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# SPRINT

## SPORTS RESEARCH INTERNATIONAL

Selected Abstracts of the 24th International  
Scientific Students' Conference

Hungarian University of Sports Science,  
April 24–26, 2024, Budapest, Hungary



# **SPRINT – Sports Research International**

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The 24th International Student Science Conference was held at the Hungarian University of Sports Science from April 24 to 26, 2024 in Budapest, Hungary. The conference attracted a total of 176 registered participants and many additional visitors. In the 11 sections, 72 high-quality presentations were given, and the three-day event was also enriched by a plenary session and two invited keynote presentations as part of the opening ceremony. The event was held for bachelor-, master- and doctorate-level students presenting their latest scientific results in front of an international audience and scientific board. The Conference was organized and supported by the university's rector Professor Tamás Sterbenz, vice-rector of Science and Innovation Professor Zsolt Radák, Chair of the Student Research Society Dr. Zsuzsanna Kneffel, and Co-Chair Dr. Szilvia Perényi.

# Selected Abstracts<sup>#</sup> of the 24th International Scientific Students' Conference held at the Hungarian University of Sports Science, April 24–26, 2024, Budapest, Hungary

<sup>#</sup> *Authors agree to the publication of their abstract and are solely responsible for the content.*

## The Matilda effect: Analysis of the Australian media coverage and impact of the 2023 Women's World Cup

Author(s): **Alana Richardson**, German Sport University, Cologne, Germany

Supervisor(s): Dr. Ansgar Molzberger

Session: Sport management, organizations & media

Soccer in Australia has a rich multicultural history. Although it is the second most participated sport in 0-14 year old boys, and the fifth most for girls of the same age, the sport has not experienced the same cultural kudos as other footballing codes such as Australian Rules or Rugby. Until the 2023 Women's football world cup where unprecedented numbers of spectators, more than ever recorded, tuned in to watch Australia's most successful women's world cup campaign. This research explores the meteoric rise of the Matilda's into household names and national heroes. This article analyses media coverage from each of the world cups that the Matildas have participated in, and compares what was different about this one. Besides the interest in a home world cup, Australian media has shown that if female athletes are represented fairly and respectfully then attitudes towards them can significantly shift. While great progress has been made in the visibility of women's sports, it is yet unclear whether this is going to have tangible impacts on the position of the women's game and moving towards gender equality in the sport. Even though the reporting was better, it certainly was not perfect and the Matildas were not completely spared of sexist reporting. Ultimately though, this seems like a positive step forward for women's sport in Australia and time will tell whether the momentum from the world cup has been leveraged to produce better outcomes for women and girls at all levels of Australian sport.

*Keywords: soccer, women, media*

## Effect of mental training on adolescent artistic swimmers

Author(s): **Borbála Bernadett Zala**, Hungarian University of Sports Science, Budapest, Hungary

Supervisor(s): Prof. Dr. László Tóth

Session: Psychological aspects of sports (PhD session)

Mental training programs have been used for decades to increase athlete performance (Wolframm and Micklewright, 2011), as mental training facilitates successful performance and improves athletes' sense of personal well-being (Vealey, 2007). Aim of our research was to examine the effect of a mental training program in artistic swimming on junior age group athletes (16-18 years). The impact assessment was conducted in a single-case experimental design (Barker, McCarthy, Jones, & Moran, 2011). Six junior athletes from a successful synchronized swimming division participated in the research. Independent variables in the arrangement were six suitable mental training interventions, while dependent variables were somatic and cognitive anxiety of athletes and their self-confidence connected with racing.

Intervention was based on a mental training program developed by Selk (2009). It included opportunities for self-confidence, relaxation, cognitive techniques, imagination, and goal setting. Comparing results of basic level and intervention measurements, all athletes had at least a moderate (2 athletes) or a large effect (4 athletes) of cognitive anxiety. After intervention, athletes coped more easily with their negative thoughts, more successfully using the positive internal speech technique in a competitive situation. When examining somatic anxiety and situation-specific self-confidence, effectiveness of sessions was not clear, as in case of both factors only on half of the study sample (3 athletes) had at least a moderate effect.

*Keywords: sport psychology, self-confidence, artistic swimming*

## **Make some noise for the electric racing – The involvement of athletes of electric motorsport series in sports diplomacy**

Author(s): **Dorottya Borbála Rafáczné Gerics**, Hungarian University of Sports Science, Budapest, Hungary

Supervisor(s): Dr. Tamás Dóczy

Session: Sports in society (PhD session)

My work examines electric racing series, which are emerging in international motorsports, focusing on the alleged sport diplomatic role of athletes in this innovative environment which reflects on a number of today's problems outside of sport. I examine the extent to which the competitors in these electric racing series can be seen as sports diplomats, representing the innovative aspirations and environmental awareness of motor sports, which are known to be polluting, to sports fans and those less affected by the sport.

My research focused on four internationally popular championships in electric racing: Formula E, Extreme E and the eTouring Car World Cup (ETCR) for race cars, and MotoE for motorcycles. Analysing of the public communication of the series and their drivers, I examined the social media platforms of the drivers and riders competing in the 2022 in the series and reviewed their interviews that gained bigger publicity. In addition, I conducted in-depth interviews with 6 drivers from the series, 2 mentors and the team principal of the team that won the first ever season of ETCR, to get to know their experiences and motivations.

