

subjects (N= 78, mean age, 33.4y; range 19-72y) were included. The subjects participated in four tests: I. Ground walking over a 20 m distance, II. Ground jogging over a 20 m distance, III. Treadmill jogging at a constant speed of 8.5 km/hr for a 15-second interval and IV. Elliptical jogging over a 20 second period at a resistance and incline level of 10, and at a steady pace within the range of 70-95 steps/min.

Results: In walking tests, the APBW value on the entire foot value was 112% (SD=15.57), 80% (SD= 15.92) on the hind foot, and 108% (SD= 15.47) on the forefoot. In ground jogging, the APBW value on the entire foot was 201% (SD= 31.24), 101% (SD= 21.78) on the hind foot, and 174% (SD=28.52) on the forefoot. In the treadmill test, the APBW value on the entire foot was 175% (SD=25.48), 88% (SD=24.86) on the hind foot, and 146% (SD=25.59) on the forefoot. In the elliptical test, the APBW value on the entire foot value was 73% (SD=13.8), 33% (SD= 13.7) on the hind foot, and 48% (SD= 15.9) on the forefoot.

Conclusion: Elliptical training significantly reduces weight-bearing as compared to other common functional and sporting activities.

Impact:

- Elliptical training can be used in cases where weight bearing needs to be reduced
- Early rehabilitation can be commenced early on in rehabilitation to prevent muscle atrophy and maintain cardio-pulmonary function

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Influence of a nonlinear pedagogy approach on individual routes of learning when acquiring a complex weightlifting skill

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Introduction: Traditionally, reducing performance variability is synonymous with 'optimal' skill learning, however, contemporary skill acquisition approaches, such as Nonlinear Pedagogy (NLP), view variability differently. Exploration (i.e., movement variability) of alternative movement patterns, even those considered suboptimal, are thought to be important in learning, facilitating the development of adaptable and individualised movement solutions (Chow et al., 2022). This exploratory study aimed to describe the individual dynamics of performance related to the level of movement exploration when learning the power clean skill using a NLP approach.

Methods: Four healthy adults, categorised as weightlifting beginners (Everett, 2012), practiced the power clean over 7 sessions for 4-weeks. Consistent with NLP design principles, analogy-based instructions were used to avoid explicit technique prescription (Komar et al., 2014) and two task constraints (poles in front of lifter and chalk on barbell; Verhoeff et al., 2018) were introduced in sessions 2-5 to infuse practice variability and encourage movement exploration. Sessions comprised a warm-up of 1×5 repetitions (20kg barbell), followed by 3×5 repetitions (30kg barbell) recorded using 3-D motion capture to track 36 retroreflective markers to create nine time-continuous variables. Cluster analysis quantified individual movement to provide an exploration/exploitation ratio (EER). Exploration occurred when movement clusters differed between

two repetitions and exploitation occurred when movement on repetitions was the same (Komar et al., 2019). To quantify performance changes, horizontal barbell displacement was measured from start position to final catch position (B×D) (Winchester et al., 2005).

Results: Individual differences in movement exploration across sessions were apparent. Lifter A demonstrated the least exploration (EER = 0.07 – 1.8) and largest improvement in B×D early in practice (S1 to S3 = 14.40%). Lifter B explored most in S4 and S5 (EER = 2.75 – 4) and showed minimal changes in B×D across sessions (S1 to S7 = -2.39%). Lifter C demonstrated high levels of exploration across all sessions (EER = 1.14 – 3.66) and improved B×D later in practice (S5 to S7 = 9.23%). Lifter D explored most in session 4 (EER = 6.50) and displayed largest improvement in B×D between S1 to S3 (5.12%).

Discussion: NLP-designed practice had different impacts on performance dynamics and levels of exploration for lifters. All lifters demonstrated improved performance outcomes, but displayed different routes of learning (Kostrubiec et al., 2012). Some learners (i.e., Lifter C) may display more exploration to discover a functional, stable performance solution (Bifurcation route). Other learners (i.e., Lifter A) may display less exploration while gradually transitioning between movement patterns (Shift route). Practical implications include how explicitly prescribing an "ideal" technique may not be necessary to achieve optimal performance, with NLP-designed practice potentially facilitating the development of individualised movement patterns matched to individual capabilities.

Impact and application to the field: Findings challenge a "one size fits all" approach, indicating that skill development is highly individualised and movement variability is not necessarily "poor performance", but may represent a beneficial exploratory component of the learning process.

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Risk factors for the development of femoroacetabular impingement in physically demanding occupations: a systematic review

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Background: Femoroacetabular impingement (FAI) syndrome, or hip impingement, is a musculoskeletal condition affecting the hip joint. It involves motion- or position-related pain originating from an abnormal, premature contact between the femoral head-neck junction (femur) and the acetabular rim (rim around the hip socket). Cumulative and repetitive mechanical overloads at the hip joint appear to contribute to the development of FAI. However, occupational exposures to such loads in potential high-risk occupational groups (e.g., military personnel and athletes) and the relationships between these exposures and the development of FAI remain unclear. Therefore, the aim of this review was to identify and synthesise findings from studies which have reported on the occurrence rates and risk factors between occupations or occupational tasks in physically demanding occupations, and the development of FAI.

