite its popularity and importance, little is known about the Sri Lankan context. As a result, this formative exploratory study aimed to examine the knowledge of, and application of, periodisation and training methods used by Sri Lankan elite-level coaches working with short-sprint athletes to achieve desired goals. Ten (n=10) expert short-sprint coaches volunteered to participate in the study, with data collected via semi-structured interviews. The data were analysed inductively, involving 'discovering patterns', 'themes' and 'categories' using the NVivo 12 qualitative software. The techniques and procedures of Brawn and Clark were also followed (Braun, V. & Clarke, V, 2006, Qualitative research in psychology, 3(2), 77-101). Four primary themes emerged from the interview data. These included "Periodisation models", "Monitoring training", "Strength development", and "Speed development". Results revealed that while coaches reported minimal or inadequate knowledge on periodised training, there appears to be a gap between coach knowledge of periodised training, strength and speed training load, and practice such as monitoring training load. They believed that their knowledge was inadequate to transfer athletes to the Olympics. The findings also highlight the importance of providing adequate coach education and development to enable coaches better prepare their athletes in Sri Lanka.

D3.S3 Quantifying methods of body mass losses of United Kingdom powerlifters in competition preparation

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Previous research in Powerlifting (PL) has qualitatively investigated rapid weight-loss (RWL) in PL athletes and body image (Nolan et al. 2020, Journal of Strength and Conditioning Research) however limited research exists in quantifying such methods adopted in PL. This study aimed to quantify methods of body mass losses during competition preparation of male and female PL athletes in the United Kingdom. Following institutional ethical approval a total of n=37 (n=19 female, n=18 male) competitive powerlifters completed an anonymous online questionnaire assessing RWL methods. Normality was assessed via Shapiro-Wilks test. A series of one-way analysis of variance (ANOVA) tests were used to identify any significant differences between dependent variables (participant PL category and biological sex) against independent variables (undertaking RWL, timeframe and advice sought). Following this, multiple regression analysis was carried out to determine the contribution of biological sex and PL category as factors relating to the adoption of RWL, timeframe of weight control and advice sought. The alpha level for significance was set at $p \leq 0.05$. Commonly reported methods of weight loss were gradual dieting (49%), fluid restriction (46%), and water loading (51%). Differences between PL category (Junior, Open, Masters One) and adopting RWL was observed ($F(1,35) = 4.506$, $P \leq 0.05$). PL category is a predictor of undertaking RWL ($R2adj = 0.160$, $F(2, 34) = 4.429$, $P \leq 0.05$), whilst biological sex is a predictor of timeframe of undertaking RWL ($R2adj = 0.123$, $F(2, 34) = 3.534$, $P \leq 0.05$). RWL strategies are adopted by PL athletes in order to

make weight for competition. Despite known effects of RWL on strength performance, limited research currently exists on these strategies specifically within PL, therefore this may be a consideration for future research. Practitioners working with PL athletes may wish to consider appropriate nutrition and weight loss strategies in preparation for PL competitions.

D3.S3 International Survey of Training Load Monitoring Practices in Competitive Swimming: How, What and Why Not?

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Training load (TL) monitoring is a key element of competitive sporting environments and involves the product of an intensity measure and volume/duration measure. Previous research into TL monitoring and competitive swimming highlights a reliance on external measures (volume/duration) and may include internal measures (heart rate and lactate). This study aimed to identify the TL monitoring practices being used in real-world competitive swimming environments, while also exploring how data collection and analysis is implemented and what metrics are considered effective. The barriers to TL monitoring were also examined. Ethical approval was granted by the University's Ethics Committee and participants gave informed consent to their information being used for research and publication purposes. Thirty-one responders working in competitive swimming programmes participated in an online survey. A total of 84% of responders acknowledged using TL monitoring, with 81% of responders using a combination of both internal and external measures, in line with current consensus statements. Swim volume (m/km) (96%) and rate of perceived exertion (RPE) (92%) were the most frequently used measures used in TL monitoring, with athlete lifestyle/wellness monitoring also being a prominent feature. Three key themes associated with barriers to TL monitoring were generated through thematic analysis. Stakeholder engagement, resource constraints or functionality and usability of the systems available were shared barriers amongst responders. Findings show there is a research-practice gap. Future approaches to TL monitoring in competitive swimming should focus on selecting methods that are valid and reliable in the swimming environment but also allow the same method and measures of TL monitoring to be used across the whole programme, (pool-based training, dryland training and competition). The implementation of a TL monitoring system should focus on overcoming the barriers associated with athlete adherence and coach /National Governing Body buy-in prior to its implementation.

D3.S3 Importance of disguising strokes in a game between two tennis experts (Federer and Djokovic)

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Tennis games, especially those of high levels, are not just the matter of ball speed and placement but tactics as well. In order to create tactical advantages, players try to "disguise" their intentions and confuse opponents. Williams et al. (2009) showed that due to manipulated (misleading) dynamics of the movement in hips, shoulders, and arm/racket regions, anticipation accuracy of the stroke direction can significantly decrease in skilled players. Hitters could potentially influence point dynamics by mimicking elements of the genuine movement to trigger opponents' incorrect anticipatory movement. We tried to answer how frequently and how effective disguising can be used by analyzing highest ranking game, the 2019 Wimbledon final, played by two tennis greats. Our hypothesis was that disguised strokes can be efficient enough to make the opponent move to the opposite direction of the ball, creating advantageous point dynamics (APD). Two expert players showed that with disguising stroke intentions they could impose tactical superiority and create advantageous point dynamics. In the 1st set analyzed (6-1, won by Federer), thirty three (38.8%) of all ground strokes made by two players were with disguised intention. For the 2nd set (7-6, won by Djokovic), disguised stroke frequency was 26.2% of all 214 ground strokes. Winners of both sets made opponents move more frequently to the opposite direction of the ball following their disguised strokes than the undisguised strokes. In the total of 99 disguised strokes by both players in both sets, 51 (51%) created an advantageous point dynamics (winners or advantage) which was significantly higher that for the undisguised strokes (40%, 86/210). Suitable training program of disguised shots should have practical utility for competitive players of any levels.