I found that most competitors only participate in the mandatory programmes that their championships or sponsors ask them to attend, but these programmes do not give the opportunity for much international publicity, typically the participants do not even share them on their social media platforms. Although series and manufacturers try to link the message of electric racing with sustainable development and electric transportation, the drivers are partners only to a limited extent and do not support these efforts beyond the mandatory activities. Nor do they highlight the electric nature of the series and its contribution to sustainability in their communication about racing and racing series.

Overall, although they are in a position to represent the interests of the championship at international level and to help achieve the federation's and the sector's objective of raising public awareness of the need for sustainable development, they do not take up this opportunity. And when some do stand out at centrally organised events, these commitments are not decisive, they disappear into the background of other marketing activities linked to the championships.

*Keywords: motorsport, sports diplomacy, electric racing*

## Exploring the element of sports and recreation on tourist motivation in Cambodia

Author(s): **Leny Keo**, Hungarian University of Sports Science, Budapest, Hungary

Supervisor(s): Dr. habil. Miklós Bánhidi

Session: Sport management, organizations & media

The travel motivation to a destination is important for destination management marketing strategies. It supports the perception of an individual on the purpose of why he/she should travel to a destination whether it is for various reasons such as relaxation, curiosity, experience, adventure, or to increase knowledge on a particular topic but without the help of an individual itself, travel motivation will not exist in the first place.

This research paper aimed to identify travel motivation by push and pull factors that affected the decision-making of international tourists in selecting Cambodia as their destination choice. Results of data analysis also revealed that tourists are willing to experience recreation and sports activities when they visit Cambodia and that local activities proposed in hotels and resorts are well offered as activities during holidays.

The findings of this study suggest that sport tourism has the potential to be a major driver of economic growth and development in Cambodia. By understanding the motivations and expectations of sports tourists, and by developing policies and programs to support sport tourism, the Cambodian government and sports tourism operators can attract more visitors and create new jobs. In conclusion, this paper was presented and some recommendations are suggested to tourism marketers to promote local activities and recreation in the tourism product mix.

*Keywords: travel motivation, sport management, visitors' experience, push and pull factors*

## Post-injury mental disorders among handball players

Author(s): **Luca Bakos**, Hungarian University of Sports Science, Budapest, Hungary

Supervisor(s): Prof. Dr. László Tóth; Renátó Tóth

Session: Sport experience

*Objectives:* The purpose of this study is to examine the mental health of handball players. There are plenty of studies on athlete's mental health where it is described that injured athlete often experiences mental disorders. Our aim is to find out what percentage of handball player suffer from mental disorders and the types of disorders that can occur during their careers and what help they seek to recover.

*Methods:* A total of 150-200 women and men handball players are taking part in our research. The physical injuries and mental health of the handball players were measured using the Hungarian version of the questionnaire, which will help us to see how the two are related and how much there is a need for professionals (sports psychologists) to work with the athletes.

*Results:* Our results indicate that a large proportion of handball players experience mental disorders (prevalent anxiety and mood disorders) and that there is a strong correlation between injuries and mental health. Our results so far also show that a higher percentage of handball players would seek professional help for their mental health problems if they had more opportunities.

*Discussion:* Handball is an injury-prone sport. Injuries are often accompanied by mental disorders that are difficult for athletes to deal with. These disturbances can affect the athletes' personal lives and performance and in many cases their mental recovery can take longer than 10 weeks.

*Conclusion:* Given our findings, the mental health of handball players should be addressed more by professionals (e.g. sports psychologists), because a much higher percentage of athletes experience mental disorders. With this change, more handball players' careers could be changed.

*Keywords: sport injuries, mental disorders, sport psychology*

## Impact of High-intensity interval exercise on executive performance and prefrontal cortex activation in the elderly: A pilot investigation

Author(s): **Marta Skurewicz**, Gdańsk University of Physical Education and Sport (GUPES), Gdańsk, Poland; **Natalia Winowiecka**, Gdańsk University of Physical Education and Sport (GUPES), Gdańsk, Poland; **Radosław Laskowski**, Gdańsk University of Physical Education and Sport (GUPES), Gdańsk, Poland

Supervisor(s): Dr. Sylwester Kujach

Session: Aging

*Objectives:* Growing body of evidence suggests that engaging in physical exercise holds considerable promise in enhancing cognitive functions. Our previous research has shown that High-intensity interval exercise (HIE) can improve the physical fitness and cognitive function of young people, but the results of studies among seniors are still ambiguous. Several studies have revealed that exercise enhances human cognition via exercise-enhanced neurotrophins and catecholamine synthesis, which is known to mediate neural plasticity and energy metabolism in the brain. However, the neural mechanisms behind the post-exercise improvement of cognitive functions in seniors are still being sought. The purpose of the present study was to assess acute effect of HIE on executive function focusing on underlying neural substrates among older adults.

*Methods:* The study involves sixteen elderlies. The main experiment consisted of two sessions, control (CTL) and high-intensity interval exercise (HIE) separated by at least one week. Each trial was conducted in a randomized, counterbalanced manner, with half of participants starting with the HIE session. The HIE protocol consists of eight 60s cycling bouts at ~90% HRmax intensity and 30 s resting. Participants performed the Trial Making Test (TMT-A and TMT-B) before and after exercise bouts or control. Cortical activation has been measured applying functional Near-Infrared Spectroscopy (fNIRS).