Method: This review was conducted according to the PRIMSA-P guidelines and registered on the Open Science Framework. PubMed, EBSCO, Scopus, Web of Science, CINAHL and ProQuest databases

were systematically searched using the following key themes: 'femoroacetabular impingement', 'work' and 'risk'. Key findings from the included studies were extracted, including risk factors, prevalence or incidence and risk ratios (e.g., relative risk, hazard ratios, and incidence rate ratios). Included studies were critically appraised using the Joanna Briggs Institute tools.

Results: Six studies met the eligibility criteria, with the average methodological quality generally indicating 'good' quality overall. The findings from this review indicate that FAI is more prevalent in occupations involving high physical activity, such as professional soccer and hockey players and military personnel compared to the general population. While specific occupational tasks were not highlighted in the included studies, the occupational demands described for each occupation suggest that occupations involving repetitive hip flexion (e.g., kicking and squatting) and sustained positions in extreme hip joint ranges were associated with FAI. Occupations where these loads are, or have been, experienced prior to skeletal maturity (e.g., professional, or elite athletes) and workers with a history of high-level sport or physical activity participation (e.g., military personnel) are at higher risk of developing FAI. The review also found military personnel with FAI were observed to have lower hip joint space measurements when compared to civilians with FAI, and this may further compound the development of FAI in military personnel by bringing the bone structures within the joint closer together and so making impingement more likely.

Discussion: The findings of this systematic review found occupations where individuals are constantly exposed to high-intensity and high-impact physical activity as well as repetitive and supra-physiologic hip loading conditions are more prone to developing FAI. However, the studies identified in this review unfortunately did not contribute to elucidating which specific occupational tasks, at which frequencies and durations, would increase the likelihood of developing FAI, particularly in physically demanding occupations.

Impact: Professional athletes and military personnel are at a higher risk of developing FAI. As FAI is a precursor for hip osteoarthritis, specific risk factors for FAI need to be more accurately identified and managed to reduce the incidence of FAI in these populations.

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A snapshot of content delivery in Australian Exercise and Sport Science undergraduate programs

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Introduction: Exercise and Sport Science (ESS) is a multidisciplinary field, with undergraduate degrees offered at most Universities in Australia. No previous studies have explored the content of the curriculum across Australian undergraduate ESS courses, and this is important to understand as these programs respond to and shape industry trends and directions and aim to prepare graduates with broad knowledge and skills to equip them for professional work in the field or to pursue further study (e.g. postgraduate). The aim of this project is to provide a snapshot of the range of units offered in Australian ESS courses, to conceptualise the broad content that encompasses the study of ESS and the preparation of graduates in the field.

Methods: Data for this exploratory study was gathered through publicly available University course material, with 31 ESS courses included. Authors independently reviewed the description and learning outcomes of each unit of study, and grouped them according to commonalities. Only core units were included in this study (i.e., elective choices were excluded). Descriptive statistics were used to compare frequency of units across the Australian ESS programs.

Results: 65 distinct core units were identified following analysis. The 10 most common units delivered across Australian ESS programs (in order) were Biomechanics (100% of courses offered this unit), Exercise Physiology (100%), Exercise Prescription and Delivery (90%), Research Methods and Data Analysis (90%), Exercise and Sport Psychology (87%), Functional Anatomy (84%), Advanced Exercise Physiology (77%), Motor Control and Learning (71%), Advanced Biomechanics (68%), Physical Activity and Exercise for Health (68%). 55% of EXSS courses offer a Career Development unit that involves placement plus career preparation classes, and 39% of courses offer a Strength and Conditioning Unit. Sports Medicine and Injury Prevention was offered in 35% of courses.

Discussion: Australian ESS programs appear to have a strong focus on exercise-related components, which may reflect current accreditation requirements for exercise science. This shift is reflected as exercise-related courses such as Biomechanics, Exercise Physiology, Exercise Prescription and Delivery are offered more frequently than sports-focused units such as Strength and Conditioning or Sports Medicine. The literature suggests a key focus on developing soft skills (e.g., interpersonal), and ability to translate scientific knowledge to key stakeholders such as coaches to be vital for ESS practitioners, suggesting that course developers may consider offering more units such as Career Development.

Impact and application to the field: This project provides a summarised snapshot of the range of content offered across Australian ESS programs, providing a picture of what ESS is conceptualised of as in academic contexts and the content that is shaping the graduates from ESS courses and thus the profession. This knowledge helps recognise the content provided in Australian Universities, allowing future research to analyse whether these content areas and how they match professional and further study requirements. Further, this will allow academics to understand how ESS courses change in the future.

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Macro periodisation of competition in international women's tennis: a long-term athlete development perspective

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Introduction: Competition profiles of future successful female tennis players are limited to anecdotal evidence and case reports. Consequently, Federations are challenged in providing empirically supported recommendations to players that align with previous research on ranking trajectories that distinguish future top 100 (T100) players. Accordingly, this study differentiated the international competition engagement of elite (T100 and top 250 [T250]) female tennis players during their youth (13-18y).

Methods: Historical tournament data was analysed for 258 female players from their international age of eligibility. Players were categorised into groups based on peak professional ranking of