D3.S3 Inter-unit reliability and validity of 10Hz GPS units in assessment of total distances covered during intermittent activity

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It is now widely accepted that higher sample rates in GPS wearable devices (10Hz) is most accurate in measuring distance covered during short, sharp movements compared to lower sample rates (1Hz and 5Hz) (Rampinini et al, 2015). This experiment compared inter unit reliability and validity of 2 separate systems, both sampling at 10Hz, in assessing total distances covered during a simulated intermittent activity circuit designed to replicate movement demands of team field sport. 2 well trained team field sport athletes participated

in the experiment. Ethical approval was sought and approved from the Institute Research Ethics Committee (IREC) at Munster Technological University. 2 participants were chosen to limit any inter-participant movement variation which may affect reliability of results. 10 STATSports Apex 10Hz units (STATSports, Northern Ireland) and 10 VXSport 10Hz units (VXSport, New Zealand) were used in the study. A circuit inspired by movement patterns evident in team field sports measuring at 119 meters in total was designed and laid out on a grass pitch using cones. Participants were instructed to ensure their posture was vertical throughout all movement ensure the GPS unit was directly above the specific area as marked by the cones and to eliminate the risk of any forward or rear leaning to affect the GPS measurement. Total distance data was measured in meters and displayed as mean ± standard deviation, reliability of data was quantified using coefficient of variation (CV%) with confidence intervals set at ±95%. The CV% represents relative reliability by displaying the typical error (TE) measurements as a percentage of the mean (Baca, 1999). Total distances recorded for 10 STATSports APEX units used were 118.9 ± 0.9m while total distances recorded for VXSport units displayed recordings of 117.2 ± 1.2m . As for variation in results, STATSports APEX displayed CV% of 0.7% while VXSport showed 1.0%. Inter unit reliability of both brands can be described as strong with no significant differences between units or differences in measurement total distance of the circuit. Inter unit reliability and validity within these particular 10Hz units can be described as strong with no significant differences in variation of results or difference in overall measurement of total distance covered. It should still be recommended to all practitioners utilising GPS to reduce instances of inter unit variability where possible by assigning the same unit to the same athlete on a repeated basis where possible.

Day 3. 5 slides in 5 minutes - Biomechanics and Motor Behaviour

D3.S4.3(2) Step regulation patterns in elite pole vaulters during a major competition

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Step regulation is a process that allows athletes to successfully negotiate dynamic interceptive actions in target directed locomotion like the pole vault, where athletes need to accurately plant the pole and place the take-off foot with the highest manageable velocity. The purpose of the study was to investigate the presence of visual regulation in elite pole vaulters during a major competition. The sample comprised 11 male (age 26.1 ± 3.9 years, height 1.84 ± 0.05 m, mass 77.5 ± 8.23 kg, personal best 5.90 ± 0.10 m) and 13 female (age 24.7 ± 5.6 years, height 1.69 ± 0.06 m, mass 59 ± 4.26 kg, personal best 4.71 ± 0.1 m) elite pole vaulters. Data were collected during the finals of the 2017 Indoor European Athletics Championship in Belgrade. Approval was obtained from the University's ethics committee. The runway was marked and spatiotemporal data from the 8th up to the last step of the approach were collected by a panning camera (sampling rate 300 fps). The maximum and minimum toe-plant box distance variability (TBVmax and TBVmin), the onset of step regulation (SR), the velocity (m/sec), distance (m), time (s) and time-to-contact estimate (tau) from the pole plant box at which this occurred were measured (Bradshaw and Sparrow, 2001, Human Movement Science, 20, 401-426). For male pole vaulters, SR commenced on the 5th last support (4th last step) of the approach at a distance of 12.65 ± 0.40 m when TBVmax reached a value of 17.18 ± 6.76 cm. This occurred 0.92 ± 0.03 s prior planting the pole, at a tau of 1.38 ± 0.05 while running with an average velocity of 9.11 ± 0.27 m/s. For females, SR commenced on the 6th last support (5th last step) at a distance of 12.90 ± 0.43 m and a TBVmax of 13.88 ± 4.69 cm. This occurred 1.15 ± 0.06 s prior planting the pole, at a velocity of 7.96 ± 0.28 m/s and a tau of 1.62 ± 0.08. Last step TBVmin was 8.74 cm and 8.73 cm for males and females respectively. Elite pole vaulters commence regulation similarly as long jumpers 4-5 steps prior to take-off but demonstrate lower TBVmax variability probably due to the higher task constraint demands imposed on them. The earlier commencement of regulation in women compared to men may be attributed to the lower approach velocity which facilitates an earlier time-to-contact estimate.

Day 3. 5 slides in 5 minutes - Physical Activity for Health

D3.S4.2(1) Factors influencing physical activity behaviour in women with polycystic ovary syndrome

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Physical activity (PA) has been shown to be an effective tool in the management of polycystic ovary syndrome (PCOS), including improvement in cardiovascular, metabolic, and reproductive outcomes. However, no studies have specifically examined the factors that influence PA behaviour in women with PCOS. Therefore, the aim of this study was to identify barriers and facilitators to PA in women with PCOS and to develop recommendations that can be incorporated into the design of PA interventions for the treatment of PCOS. Participants were recruited from an over-arching feasibility trial to determine the acceptability of physical activity interventions for women with PCOS. Eleven participants with PCOS were purposively sampled from the main sample (n=36). Institutional and HRA ethical approval was obtained. Semi-structured interviews were conducted to explore factors that influence PA behaviour separately from the trial. Interviews were audio-recorded and transcribed verbatim. Data were analysed using thematic analysis, whereby raw data codes were interpreted, organised, and refined into higher and lower order themes. Results indicated five main factors that influenced PA behaviour in women with PCOS. These included 1) generic factors such as lifestyle (for example, work and the weather), 2) knowledge about PA, and 3) social elements (such as competition and socialising, which encouraged PA behaviour). PCOS specific factors were also identified, such as 4) PCOS symptoms, particularly self-esteem, low mood, and fatigue. These symptoms often acted as a barrier to PA, and thus further worsened the symptoms in a negative feedback loop. In addition, 5) self-regulation (including individual prioritisation of PA) was identified as a complex factor influencing PA. These findings suggest that while participants may cite 'lack of time' as a barrier to PA, there may be an underlying issue of low prioritisation of PA. Thus, to overcome these barriers to PA, particularly in the context of increasing adherence to PA interventions, recommendations include providing resources that improve knowledge of the beneficial effects of PA on PCOS, providing measures of accountability, and shifting attitudes about PA toward something with inherent value that can improve symptoms and increase individual ownership over the long-term management of the condition. This study has explored the interplay between living with PCOS and PA behaviour. The findings can be used for improving the effectiveness of PA interventions, and providing positive experiences for women with PCOS taking part in PA.