*Results:* HIE contributed to a significant, shorter execution time in TMT-B test. Moreover, an increased prefrontal activation in left dorsolateral prefrontal cortex - DLPFC and in the middle frontal gyrus - MFG has been observed following acute bout of HIE.

*Discussion:* The aim of the present study was to assess acute effect of HIE on executive performance and prefrontal cortex activation among older adults. We found Stroop interference-induced brain activation in both hemispheres DLPFC and MFG. This activation was significantly increased in response to an acute bout of HIE, which coincided with cognitive abilities improvements.

*Conclusions:* The results suggest that the proposed HIE protocol can effectively improve executive function in the elderly, which can be attributed to increased activation in cortical areas relevant to cognitive functioning.

This work was supported by the Polish National Science Center under Grant No: 2019/33/B/NZ7/01980

*Keywords:* High-intensity interval exercise, executive performance, prefrontal cortex activation

## Incline-dependency of the power-duration relationship in cross-country skiing

Author(s): **Márton Horváth**, Mid Sweden University, Östersund, Sweden

Supervisor(s): Dr. Erik Andersson

Session: Sport and Performance

This study aimed to investigate the influence of incline on power output and the power-duration relationship in cross-country skiing through a novel approach advanced from Morton's three-parameter critical power model.

Twelve trained male cross-country skiers (age:  $32 \pm 6$  yrs) completed the identical exercise protocol both at  $2^\circ$  and  $8^\circ$  incline in a randomized order by utilizing the double-poling sub-technique. The protocol included an incremental maximum speed test and four constant work rate trials with target durations of 5, 20, 80 and 320 seconds, performed until volitional exhaustion.

Comparing  $2^\circ$  and  $8^\circ$  incline, participants reached significantly lower end speeds during the maximum speed tests while eliciting significantly higher mechanical power outputs at the  $8^\circ$  incline (both  $p < 0.001$ ). Throughout the predictive trials, participants demonstrated 58-111% greater power outputs at  $8^\circ$  compared to  $2^\circ$  incline, with a trend of steadily declining difference as exercise duration increased. Regarding extracted model parameters, anaerobic work capacity significantly differed at  $2^\circ$  versus  $8^\circ$  incline ( $6.8 \pm 1.6$  kJ vs.  $21 \pm 7.5$  kJ,  $p < 0.001$ ). In contrast, critical power values exhibited a relatively small difference of 9% between the two setups ( $p = 0.1$ ).

The results of our investigation indicate that anaerobic work capacity is incline-dependent but not critical power. Furthermore, they suggest that the increased power output during predictive trials at an  $8^\circ$  incline stems from the expanded availability of work above the critical power. The developed methodology shows great potential for extending the current screening protocols in cross-country skiing diagnostics.

**Keywords:** *critical power, anaerobic work capacity, cross-country skiing*

## Physical activity of female students of the University of Montenegro

Author(s): **Milena Mitrović**, University of Montenegro, Podgorica, Montenegro; Educons University, Sremska Kamenica, Serbia; **Nikolina Kovačević**, University of Montenegro, Podgorica, Montenegro; **Abdela Čarapić**, University of Montenegro, Podgorica, Montenegro

Supervisor(s): Prof. Dr. Dušan Stupar; Dr. Bojan Mašanović

Session: Physical activity

**Objectives:** Physical activity is one of the most important aspects of a healthy lifestyle at any age. Despite this, the latest results presented by the WHO (2022) are extremely worrying. According to them, 28% of the world's adult population and even 81% of adolescents are not physically active enough. The main goal of this research is to determine physical activity in the weekly regime of the life cycle of students in Montenegro.

**Methods:** The sample of respondents consisted of 369 female students (18-24 years old) of undergraduate and master studies at the Faculty of Philosophy and Philology in Nikšić, University of Montenegro. The research instrument was a short version of the IPAQ questionnaire, which assesses physical activity in the last week. It was estimated, using the metabolic equivalent (MET minutes), how much time female students spend weekly performing total physical activity, intensive (MET min = minutes  $\times$  8), moderate (MET min = minutes  $\times$  4) and light physical activity (MET min = minutes  $\times$  3). Descriptive statistics (arithmetic mean, standard deviation) were used for data processing.

**Results:** The results show that female students of the University of Montenegro spend  $702.91 \pm 259.56$  MET minutes per week performing physical activities. At the same time, female students mostly practice moderate physical activity ( $288.46 \pm 87.12$  MET minutes, 72 minutes/week), then light ( $160.65 \pm 29.16$  MET minutes, 53 minutes/week) and the least intense ( $253.80 \pm 143.80$  MET minutes, 30 minutes/



week). Also, female students of the first year are more active compared to other years. When it comes to basic studies, physical activity decreases with age, and then increases in master's studies.

*Discussion:* According to the criteria proposed by the WHO, the activity of Montenegrin female students is at a moderate level. The reasons for this can be found in the lack of free time for physical activity due to studies, as well as additional obligations, academic stress, etc. also affect reduced physical activity. Comparing the results with the results of other researches, it can be noticed that the level of physical activity of female students is at the level of female colleagues from the region, but much lower than that of female students from Europe.