D3.S4.2(2) An immersive online approach to teaching physical skills to students in a clinical setting

Sam Jones[1], Gareth Jones[2]

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COVID-19 has led to shortages of clinical placements across academia (Twogood et al., 2020, British Medical Journal online, 9, e001107), which was felt within the School of Allied Health Professions (SAHP) at Keele University who lost 12 placements in September and 73 placements in November 2020. To counteract this loss, SAHP and governing bodies requested clinical partners who were able to, provide virtual experiences to a larger number of students, reducing the possibility of cancelling placements. Simulation placements have been used with the medical professional previously to great success (Wright et al., 2018, Advances in Simulation, 3(3), s41077-018). However, these alterations required a rapid response that maintained quality. To this extent the potential outcome was unclear, as this needed to be managed without the usual level of quality assurance. This was done via communication with clinical partners and students. The qualitative focus group study consisted of (n=4) final year Physiotherapy students who opted to partake in the analysis, with questions developed from a Likert questionnaire completed by all students (n=11) who attended placements with Cardiac Rehabilitation from September to December 2020. Ethical approval was gained from the student project ethics committee. The students highlighted excellent communication between their educator and CR team, while some remarked a lack of increased clinical skills. However, all considered the placement to be successful in COVID-19 but would not have liked a virtual placement outside of these terms. Two students highlighted an absence of physical patient contact as a major concern as they move into clinical practice. They also highlighted reduced confidence in applying exercise prescription principles particularly progressive overload and handling unforeseen circumstances such as unexpected exercise regression. The placement fulfilled its objectives of opening extra student capacity, while maintaining quality, allowing for students to graduate with appropriate clinical hours. This study will be useful for future Physiotherapy placement planning should capacity issues arise and as a route to clinician contact for courses that do not offer professional experience. The future impact of this study will provide Sports Rehabilitation and Exercise Science students with clinical contact at little cost to university budgets and may be further developed into a weighted module.

Day 3. 5 slides in 5 minutes - Biomechanics and Motor Behaviour

D3.S4.3(2) Step regulation patterns in elite pole vaulters during a major competition

Apostolos Theodorou[1], Vassilios Panoutsakopoulos[2], Mariana Kotzamanidou[3], Flora Panteli[1], Athanasia Smirnioti[1]

[1]National And Kapodistrian University of Athens, Athens, Greece, [2]Aristotle University of Thessaloniki, Thessaloniki, Greece, [3]Metropolitan College of Thessaloniki, Thessaloniki, Greece

Step regulation is a process that allows athletes to successfully negotiate dynamic interceptive actions in target directed locomotion like the pole vault, where athletes need to accurately plant the pole and place the take-off foot with the highest manageable velocity. The purpose of the study was to investigate the presence of visual regulation in elite pole vaulters during a major competition. The sample comprised 11 male (age 26.1 ± 3.9 years, height 1.84 ± 0.05 m, mass 77.5 ± 8.23 kg, personal best 5.90 ± 0.10 m) and 13 female (age 24.7 ± 5.6 years, height 1.69 ± 0.06 m, mass 59 ± 4.26 kg, personal best 4.71 ± 0.1 m) elite pole vaulters. Data were collected during the finals of the 2017 Indoor European Athletics Championship in Belgrade. Approval was obtained from the University's ethics committee. The runway was marked and spatiotemporal data from the 8th up to the last step of the approach were collected by a panning camera (sampling rate 300 fps). The maximum and minimum toe-plant box distance variability (TBVmax and TBVmin), the onset of step regulation (SR), the velocity (m/sec), distance (m), time (s) and time-to-contact estimate (tau) from the pole plant box at which this occurred were measured (Bradshaw and Sparrow, 2001, Human Movement Science, 20, 401-426). For male pole vaulters, SR commenced on the 5th last support (4th last step) of the approach at a distance of 12.65 ± 0.40 m when TBVmax reached a value of 17.18 ± 6.76 cm. This occurred 0.92 ± 0.03 s prior planting the pole, at a tau of 1.38 ± 0.05 while running with an average velocity of 9.11 ± 0.27 m/s. For females, SR commenced on the 6th last support (5th last step) at a distance of 12.90 ± 0.43 m and a TBVmax of 13.88 ± 4.69 cm. This occurred 1.15 ± 0.06 s prior planting the pole, at a velocity of 7.96 ± 0.28 m/s and a tau of 1.62 ± 0.08. Last step TBVmin was 8.74 cm and 8.73 cm for males and females respectively. Elite pole vaulters commence regulation similarly as long jumpers 4-5 steps prior to take-off but demonstrate lower TBVmax variability probably due to the higher task constraint demands imposed on them. The earlier commencement of regulation in women compared to men may be attributed to the lower approach velocity which facilitates an earlier time-to-contact estimate.

longevity in elite athletes with very high volumes of exercise. Participants in the Tour de France represent a group of athletes who have one of the highest total exercise volumes across all elite athletes. Therefore the aim of this study was to select the best Tour de France riders, those who have worn the leaders 'Yellow Jersey' (1903-2020) and determine their longevity in comparison to the general population for their country of birth. A total of 294 cyclists have worn the yellow jersey and thus qualify for this study. Dates of birth and death were determined from Wikipedia for all but one rider and used to calculate age at death or current age. From the sample 164 riders were still alive with 129 having died. Age of death or current age for each rider was compared to the longevity at birth in 5 year blocks for the country of their birth determined from the Human Mortality Database (mortality.org). Data was analysed with a Mann-Whitney U non-parametric independent-t test. The age at death (M=68.6, SD=17.7 years) was 20.1 years (95% CI 16.8-23.5) years older than the equivalent general population. For those riders still alive 46 of them had already passed the expected population age for general public born in the same year and country, and overall had already lived 22.1 years (SD=13.1) longer than expected. These results suggest that the best Tour de France cyclists live on average significantly ($P<0.01$) longer than equivalent general population and longer than previous similar studies have suggested (Sanchis-Gomar et al. 2011, International Journal of Sports Medicine 32, 644-647). There are limitations to this type of analysis as it is not possible to determine lifestyles beyond their professional cycling career which could have a significant influence on health and longevity. However, these and other results now seem to challenge the common belief that large lifetime volumes of exercise could be harmful to health and thus longevity.

D3.S4.2(6) Physical education teachers and strength and conditioning coaches' perceptions of motor competencies across different stages of maturity

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[1]*Leeds Beckett University, Leeds, United Kingdom,* [2]*Queen Ethelburga's Collegiate, York, United Kingdom,* [3]*Leeds Rhinos Rugby League Club, Leeds, United Kingdom,* [4]*University of Nebraska-Kearney, Kearney, United States of America*

Proficient motor competence is important for the health and athleticism of all youths (Cattuzzo et al., 2016, Journal of Science and Medicine in Sport, 19, 123-129). Recent research indicates that strength and conditioning (S&C) coaches perceive it as important to develop a broad range of motor competencies within youths (Burton et al., 2021, Journal of Sports Sciences, 1-9). However, research is yet to consider the perspectives of other practitioners (e.g., Physical Education [PE] teachers), or how perceptions change based on an individual's stage of maturity (e.g., childhood vs. adolescence). Therefore, this study aimed to investigate PE teachers and S&C coaches' perceptions of motor competence importance and compare importance across different stages of maturity. Following institutional ethical approval, 47 PE teachers (experience = 10.3±6.6 years) and 48 S&C coaches (experience = 8.6±4.8 years) reported their perceived importance for developing 21 motor competencies (e.g., running, jumping). For each motor competency, participants rated their perceived importance using a 5-point Likert-scale (1 = not important, 5 = very important), at 4 stages of maturity (i.e., childhood, pre-peak height velocity [PHV], circa-PHV, post-PHV). PE teachers and S&C coaches' responses were converted to percentage of response frequency for analysis. Greater than 55% of PE teachers rated 10, 13, 14 and 15 motor competencies important at childhood, pre-PHV, circa-PHV, and post-PHV respectively. During childhood, pre-PHV, circa-PHV and post-PHV, >55% of S&C coaches perceived 12, 18, 17 and 17 motor competencies important. Neither PE teachers nor S&C coaches' perceived resistance training movements (e.g., upper body pushing/pulling) important in childhood. The results indicate that PE teachers perceive fewer motor competencies to be important across all development stages, compared to S&C coaches. Therefore, PE alone may be insufficient to develop a broad range of motor competencies within youths. Additionally, findings suggest that PE teachers and S&C coaches' perceive that more motor competencies become important as youths develop towards post-PHV, but perceive resistance training competencies to not be important in childhood. These findings conflict with previous theory highlighting the importance of developing a broad foundation of motor competencies during childhood (Gallahue et al., 2012, Understanding Motor Development: Infants, Children, Adolescents, Adults. New York, NY: McGraw-Hill), and previous research reporting the benefits of resistance training for motor competence in children (Behringer et al., 2011, Pediatric Exercise Science, 23, 186-206). Therefore, continued education of practitioners, and between practitioner collaboration may be warranted to enhance the development of motor competence of youths.

D3.S4.2(7) Standardising the reporting of objectively measured changes in sedentary behaviour for intervention studies – the development of a Core Research Outcome set, for Sedentary Behaviour Interventions (CROSBI)

Fiona Curran[1], Kieran O' Dowd[2], Casey Perris[3], Hidde van der Ploeg[4], Mark Tremblay[5], Grainne O' Donoghue[1]

[1]*University College Dublin, Dublin, Ireland,* [2]*Athlone Institute of Technology, Athlone, Ireland,* [3]*La Trobe University, Victoria, Austrailia,* [4]*Amsterdam University Medical Centres, Amsterdam, The Netherlands,* [5]*University of Ottowa, Ottowa, Canada*

Title Standardising the reporting of objectively measured changes in sedentary behaviour for intervention studies – the development of a Core Research Outcome set, for Sedentary Behaviour Interventions (CROSBI)

Background: Effectiveness of interventions to ameliorate the health effects of sedentary behaviour is scarce, despite the rapid growth in research in the area. Heterogeneity of

outcomes, measured and reported, contribute to the lack of evidence. There is an increasing need for standardisation of a minimum or essential set of data to be included in sedentary behaviour research. This minimum dataset of core outcomes can provide the framework for multi-disciplinary research and practice.

Objectives: to identify and validate by consensus, a core set of domains and items ('what to measure') for reporting change in objectively measured sedentary behaviour in interventional studies, using a Delphi approach.

Method: A recent systematic literature review will be used to identify outcomes and measures reported in sedentary behaviour (SB) interventional research. The research team will categorise the extracted data into data domains and data items specifically relating to core outcomes and measures, with explanatory notes provided for each item (core outcome set COS V.0). International SB experts (n=5) will review the proposed COS to identify additional items and provide feedback. Additional items and recommendations will be included into CROSBI V.1. Wider consensus will be achieved by inviting members of the Sedentary Behaviour Research Network (SBRN) (n>500 active members) and additional suitable participants identified by the expert group (snowball sampling), to review and provide feedback on the proposed CROSBI via an online electronic Delphi survey. Two rounds of the Delphi will be issued requesting participants to rate the importance of each proposed domain item. Feedback and additional items identified in round one of the Delphi will be incorporated into round two. Consensus achieved in the second round will be finalised by the research team into a final COS (CROSBI). The results will be published in an international peer reviewed journal and among sedentary behaviour research networks

Conclusion: Using a robust methodology, the standardisation of core outcome measures for inclusion in sedentary behaviour research will enhance synthesis of evidence and meta-analysis of data. This COS will be useful for all researchers, clinicians, public health policymakers or patient registries, interested in understanding the effects of sedentary behavior.

Keywords: Sedentary behaviour, Stationary behaviour, Physical inactivity, Outcome Measures, Core Outcome Set, Minimum Dataset.