*Conclusion:* Given the importance of physical activity in all areas of life, it is necessary to take appropriate measures to improve the physical activity of female students through the introduction of regular physical education classes at faculties, organized exercise, etc. It is also necessary to conduct additional research that includes other faculties and a larger number of students, in order to obtain as precise results and conclusions as possible.

*Keywords:* *physical activity, female students, Montenegro*

## **The correlation between hand strength, flexibility and cognitive function in rhythmic gymnasts aged 6-8 years old**

Author(s): **Min Ye**, The Russian University of Sport (GTSOLIFK), Moscow, Russia

Supervisor(s): Prof. Dr. Tatyana Solomonovna Lisitskaya

Session: Exercise in Youth

*Objectives:* To explore the relationship between hand strength, flexibility and cognitive function in rhythmic gymnasts aged 6-8 years.

*Subjects:* 12 girls from Moscow Sofia Rhythmic Gymnastics Club, (age  $6.75 \pm 0.95y$ ).

*Methods:* Measuring hand grip strength, count the number of flexibility test movements within 10 seconds, cognitive functions including visual search, working memory and mental arithmetic ability measured by the 5×5 square Schulte table.

*Results:*

1. Schulte square has a negative correlation with left ( $r=-0.508, P0.05$ ) and right hand grip strength ( $r=-0.813, P0.05$ ), and Age has a positive correlation ( $r=0.683, P0.05$ ).

2. Age has a positive correlation with right hand flexibility ( $r=0.499, P0.05$ ), and right hand grip strength ( $r=0.631, P0.05$ ).

*Discussion:* As age increases, the development of the nervous system leads to improved cognitive function. The training load of rhythmic gymnasts exceeds the exercise load that children aged 6-8 years old can bear, resulting in excessive fatigue. As a result, the higher the grip strength, the weaker the cognitive function.

Hand flexibility and grip strength increase with age, which is in line with the growth and development patterns of children.

*Conclusion:* 1. Cognitive functions including visual search, working memory and arithmetic increase with age.

2. The growth of hand grip strength is related to age.

3. The training load for rhythmic gymnasts aged 6-8 years old should avoid excessive fatigue.

*Keywords:* *rhythmic gymnastics, grip strength, cognitive function*

## Healthy lifestyle habits among female university students

Author(s): **Mirjana Đukić**, University of Novi Sad, Novi Sad, Serbia; **Marijana Ranisavljev**, University of Novi Sad, Novi Sad, Serbia

Supervisor(s): Dr. Valdemar Štajer

Session: Physical activity

*Objectives:* Physical inactivity, sedentary lifestyle, and poor nutrition contribute to obesity among both youth and university students as young adults. (Knežević & Jandrić-Kočić, 2023). This paper examines the lifestyle habits among students at the University of Novi Sad, Serbia. *Methods:* The research included female students (N = 121) from three faculties. They filled out a questionnaire to assess lifestyle habits using Health Promoting Lifestyle Profile II (HPLP-II). *Results/Findings:* The main findings indicated that students from the Faculty of Sport and Physical Education (FSPE) had significantly higher scores ( $p < 0.001$ ) on the HPLP-II questionnaire compared with both the students from the Faculty of Medicine and the Faculty of Technical Sciences. No statistically significant differences were observed between the other two faculties. *Discussion:* The observed differences indicate that students from the FSPE have excellent lifestyle habits as indicated by the HPLP-II (Walker & Pender, 2009), while female students of the other two faculties have moderate to good lifestyle habits. *Conclusion:* By analyzing the lifestyle habits of students, we will have a better chance to evaluate their starting points, and the expected trajectory of improvement when we want to include them in some type of physical exercise program, in hopes of reducing physical inactivity and sedentarism.

*Keywords:* healthy habits, physical activity, university students

## Athlete's attitudes about commercial sports brand sponsorship and brand knowledge in the international tennis table event

Author(s): **Nikola Sarkovic**, University of Novi Sad, Novi Sad, Serbia; **Dimitrije Takaci**, University of Novi Sad, Novi Sad, Serbia

Supervisor(s): Dr. Radenko Matic

Session: Sport management, organizations & media

*Objectives:* Sponsorship in sports is of enormous interest in sports management. Its effects are essential for sports event organizers and commercial or non-sport commercial brands that use sports events to obtain publicity. The paper examines the influence of athletes' attitudes toward commercial sports sponsorship regarding a brand's ability to recall memories or associate with a brand and its products. *Methods:* The research included elite tennis table athletes (N = 281) who competed in the 25th International Christmas GEWO tennis table sport event organized in Novi Sad (Serbia) in December 2022. The congruity effects of commercial brand sponsorship on brand knowledge were monitored through a conceptual model that considered the Event Image, Event Usage, Sponsor Brand Image, and Fit as independent variables, further Self-congruity with event image as mediator, and Brand Knowledge as the dependent variable. The statistical analysis included measurement and structural models. *Results/Findings:* The main findings indicated that the Sponsor's Brand Image directly influences athletes' brand knowledge. At the same time, self-congruity with the event image mediates the relationship between other independent dimensions and brand knowledge. *Discussion:* Sponsor brand image is vital in strategic marketing, emphasizing quality, brand personality, and better characteristics than competitors. Further, Self-congruity with the event image of athletes contributes a lot to transferring the impact of essential sports event characteristics to brand knowledge about commercial sports brands. *Conclusion:* The theoretical and applied value of these results is vital for sports marketers and managers regarding the organization of similar small-scale sports events settings.