Day 3. 5 slides in 5 minutes - Physiology and Nutrition

D3.S4.3(1) The impact of resistance training on cardiac structure and function: A Systematic Review and Meta-Analysis

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Substantial evidence on alterations in cardiac structure and function in individual's exposed to chronic exercise training has been well-documented. Specifically, it has been hypothesised that such adaptations may be training-specific with endurance, and resistance training both reflecting a differing haemodynamic demand (Utomi, et al., 2013, Heart, 99(23), 1727-1733). However, with imaging modalities developing over recent years and previous research typically limited to young, elite males, questions regarding the extent of these changes have been raised. The aim of this review was to examine the influence of chronic resistance exercise on myocardial structure and functional variables. The review was designed in accordance with PRISMA guidelines and registered to PROSPERO (CRD42020197272). Institutional ethical approval was obtained. Six electronic databases (PubMed, CINAHL, MEDLINE, ScienceDirect, EBSCO and Academic Search Elite) were systematically searched in February 2021. Study quality was assessed using Appraisal tool for cross-sectional studies (AXIS). Relevant cardiac data was extracted from individual studies. A mixed-effect, random meta-analysis model was applied with Hedges' g effect sizes and 95% confidence intervals (95%CI). Effect sizes were described according to Cohen, J. (2013, Statistical power analysis for the behavioral sciences Academic press. New York: Academic Press). To quantify study-to-study heterogeneity a Q statistic $p< 0.05$ and I2 statistic >50% was deemed significant. Database searching identified 620 studies, following duplicate removal 326 study title and abstracts were screened. A further 196 studies were removed (128 remained). Following full-text screening, 32 studies with 2060 participants remained for final synthesis. Study quality scored an average of 16/20. Findings demonstrated no effect size for tissue doppler imaging a' lateral (Hedges' g = -0.01, P=0.942, [95%CI -0.53 to 0.50], studies: n=6, participants: n=220) and a small-medium effect size for right diastolic area (Hedges' g = -0.43, P=0.008 [95%CI -1.14 to 0.27], studies: n=3, participants: n=166). For both ventricular structure (wall thicknesses, chamber volumes, chamber diameters, aortic diameter, left ventricular mass, right systolic area) and function (stroke volume, ejection fraction, fraction shortening, flow velocities, tissue doppler imaging, global strain) variables there was significant evidence of study-to-study heterogeneity (55-96%). Athletes in this review presented with some morphological characteristics of the athlete's heart, however, heterogeneity between the prospective studies is large. This highlights the importance of clear, more-suitable guidelines with regards to cardiac imaging going forward. Furthermore, subgroup analysis based on steroid-use, imaging modality and competition status should be considered.

Day 3. 5 slides in 5 minutes – Psychology

D3.S4.3(4) Changes in athletes' wellbeing during COVID-19: the moderating roles of gender and athletic identity

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Social distancing restrictions which have been implemented to combat the spread of COVID-19 have presented a number of challenges for athletes' wellbeing. In particular, the sudden cessation of training/competitions, closure of sports facilities and isolation from the sport environment have had a significant negative impact on athletes' mental health, and have been described as similar to the impact of a career-ending injury. Previous research suggests that female athletes, as well as those who have experienced COVID-19 as a threat to their athletic identity may be more susceptible to negative changes in wellbeing (i.e., increased anxiety, depression, disordered eating/exercise) during the pandemic. This longitudinal study aimed to (1) determine whether females and those who report decreased athletic identity (relative to before the pandemic) have poorer levels of wellbeing vs males and those who have maintained athletic identity, (2) explore how athletes' levels of anxiety, depression, disordered eating and compulsive exercise change over a 7-month period during the COVID-19 pandemic, and (3) investigate whether gender or athletic identity (decreased vs maintained) moderate the degree of wellbeing change. Athletes (N=199, mean age=36 years, n=111 female, n=60 elite level) completed an online survey assessing anxiety, depression, disordered eating and compulsive exercise over the course of seven months. The three data collection time points (T1=July, 2020, T2=November, 2020, T3=February, 2021) represent increased severity of COVID-19 restrictions over time. Ethical approval was granted by the University of Nottingham (reference: s1269). Findings from a series of between-subjects ANOVAS revealed that, while levels of disordered eating and compulsive exercise remained stable over time, levels of anxiety and depression increased significantly from T2-T3. Female athletes and those reporting a decrease in athletic identity had poorer levels of wellbeing at all three time points compared to males and those who maintained their athletic identity. While gender failed to moderate change in wellbeing, those who had reported a decrease in athletic identity experienced a higher increase in anxiety from T2-T3 compared to those who maintained their athletic identity. These results suggest that athletes who face significant periods of interruption to their training and competition (e.g., due to COVID-19) may experience an increase in anxiety and depression, particularly if athletes have experienced the interruption as a threat to their athletic identity. It is vital that coaches and sport personnel are providing sufficient mental health support for their athletes during periods of uncertainty and encourage athletes to explore other aspects of their identity.

D3.S4.3(5) Transitioning from elite gymnastics to contemporary circus: A longitudinal case study

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Career transitions in gymnastics are increasingly occurring across performance domains into contemporary circus. These transitions are often normative, occurring as a relatively predictable event after the termination of an elite gymnastics career. To enable gymnasts to thrive in the circus, significant lifestyle changes, new social networks, culture experiences, and potential identity changes, all need to be successfully navigated across multiple transition phases. The aim of this study was to investigate the longitudinal experience of an elite gymnast at various phases of the transition into contemporary circus, extending the current literature by van Rens and Filho (2019, Journal of Clinical Sport Psychology, 14, 127-148). A single case-study design was conducted with a 22-year old Caucasian female transitioning from power-tumbling into a worldwide circus company. Following institutional ethical approval, data was collected through observation and semi-structured interviews (n=6), over a six-month period (totalling 6.16 hrs). A reflexive journal and critical friend were used by the first author who was previously an elite gymnast and still involved in the gymnastics culture, to document potential influences on data collection and the analytic process (Smith and McGannon, 2018, International Review of Sport and Exercise Psychology, 11, 101-121). Data were analysed using vertical thematic analysis (Braun and Clarke, 2006, Qualitative Research in Psychology, 3, 77-101). Three overarching themes were identified: the desire to change, adjusting to the circus, and becoming an artist. Findings highlighted the additional factors that gymnasts from specific disciplines can experience when transitioning to a new domain, such as circus pressures, learning to perform, and elements of growth. This research illustrates a need for an increased social support network and educating coaches, organisations, and sport psychology practitioners on the unique transitional phases, if artists are to be appropriately supported and subsequently thrive in their new context. Finally, a call for transitional models that are specific to cross-domain transitions are warranted.

D3.S4.3(5) The effects of Rational Emotive Behaviour Therapy on irrational beliefs, mood, motivation and return to sport anxiety in injured athletes

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Rational Emotive Behaviour Therapy (REBT) aims to dispute the irrational thoughts of an individual to more rational ones (Wood et al., 2017, "The Sport Psychologist", 31(1), 78-87.) There may be a difference in the irrational beliefs of individuals who suffer from psychological disorders such as depression and anxiety (Nieuwenhuijsen et al., 2010, "Journal of Rational-Emotive & Cognitive-Behavior Therapy", 28(2), 57-72). Specifically, return to sport anxiety has been shown to negatively impact an athlete's mental health on their return to sport in full physical health (Chan et al., 2011, "Psychology of Sport and Exercise", 12(2), 83-92). It was vital to explore the effects of REBT on injured athletes' return to sport anxiety due to the pressures they face to perform to their pre-injury, physical capability. This study, having been granted ethical approval, aims to identify the effects of REBT on the irrational beliefs, motivation, mood and return to sport anxiety of two semi-professional footballers with chronic injury. These two injured athletes received five, one-to-one REBT sessions each week. These interactive sessions consisted of discussions surrounding the REBT ABCDE framework. Each participant had their irrational beliefs, motivation, mood and return to sport anxiety measured pre- and post-intervention using validated questionnaires (Irrational Performance Beliefs Inventory (iPBI), self-motivation scale, Positive and Negative Affect Schedule (PANAS), Injury-Psychological Readiness to Return to Sport (I-PRRS)). Between sessions, participants completed one homework worksheet to confirm knowledge acquired in the session prior. A paired-samples t-test was undertaken to analyse the data collected pre- and post-intervention. No significant pre- or post-differences were observed for irrational beliefs (pre = 89.00, post = 70.00, P = 0.33), negative affect, (pre = 9.00, post = 11.50, P = 0.13), positive affect (pre = 17.50, post = 18.00, P = 0.95) or motivation (pre = 43.00, post = 43.50, P = 0.50). There was a significant difference in return to sport anxiety (pre = 190.00, post = 450.00, P = 0.05). In conclusion, this study explored the ways that an REBT intervention could improve irrational thoughts, motivation, mood and return to sport anxiety in injured athletes. Future research should investigate the sustainability of REBT in athletes, including those in full physical health, to lower the prevalence of these factors contributing to poor mental health if injury was to occur. Therefore, coaches should be aware and educated about poor mental health caused by return to sport anxiety, low mood and motivation and irrational beliefs.

D3.S4.3(6) Emotion Mapping: Understanding the relationship between emotion and space in long-term injured athletes

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Long-term injury is a regular occurrence for professional athletes. It has been well documented that athletes experience psychological and emotional vulnerability when injured. However, to date there has been little understanding of the interactions between the working environments that athletes inhabit and their emotional responses within them. This is critical to explore as research demonstrates that the articulation of emotion is intertwined with the space within which it occurs, as well the people who occupy it. Throughout their rehabilitation, athletes experience the same spaces but in a different way. For example, a 'fit' athlete in a physiotherapy room receiving preventative care experiences this space very differently from an injured athlete who has to live in there for months receiving treatment.

To date, there has been limited research in sport psychology that serves to understand the relationship between space and affect. However, art-based methodologies offer an opportunity to illuminate the complexity of this relationship. Emotion mapping is one such method that enables participants to create maps of the spaces they occupy and identify their associated emotional landscapes. Therefore, this study utilised emotion mapping in order to elucidate the relationship between the working spaces of long-term injured athletes, and they emotions they experienced in those spaces. Ethical approval was given prior to the commencement of the study. Nine professional male athletes who had experienced a long-term injury participated in the study using the method of emotion mapping to uncover the relationships between space and emotion.

Using this novel lens, the study further supports existing literature that details the psychological and emotional damage that can be induced by long-term injury. Therefore, emotion mapping as a method was useful and instrumental in revealing previously unknown interactions between affect and space within the context of long-term injury in professional athletes. Thus, this study highlighted the space-specific-emotional-states experienced by long-term injured professional athletes. A finding of particular note is the prevalence and intensity of negative emotions such as anger, fear and sadness in the physiotherapy room. This, alongside other findings from the study, has numerous implications for practitioners working with injured athletes and will enable practitioners to have new conversations about recovery and how negative affect may be impeding it.

Day 3. 5 slides in 5 minutes - Sport and Performance

D3.S4.1(1) Cardiovascular and metabolic responses during kettlebell high-intensity interval training in wrestlers

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Muscular strength and endurance are key physical qualities for the successful performance of wrestlers (Passelergue & Lac, 2012). High intensity interval training (HIIT) by using kettlebell strength exercises is suitable for the development of strength and endurance (Franchini et. al, 2019). Therefore, the aim of this study was to assess the effect of kettlebell HIIT on wrestlers on strength and endurance. The average HR at rest was 79±18 bpm, during warm up 121±15 bpm, during circle 1 to 4: 166±8 bpm, 170±9 bpm, 174±9 bpm, 177±8 bpm, respectively, and 10 min after the HIIT was 112±12 bpm. The mean La was 1 mmol/L at rest, 2±1 mmol/L before the HIIT, 9±5 mmol/L after the HIIT, and 4±2 mmol/L 15 min after the HIIT (recovery). Heart rate (HR) was registered continuously by using Polar H7. Blood lactate concentration (La) was measured at rest, before, immediately after, and 15 min after the HIIT. The study included 8 free style competitive wrestler (age: 22±2 years, wrestling experience: 10±3 years), at the Bulgarian Wrestling Championships. Height, weight, 8 circumferences and 8 skinfolds were measured. BMI, body fat (%BF) and skeletal muscle mass (%SMM) were calculated. With institutional ethics approval, the wrestlers performed circuit HIIT consisting of four circles with 16 kg kettlebells (8 exercises, 20 sec. work and 10 sec. rest), separated by 1 min rest. The number of repetitions for each exercise were recorded. The mean height of the wrestlers was 175±7 cm, their weight was 85±13 kg, and BMI was 28±3 kg/m2. The %BF was 10±4% and %SMM was 42±2%. The relative mean reps (per 100 kg body mass) of exercises 1 to 8 were as follows: 19±12, 26±18, 21±15, 20±14, 19±15, 17±13, 21 ±15, 19±16, respectively. For the achievement an optimal number of repetitions (10-15 reps) to improve muscular strength, it was recommended to increase the kettlebell weight for 3 wrestlers and to decrease it for 1 wrestler. The individual HR or each wrestler during the kettlebell HIIT was above 75% of HRmax, and La was above the anaerobic threshold (>4mmol/L).