*Keywords:* sponsorship, athletes, table tennis, sport event, sports brand

## E-sport performance measurement with physical activity intervention

Author(s): **Olivér Szabella**, Eötvös Loránd University, Budapest, Hungary

Supervisor(s): Dr. Lili Kassay; Prof. Dr. Attila Szabo

Session: Psychological aspects of sports (PhD session)

*Introduction:* E-sports are associated with sedentary lifestyle, with the most influential factors in performance being the cognitive functions (Leis and Lautenbach, 2020; Ding et al., 2018). Cognitive functions can be measured with an EEG device (Shou and Ding, 2013; Shen et al., 2008; Trejo et al., 2015; Chai et al., 2016) and can be affected with physical activity (American College of Sports Medicine, 2022). This experiment, which already has preliminary unique test results, looked for the answer to whether there is a demonstrable relationship between fitness (VO<sub>2</sub>max) and brain waves, as well as the measurable performance of e-sports in-game and out-of-game.

*Sample and method:* A group of 12 volunteer, nationally and internationally active male e-sports competitors participated in a multi-step study. We assessed their absolute VO<sub>2</sub>max capacity with Cosmed Omnia software and treadmill, Garmin HR monitor and "esport\_test" protocol. We then performed a STROOP test using an EEG device. After at least 1 hour of rest, fresh air, walking and eating, we performed a specific e-sport performance test. Throughout the test, the players had an EEG monitor on their head, which measured Alpha, Beta, Gamma, Theta and Delta brain waves with a response time of 1ms. The participants completed the test twice. Once without a break (control), once interrupted by a physical activity intervention (PA). There was a 15-minute break between the control and PA tests. At the end of the study, they filled out a questionnaire with demographic, game-specific, IPAQ and subjective mental fatigue questions.

*Results:* The results of the preliminary measurements show that we were able to induce mental fatigue with a long e-sport game and positive changes can be observed in the e-sport performance elements after HIIT training and in the question of subjective mental fatigue as well.

*Conclusions:* Based on the preliminary results of the series of tests carried out on a small sample, we assume that physical activity has effects on the subjective feeling of fatigue (based on the questionnaire detail of the research) and on the brain wave graphs generated by the EEG, especially the low-spectrum (alpha, delta and theta) waves. We plan to repeat the research on a larger international sample of at least 100 people, with the same design as the current one.

*Keywords:* E-sports, physical activity, EEG, VO<sub>2</sub>max

## Effects of offensive and defensive playing strategy conditions on external loads in elite junior tennis players

Author(s): Péter János Tóth, Hungarian University of Sports Science, Budapest, Hungary

Supervisor(s): Dr. Csaba Ökrös

Session: Sport and Performance

**INTRODUCTION:** Tennis is an unpredictable individual sport, where the outcome of the matches can be influenced by the players' style, technical-tactical decisions, their state of readiness, the court surface, and the weather (Kovacs, 2006). Of all these, the style of play is one of the most decisive factors. In tennis, four types are distinguished (counterpuncher, aggressive baseliner, serve and volleyer, and all-court player), which are predominantly associated with an offensive or defensive strategy (Roetert and Kovacs, 2019). Examining amateur female tennis players, these two types of strategies have different technical-tactical actions, activity profiles, and external and internal loads (Hoppe et al., 2019, 2020). The present study aimed to examine the differences in the external loads between offensive and defensive playing strategy conditions in elite junior tennis players.

**METHODS:** Six junior male tennis players (age:  $15.7 \pm 1.0$  years; height:  $180.7 \pm 6.5$  cm; weight:  $71.0 \pm 10.8$  kg) played points in two playing conditions (offensive vs. offensive, defensive vs. defensive) for 10 minutes each. To determine the external load volume parameters, micromovement data (accelerations, decelerations, change of directions, and jumps) were measured using portable micro-sensors (Catapult OptimEye S5, Catapult Sports, Melbourne, Australia) at a sampling frequency of 10 Hz for the GPS and 100 Hz for the tri-axial accelerometer, gyroscope, and magnetometer. In addition, we also assessed intensity indicators of each tennis shot with smart tennis sensors (Zepp Tennis 2 Sensor, Zepp Labs, USA) which we mounted on the end of players' rackets. Wilcoxon signed-rank tests were used to determine the differences between offensive and defensive playing strategy conditions. The significance level was set at  $p < 0.05$ .

**RESULTS:** There were statistically significant differences between the two conditions in the total player load ( $T = 0.0$ ;  $Z = -2.201$ ;  $p = 0.031$ ;  $r = -0.90$ ) and in the change-of-direction low right parameter ( $T = 0.0$ ;  $Z = -2.201$ ;  $p = 0.031$ ;  $r = -0.90$ ). Moreover, in the defensive playing condition, the tennis players hit the forehands ( $T = 0.0$ ;  $Z = -2.201$ ;  $p = 0.031$ ;  $r = -0.90$ ) and the backhands ( $T = 0.0$ ;  $Z = -2.201$ ;  $p = 0.031$ ;  $r = -0.90$ ) with more spin. No significant differences were found between the two playing strategies in other variables.

**CONCLUSION:** Overall, our results indicate that tennis players perform more accelerations in all three planes of motion during the defensive strategy condition, suggesting that a high level of speed endurance is needed for this strategy. In addition, the players hit the ball with a higher spin in this strategy to push the opponent back as much as possible and to avoid unforced errors.