D3.S4.1(2) Prevalence of overuse shoulder injuries within competitive male volleyball players in Kuwait

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Musculoskeletal overuse injuries in volleyball account for 2.5 injuries per 1000 hours exposure, with the shoulder joint the most common site of injury accounting for 12% of all the overuse injuries (Asker et al. [2018]. British journal of sports medicine, 52(20), 1312-1319). There is a lack of incidence, prevalence, and aetiology data of volleyball-specific injuries in sub elite populations, particularly overuse shoulder injuries (Kilic et al. [2017]. European journal of sport science, 17(6), 765-793). Therefore, this study aimed to establish the prevalence of overuse shoulder injuries among competitive male volleyball players in Kuwait. Following institutional ethical approval, eleven Kuwaiti competitive male volleyball teams (174 players aged 27±5 years, mass 80±12 Kg, height 182 ±17 cm) were followed throughout an 8-month season. The average weekly amount of volleyball exposure during the study was 8 hours. All players completed the Oslo Sports Trauma Research Centre Overuse Shoulder Injury Questionnaire every week throughout the season (Aasheim et al. [2018]. BMJ Open Sport & Exercise Medicine, 4(1), e000391–e000391). Roos & Marshall (2014) systematic review recommended to adopt prospective studies to address athlete-based methods for overuse data collection and comparing the results to the overuse injuries detected by monitoring systems (Roos et al. [2014]. Sports medicine, 44(3), 405-421). This supports the approach taken in the present study for investigating the prevalence of overuse shoulder injuries among volleyball athletes The average response rates during the season for all players was 56.5%. The questionnaire consists of four questions on the consequences of overuse injury on sports participation, training volume and sports performance, as well as pain. Players were defined as having an overuse shoulder injury if they recorded any reduced volleyball participation, training volume or performance, or experienced pain. They were defined as having a substantial overuse shoulder injury if they reported moderate or severe reductions in training volume and/or performance, or a complete inability to participate in volleyball. The average prevalence of overuse shoulder injury was 13.38% (95% CI 12.35% to 8.37%). The average prevalence of substantial overuse injuries was 14.41% (95% CI 22.7% to 9%). These findings suggest that overuse shoulder injuries among male competitive volleyball players are significant. The development of effective volleyball specific prevention strategies for overuse shoulder injuries should therefore be a priority.

D3.S4.1(3) Effect of strength training program with random recovery times between sets in different ratings of perceived exertion after a basketball game

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The repeated power ability training (RPA) with random recovery times between sets is an effective method to improve high-intensity actions during a basketball game (Arede, Leite, Tous-Fajardo, Bishop, and Gonzalo-Skok, 2021, Journal of Strength and Conditioning Research), however, little is known how this training protocol affects perceived exertion after a basketball game. This study analysed the effects of RPA program with random recovery times between sets in perceived exertion after a basketball game. With institutional ethics approval, twenty male basketball players were assigned, either to strength training group (n = 10), or a control group (n = 10). The strength training included: parallel back squat and bench press exercises, twice a week for the duration of 10 weeks, with two blocks of 5 sets × 5 repetitions interspersed with variable passive recovery (range = 15–35 sec.) between sets, and constant passive recovery (3-min) between blocks with the load that maximized propulsive power output. The pre- and post-test assessments included a 5-on-5 full-court situation (1 x 10 min.). Thirty minutes after each basketball game, players provided ratings for match exertion (RPE-M), along with differential ratings for breathlessness (RPE-B), and leg exertion (RPE-L), upper body exertion (RPE-U), and technical demands (RPE-T) (Weston, Siegler, Bahnert, McBrien, and Lovell, 2015, Journal of Science and Medicine in Sport, 18(6): 704–708). After training period occurred higher RPE-B ($p < 0.01$; $d = 1.07$) during 5-on-5 full-court situation for training group; and lower RPE-M ($p < 0.01$; $d = -1.05$) and higher RPE-L ($p < 0.001$; $d = 1.64$) and RPE-U ($p < 0.001$; $d = 1.77$) for control group. A significant interaction effect (group x time) was observed on RPE-B ($p < 0.05$, $\eta 2 = 0.04$, minimum effect), RPE-L ($p < 0.01$, $\eta 2 = 0.07$, minimum effect), and RPE-U ($p < 0.01$, $\eta 2 = 0.08$, minimum effect). After training program, athletes reported higher RPE-B during a basketball game, possibly reflecting higher physiological demands resulting from higher number of high-intensity actions; however, the same method seems to be effective to prevent exacerbated muscle peripheral exertion, possibly due to improved fatigue resistance. That said, practitioners can use RPA with random recovery times between sets to increase high-intensity actions and prevent exacerbated leg and upper body exertion during game. Funding: Foundation for Science and Technology (FCT, Portugal), through a Doctoral grant endorsed to the first author [SFRH/BD/122259/2016] and under project UID04045/2020.

D3.S4.1(4) Talent Identification and Relative Age Effects in English Male Rugby Union Pathways: From Entry to Expertise

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A common practice in youth rugby union is to group players based on (bi)annual age with fixed cut-off dates. The over-representation of players born at the start of the cut-off date and the underrepresentation of players born toward the end of the cut-off date are termed relative age effects (RAEs). With institutional ethics approval, the aim of this study was to examine RAEs during entry into professional and international rugby union pathways in England, as well as comparing them to their respective senior cohort: U15 Regional Academy Player (n = 1,114) vs. Senior Professional Player (n = 281) and U16–23 England Academy Player (n = 849) vs. Senior International Player (n = 48). Chi-square ($\chi 2$) analysis compared birth quarter (BQ) distributions against expected distributions. Odds ratios and 95% confidence intervals compared the likelihood of a BQ being selected. Findings revealed a significant overrepresentation of relatively older players compared with their relatively younger peers within both youth cohorts ($P < 0.001$; BQ1 = 42.5% vs. BQ4 = 9.6%; BQ1 = 36.5% vs. BQ4 = 15.2%). In comparison, there was no significant difference in the BQ distributions within both senior cohorts. Further, BQ4s were 3.86 and 3.9 times more likely to achieve senior professional and international levels than BQ1s and BQ2s, respectively. It is suggested that relatively younger players may have a greater likelihood of achieving expertise following entry into a rugby union talent pathway due to benefitting from more competitive play against relatively older counterparts during their development (e.g., reversal effects; the underdog hypothesis). Moreover, possible solutions (e.g., age and anthropometric banding; playing-up and playing-down) are discussed to encourage practitioners and policy makers to create the most appropriate learning environment for every player (Kelly et al., 2021, Frontiers in Sports and Active Living, 3, 640607).

D3.S4.1(5) Muscle damage and soreness after a change-of-direction and straight sprinting exercise protocol in male collegiate basketball players

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Change-of-direction (COD) and straight sprinting (SS) exercise differ for the amount of eccentric muscle action, since COD

requires a quick deceleration coupled with a reacceleration in a new direction (Chaabene et al., 2018, Sports Medicine, 48(8), 1773-1779). Eccentric muscle action has been postulated to induce a high magnitude of muscle damage (Hody et al., 2019, Frontiers in Physiology 10:536), even though substantial evidence is lacking for the comparison between COD and SS exercise in inducing muscle damage. Therefore, the aim of this study was to compare the time-course of recovery between a COD and SS exercise protocol. With institutional ethical approval (IRB-2018-079), a randomized, controlled, crossover study design was conducted. Nineteen male collegiate basketball players (age: 19.8 ± 1.3 years; stature: 182.5 ± 7.0 cm; body mass: 75.9 ± 7.8 kg) performed a volume-equated COD and SS exercise protocol. The COD exercise protocol consisted of 11 consecutive 10-m shuttle sprints for 5 sets for 3 blocks, with a 1- and 3-min rest interval between sets and blocks, respectively. The SS exercise protocol consisted of single linear 10-m sprints without COD actions with the same volume. Creatine kinase (CK), interleukin-6 (IL-6), muscle soreness (VAS), and performance outcome (505 test) were measured at baseline, POST, 24, 48, 72 h after exercise protocol. Repeated measure ANOVAs (condition: COD, SS; time: baseline, POST, 24h, 48h, 72h) and effect sizes (Cohen's d) were applied. An interaction effect emerged for CK, with elevated concentrations until 72h for SS condition only, whilst lower CK effluxes emerged for COD at 24h (251.1 ± 149.8 IU/L, P = 0.002, d = 0.68), 48h (205.1 ± 132.7 IU/L, P = 0.001, d = 0.64) and 72h (194.8 ± 109.4 IU/L, P = 0.027, d = 0.39) compared with SS (24h: 472.2 ± 449.9 IU/L; 48h: 403.8 ± 482.6 IU/L; 72h: 301.9 ± 300.9 IU/L). A time effect emerged for VAS, IL-6, and performance outcome. Compared with baseline (0.3 ± 0.6 AU), VAS peaked at 24h (5.3 ± 2.5 AU, P < 0.01, d = 2.80) and remained elevated until 72h (2.8 ± 1.9 AU, P < 0.01, d = 1.84). IL-6 and performance outcomes were elevated only at POST and returned immediately at baseline level. This study demonstrated a different magnitude of muscle damage and pattern of time-course of recovery between SS and COD exercise protocol, regardless the eccentric muscle component, providing guidance for training program prescription in team sports.

D3.S4.1(6) Exploring numerical unbalanced scenarios in ball possession small-sided soccer games

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Players' performance in soccer results from their ability to use the environmental information to sustain their decision-making process. However, when players are exposed to different rules, as unbalanced number scenarios, different behaviours may emerge compared to equal number. This study aimed to explore the effects of playing different numerical unbalanced ball possession small-sided games on external workload (distance covered while walking, running, sprinting, and max speed) and internal load of perceptions (RPE) on under-23 soccer players. Twenty-one players participated in this study, performing a 4-series of 4vsX (2, 3, 4, 5 and 6) SSGs for ball possession on a 30x25m playing area. On the opposition-based perspective, variables were analysed by fixing the same four players and compared them against 2 (High-Superiority), 3 (Superiority), 4 (Balanced), 5 (Inferiority) and 6 (High-Inferiority); on the cooperation-based perspective, variables were analysed by comparing performances from the same 2 players when counting with 0 (Very Low-Cooperation), 1 (Low-Cooperation), 2 (Balanced), 3 (High-Cooperation) and 4 (Very High-Cooperation). Global positioning system was used to collect external workload and Borg Scale CR10 to RPE. Pairwise comparisons were carried with 95% Confidence Intervals. The experimental protocol and investigation were approved by the local Institutional Research Ethics Committee and performed in accordance with the ethical standards of the Helsinki Declaration. Written informed consent procedure was undertaken with all participants, the coach and the club before data collection. In opposition, differences were found for High-Superiority (4v2), with large effects on running and RPE, and for High-Inferiority (4v6) on sprinting, max speed and RPE. In cooperation, differences were found on Very Low-Cooperation (4v2+0), with very large effects on walking and large effects on running and sprinting; and on Very High-Cooperation (4v2+4), with large effects on running, max speed and RPE. Greater effects were observed on unbalanced formats of two players, for both perspectives: teams in numerical inferiority covered more distances at higher intensities and perceived the exercise more intense, while teams in superiority covered more walking distance. As so, coaches may use inferiority scenarios to foster players' physical demands (e.g., for players that did not perform 60 min of the match), while using a team in superiority (e.g., line up players) to perform active recovery, while simultaneous developing the ability to maintain ball possession.

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