**Keywords:** tennis, strategy, external load

## Exercise inhibits Hcc tumor growth and modulates lipid metabolism reprogramming in Tme and downregulates AMPK pathway

Author(s): **Qian Yu**, Chengdu Sport University, Chengdu, Sichuan Province, China

Supervisor(s): Dr. Wang Chun

Session: Nutrition and Metabolism

**PURPOSE:** To examine the impact of exercise intervention on hepatocellular carcinoma and its metabolic processes.

**METHODS:** Male C57BL/6 mice were randomly assigned to either a sedentary group (Sed) or an exercise group (Ex). After a period of 6 weeks, all mice were subcutaneously inoculated with Hepa1-6 cells on their right back. The exercise group (Ex) continued their exercise regimen for an additional 4 weeks in order to observe tumor growth in vivo. Mouse tumor tissues were subjected to LC-MS non-target metabolome sequencing. The expression of FASN was assessed in both tumor and adjacent tissues of hepatocellular carcinoma patients. Furthermore, the expressions of FASN, CPT1, CD36, and Ki67 were measured. Finally, the triglyceride content in mouse tumor tissue was determined.

**RESULTS:** The tumor inhibition rate in the Ex group ( $475.23 \pm 22.16$ ) exhibited a 20% decrease compared to the Sed group ( $590.59 \pm 54.29$ ), and there was a decrease in the expression of Ki67 ( $0.67 \pm 0.075$ ;  $1.22 \pm 0.068$ ;  $P < 0.05$ ). KEGG enrichment analysis of different metabolites in the Ex group and Sed group revealed that the AMPK signaling pathway enrichment was the most significant ( $P < 0.01$ ). ADP was significantly up-regulated in the Ex group ( $136.64 \pm 3.95$ ;  $79.13 \pm 49.03$ ;  $P < 0.05$ ), while AICAR was significantly down-regulated ( $164.59 \pm 48.13$ ;  $254.69 \pm 12.32$ ;  $P < 0.05$ ). The expression of FASN in clinical tumor samples ( $222.7 \pm 16.46$ ) was significantly higher compared to that in para-cancer liver tissues ( $165.2 \pm 11.85$ ) ( $P < 0.05$ ). Additionally, in the  $102.975 \pm 12.97$  group, the expressions of FASN, CPT1, and CD36 were significantly higher than those in the Sed group ( $350.276 \pm 3.75$ ;  $24.807 \pm 3.42$ ;  $183.789 \pm 17.18$ ) ( $P < 0.05$ ). Moreover, there was a noticeable increase in the accumulation of lipid droplets in tumor cells.

**CONCLUSIONS:** Exercise has the potential to further restrict the energy supply of tumor cells through the inhibition of fatty acid uptake, oxidative degradation, and de novo synthesis.

**Keywords:** *running wheel, cancer, lipid metabolism*

## Effect of an ACL prevention programme on dynamic knee valgus in female football

Author(s): **Rodrigo Silva Sousa**, Hungarian University of Sports Science, Budapest, Hungary

Supervisor(s): Dr. Míra Ambrus

Session: Biomechanics

**Introduction:** Knee injuries, prevalent in soccer, often result from high loads during landing or directional changes, leading to dynamic knee valgus (DKV). Excessive DKV heightens the risk of knee injuries, notably ACL injury, particularly in women's soccer, affecting players' careers. Well-designed prevention programs can improve joint stability and movement technique, thereby reducing the risk of injury. Preventing ACL injuries is crucial for female soccer players' health and success. However, research on injury prevention primarily targets male athletes or other sports, underscoring the necessity to assess tailored programs for female soccer players.

**Hypothesis/Objective:** This study aims to assess a physiotherapy program's effectiveness in reducing DKV and preventing ACL injuries in female soccer players.

**Methods:** Eighteen young female soccer players (mean age =  $15 \pm 1.11$ ) without lower limb injury history participated. DKV was measured using a Kinect camera before and after the program. Paired-samples t-tests compared DKV and squat depth pre- and post-intervention.

*Results:* Significant differences were found in DKV right ( $p=0.02$ ) and squat depth on both sides ( $p<0.001$ ) between pre- and post-tests. Meanwhile, there was no significant difference on the DKV left side ( $p=0.50$ ). Players exhibited right-side dominance.

*Discussion:* This study assessed the program's effectiveness in reducing DKV on dominant side, thus may prevent ACL injuries in female soccer players. Tailored physiotherapy programs could mitigate DKV and lower ACL injury risks, urging coaches and sports health professionals to consider such interventions for injury prevention and performance optimization.

*Keywords:* *dynamic knee valgus, female football, ACL prevention*

## **PGC-1 $\alpha$ activation boosts exercise-dependent cellular response in the skeletal muscle**

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Supervisor(s): Prof. Dr. Zsolt Radák

Session: Nutrition and Metabolism

The role of Peroxisome proliferator-activated receptor-gamma coactivator alpha (PGC-1 $\alpha$ ) in fat metabolism is not well known. In this study, we compared the mechanisms of muscle-specific PGC-1 $\alpha$  overexpression and exercise-related adaptation-dependent fat metabolism. PGC-1 $\alpha$  trained (PGC-1 $\alpha$  Ex) and wild-trained (wt-ex) mice were trained for 10 weeks, five times a week at 30 min per day with 60 percent of their maximal running capacity. The PGC-1 $\alpha$  overexpressed animals exhibited higher levels of Fibronectin type III domain-containing protein 5 (FNDC5), 5' adenosine monophosphate-activated protein kinase alpha (AMPK- $\alpha$ ), the mammalian target of rapamycin (mTOR), Sirtuin 1 (SIRT1), Lon protease homolog 1 (LONP1), citrate synthase (CS), succinate dehydrogenase complex flavoprotein subunit A (SDHA), Mitofusin-1 (Mfn1), endothelial nitric oxide synthase (eNOS), Hormone-sensitive lipase (HSL), adipose triglyceride lipase (ATGL), G protein-coupled receptor 41 (GPR41), and Phosphatidylcholine Cytidylyltransferase 2 (PCYT2), and lower levels of Sirtuin 3 (SIRT3) compared to wild-type animals. Exercise training increased the protein content levels of SIRT1, HSL, and ATGL in both the wt-ex and PGC-1 $\alpha$  trained groups. PGC-1 $\alpha$  has a complex role in cellular signaling, including the upregulation of lipid metabolism-associated proteins. Our data reveals that although exercise training mimics the effects of PGC-1 $\alpha$  overexpression, it incorporates some PGC-1 $\alpha$ -independent adaptive mechanisms in fat uptake and cell signaling.

*Keywords:* *exercise, mitochondrial function, lipid metabolism*

## **Evaluation of the quality of supporting activities at Charles University**

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Supervisor(s): Dr. Jan Šíma

Session: Physical activity

Contemporary educational institutions are no longer confined to offering academic study programs alone; they have expanded their scope to encompass a diverse range of supporting activities aimed at creating a conducive and holistic environment for students and other target groups. The success of these institutions is no longer solely dependent on the quality of education they provide but also on the perceived quality of the supplementary services they offer, which often surpass the demand for formal education. While academic program evaluations are legally mandated in the Czech Republic, the assessment of supporting activities remains understudied and underappreciated.

This research project focuses on addressing this gap by undertaking a comprehensive evaluation of the quality of supporting activities at Charles University, a prominent institution in the Czech Republic. The primary objectives are to gather information regarding student satisfaction with the various supporting activities available at the university and to formulate recommendations for enhancing student contentment. Additionally, the study aims to propose a methodological framework for systematically collecting data to evaluate the quality of supporting activities across all faculties at Charles University.

In the initial phase of the project, a preliminary study was conducted to understand students' expectations from key supporting activities, namely the canteen, study room/library, and services provided by the study department. This preliminary research provides valuable insights into the baseline expectations of students. The subsequent phase, which is currently in progress, will focus on evaluating the extent to which these expectations have been met by assessing the perceived quality of the services offered.

The anticipated outcomes of this research include valuable insights into student satisfaction levels with the supporting activities at Charles University. The findings will serve as a foundation for making improvements in the supplementary services offered to students. Moreover, the proposed methodological approach can be adapted and applied to assess the quality of supporting activities in other educational institutions, thereby contributing to the enhancement of student experiences and overall educational quality. This study aligns with the ongoing efforts to foster excellence in Czech higher education and ensure that students receive a well-rounded and fulfilling educational experience.

*Keywords: quality, higher education, supporting activities*

## The appearance of homonegativity and discrimination in physical education and sport among university students

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Supervisor(s): Dr. Noémi Gyömbér

Session: Sport experience

*Introduction:* Negative attitudes and discrimination permeate many areas of life, including the sporting environment and physical education, with the academic environment and the field of competitive sport being no exception. The hierarchical structure, physical contact and authoritarian leadership in sport can create an atmosphere that can lead to abuse among athletes (Vertommen et al., 2018). A common basis for discrimination is sexual identity. Homonegativity is a broader concept than homophobia, which includes cognitive beliefs regarding homosexual persons (Hudson & Ricketts, 1980). Discrimination can have a negative impact on mental health (Coggen et al., 2003), academic achievement (Juvonen, 2010), and the love of sport (Jewett et al., 2019). Regarding mental health, the concept of resilience is receiving increasing attention as a protective factor (Keczeli, 2019). Resilience is psychological flexibility or mental fortitude (Vargha et al., 2020), which helps restore mental health after difficult and challenging experiences, and reduces the negative effects of stress (Herrman et al., 2011).

*Objective and hypotheses:* Our research aims to investigate specific forms of prejudice and discrimination among male university students and competitive athletes. Our study covers the manifestations of discrimination and its prevalence, as well as the extent of homonegativity and its relationship with mental health.

*Sample and methods:* The target population of the study was male university students aged 18 years and older (N=123; Mage=22.29; SD=5.20). In addition to demographic questions, subjects completed a test battery consisting of several questionnaires (Bogardus Social Distance Scale; Modern Homonegativity Scale; Mental Health Test) on an online platform, which took approximately 20 minutes.

*Results:* The discrimination experienced by respondents was most often reported in physical education classes (47.2%) and training sessions (29.3%), and most commonly related to sexual orientation and gender identity (31.7%). Heterosexuals were found to be significantly more homonegative than non-heterosexuals ( $t=10.592$ ,  $p<0.01$ ), as well as competitive athletes than non-competitive athletes ( $t=1.742$ ,  $p<0.01$ ). Greater social distance is held by heterosexuals and those who have not experienced discrimination. In terms of resilience, the results for those who experienced discrimination were significantly more negative ( $p<0.001$ ).

*Summary:* In the light of our findings, we consider it important to draw attention to the fact that discrimination is often directed at sexual orientation, and it would be particularly useful to take steps to prevent it through psychoeducation, including resilience and mental health related aspects. Providing an appropriate environment and atmosphere before PE lessons and trainings can further enhance the already known positive effects of physical activity.

*Keywords:* homonegativity, discrimination, mental health

## Evaluating football clubs using ORESTE and AGREPREF

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Session: Sport management, organizations & media

Understanding and evaluating the performance of football clubs is crucial for stakeholders ranging from fans to investors. Many researchers have created many approaches to evaluate their efficiency, usually using data envelopment analysis (DEA) (e.g. Badmus, 2019; Haas, 2003; Jardin 2009). Some researchers have constructed an econometric model (e.g. Baur and McKeating, 2009). There is no scientific consensus on how to evaluate their performance in a season, especially when it comes to selected criteria. According to Freyrer (1991), a football club has 3 goals – sporting, financial and social. Only few studies evaluate clubs based on all three areas.

In this study, we propose a comprehensive evaluation framework utilizing the ORESTE and AGREPREF methods, both of which are multi-criteria decision-making techniques. ORESTE is based on based on the ordinal order of variants and criteria. AGREPREF is based on pairwise comparisons of individual variants. Our sample comprises football clubs from the English Premier League during the 2018/19 season. The criteria were selected based on Šíma (2019) and Badmus (2019) approach. Both Šíma (2019) and Badmus (2019) used DEA to evaluate the efficiency of football clubs. They tried to focus on all three goals of football clubs. The selected criteria for the study were the number of points, revenue, increase of Facebook fans, wages, number of employees, and assets consumed. Every criterium was evaluated by points at the scale 1 to 20 and the weight was calculated based on the points allocated.

Analysis using the ORESTE method identifies Wolverhampton Wanderers, Watford, and Tottenham Hotspur as top performers. On the bottom, there were Manchester United and Arsenal. AGREPREF findings confirm the dominance of Wolverhampton and Watford, while also showcasing the strong performance of Manchester City. The worst results showed Fulham and Bournemouth. Both ORESTE and AGREPREF selected Wolverhampton as the winner, but the rest of the ranking is slightly different.

*Keywords:* ORESTE, AGREPREF, football club

## Acute aerobic and resistance high-intensity interval trainings affect tryptophan metabolism among the elderly

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Session: Aging

*Objectives:* Tryptophan (Trp) metabolism is a well-understood metabolic pathway with diverse effects on tissues such as muscles, liver, and the brain. Trp metabolites have neurotoxic or neuroprotective effects, and their imbalance is observed, among others, in aging. Aging is associated in general with, but not limited to, the decreased physical activity levels. Hence, the search for exercise interventions that increase the level of neuroprotective metabolites and reduce neurotoxic: neuroprotective metabolite



ratios in the elderly people are required. Therefore, we propose acute high-intensity interval training (HIIT) as a potential modulator of Trp metabolism.

*Methods:* Single bout of HIIT was completed by 39 participants who were divided into two groups: aerobic HIIT (AHIIT; n=19; 69.3 ± 3.1 years old; 14 women and 5 men) and resistance HIIT (RHIIT; n=20; 69.7 ± 3.8 years old; 15 women and 5 men). AHIIT comprised 8 sets of 1-min exercise on a bicycle ergometer at 90% of maximal aerobic power with 1 min passive rest between sets. RHIIT consisted of performing 8 resistance exercises with their own body weight or using resistance bands, lasting 1 minute with a 1-minute passive rest between sets. All training procedures were preceded by a 5-minute warm-up and ended with a 3-minute cool-down. Blood samples from the cubital vein were collected before and immediately after acute AHIIT and RHIIT for the Trp metabolites analysis using the LCMS method.

*Results:* Trp levels decreased after acute exercise in the RHIIT group (p=0.04) and showed a decreasing tendency in the AHIIT group (p=0.09). No significant changes had been observed in metabolites such as kynurenine (KYN), kynurenic acid (KYNA), 3-hydroxylkynurenine (3-HAA), 3-hydroxyanthranilic acid (3-HA), xanthurenic acid (XA) and quinolinic acid (QA) (all p>0.05). Interestingly, the combined results indicated a decrease in Trp concentration and (KYN+3HK):(KYNA+XA) ratio levels from pre to post HIIT (p=0.01 and p=0.04, respectively)

*Discussion:* Acute HIIT changes the metabolism of Trp towards increasing the concentration of neuroprotective metabolites. The decreased level of the neurotoxic: neuroprotective metabolite ratio expressed as (KYN+3HK):(KYNA+XA) is a promising direction of changes following HIIT. Hence, long-term (at least 12-week) exposure to AHIIT and RHIIT may be a sufficient stimulus to induce beneficial changes in Trp metabolism among the elderly.

*Conclusion:* Decreased Trp concentration and (KYN+3HK):(KYNA+XA) ratio levels in the blood following acute HIIT are promising changes for health among the elderly.

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*Keywords:* kynurenine pathway, high-intensity interval training, aging