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Sport and Physical Activity as Correlates of Cannabis Misuse in College Students: A Cross-Sectional Study over the Early Postpandemic Period

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Abstract

Sport and physical activity (PA) are considered protective against substance misuse, including cannabis misuse (CM). This study aimed to investigate the associations between various sport factors (SF) and PA, and CM (outcome) in college students in the early post-pandemic period. The participants were 650 college students from Croatia and Bosnia and Herzegovina (19-23 years of age, 306 females). They were tested on SF (participation in sport, sport competitive achievement, time of involvement in sport), PA (all predictors), and CM (outcome). Gender-stratified logistic regressions between predictors and binarized CM (users vs nonusers) were calculated. Males were more involved in sports (Mann–Whitney =9.36, $p<0.001$) had more experience in competitive sports (MW=11.15, $p<0.001$) and achieved better sport success than females (Mann–Whitney =8.21, $p<0.001$). Logistic regression revealed a lower likelihood of CM in males who achieved greater competitive success in sports (OR=0.87, 95% CI: 0.77–0.94) and in females who reported greater PA (OR=0.79, 95% CI: 0.59–0.97). The associations between sport success (in males) and greater PA (in females) with lower CM are multifaceted and should be investigated in more detail prospectively.

Keywords: *lifestyle medicine, psychoactive substances, correlations, influence, sports*

Introduction

Cannabis misuse (CM) can lead to a variety of physical, psychological, and social risks. Among the physical health risks, the most important are related to respiratory issues (known cases of chronic bronchitis, lung irritation, cough, and phlegm production similar to tobacco smoke), cardiovascular problems (increased heart rate and blood pressure, potentially leading to cardiovascular issues), impaired motor skills (negative effects on coordination and reaction time), and immune system suppression (cannabis may suppress the immune system, making users more susceptible to infections) (Connor et al., 2021; Hasin, 2018). With regard to psychological and mental health risks, the most important problems associated with CM are addiction (approximately 9% of users develop a dependency) and cognitive impairment (negative effects on short-term memory, attention, and learning). Furthermore, CM is associated with an increased risk of developing anxiety, depression, and psychosis, particularly in individuals who are predisposed to these conditions. Finally, CM can negatively impact academic performance and work productivity, leading to poor grades, job loss, and decreased overall life satisfaction (Connor et al., 2021). For that reason, prevention of CM is highly prioritized in public health policies worldwide.

Engaging in physical activity (PA) and sports can be an effective strategy for preventing substance misuse, including CM (Thompson et al., 2020). First, regular PA reduces stress and anxiety, which are common triggers for substance misuse. Second, exercise releases endorphins, which promote a

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sense of well-being, while PA can help alleviate symptoms of depression and improve overall mood, reducing the likelihood of CM. Further, participation in sports and PA can improve self-esteem and body image, which are protective factors against substance misuse in general. Being part of a sports team or fitness community can provide a supportive network of peers who promote healthy behaviors and discourage CM.

Not surprisingly, studies have investigated the associations between PA and sport with CM patterns in various populations, but the findings have been inconsistent. In brief, some studies found no significant difference in PA levels between groups based on CM patterns, while other research suggested that CM is associated with higher levels of PA (Ong et al., 2021; Thompson et al., 2020). Further, some studies reported lower levels of moderate and vigorous PA among participants who reported CM, while other studies noted that engaging in sports and exercise was negatively associated with CM (Henchoz et al., 2014; West et al., 2020). Collectively, it seems that association between PA and sport, and CM should be studied specifically for different populations, taking into account specific context when the researches are done.

The COVID-19 pandemic significantly impacted CM patterns. Although some studies reported no substantial changes, others found increased CM during the pandemic, while to the best of our knowledge, no study has shown a decrease in CM during this period (Mehra et al., 2023; Miller et al., 2022). Notably, individuals who used cannabis less frequently before the pandemic were more likely to increase their use during this period (Assaf et al., 2022). Factors associated with increased CM included younger age, mental health issues, pandemic-related stress, and self-isolation (Bartel et al., 2020; Mehra et al., 2023). This negative trend was particularly alarming since some studies have suggested that cannabis users might be more vulnerable to COVID-19 complications due to respiratory system effects (Borgonhi et al., 2021).

On the other hand, the COVID-19 pandemic negatively influenced PA patterns and sport partcipation globally. Multiple studies have reported substantial decreases in PA levels across various populations during lockdowns and restrictions, with dramatic decrease of organized sport participation (Kozubal et al., 2022; Sekulic et al., 2021). University students experienced decreases in light, moderate, and vigorous PA, while studies evidenced negative influence on physical and mental well-being (López-Valenciano et al., 2021; Muracki et al., 2023). However, despite the globally negative trends in PAs, some positive adaptations also occurred. For example, there was a surge in home workout routines, with many individuals turning to online fitness classes, virtual personal training, and exercise apps to stay active. Additionally, outdoor activities such as walking, running, and cycling saw an increase in popularity, as they were among the few permissible forms of exercise that allowed for social distancing. Finally, wearable fitness technology and online fitness communities gained traction, helping people track their PA levels and stay motivated.

The college and university education period is among the most stressful periods in life due to various academic, social, and personal factors. College and university students (CUS) must balance multiple assignments, exams, and projects, which can be overwhelming. At the same time, they often feel pressured to achieve high grades and academic excellence, which is additionally aggravated by the cost of education, leading to stress about paying for tuition, books, and other expenses, including managing rented food, transportation, and other living costs. Additionally, CUS are naturally challenged by navigating friendships, romantic relationships, and family expectations, while feelings of loneliness and homesickness are common, particularly for students who are far from home. Not surprisingly, CUS are often engaged in substance misuse, including CM, while their PA decreases, both resulting in detrimental health-related and negative social consequences (Elbendary et al., 2020).

From the previous literature overview, it is clear that CM should be considered a health-threatening behavior, while PA and sport participation are often considered potentially important preventive factors against CM (West et al., 2020). The potential association between these factors is even more intriguing given that both PA (including sport participation) and avoiding substance misuse are pillars of lifestyle medicine (Rippe, 2011). Its importance is particularly highlighted in the postpandemic period since the COVID-19 pandemic resulted in (i) an increased prevalence of CM and (ii) decreased PA and sport participation (Gilic et al., 2021; Mehra et al., 2023; Smirmaul et al., 2021). Studies have investigated associations between PA and sport and between PA and patterns of substance misuse in the first postpandemic year while observing alcohol consumption and smoking as outcomes (Drenjak, Pehar, et al., 2023; Drenjak, Užičanin, et al., 2023). However, there is an evident lack of studied which examined associations between PA and sports, with CM as an outcome in the early postpandemic period. Therefore, the aim of this study was to evaluate the gender-specific associations between PA and sport participation and CM in CUS in the early postpandemic period (the first postpandemic school year). We hypothesized that lower PA and sport participation would be associated with a greater likelihood of CM in CUS, irrespective of sex.

Methods

Participants

The study included 650 participants, including 306 females, who were college/university students aged 18 to 21 years. All participants were full-time students from universities in Croatia and Bosnia and Herzegovina. The researchers used multistage sampling to select participants from three convenient universities where they were employed as teachers. The faculties, the main organizational units of the universities, were categorized as "large" or "small" based on the number of students. Subsequently, 50% of the faculties in each category were chosen at random. To ensure representation from all academic years, one year was examined in each selected faculty, with the students from each academic year being randomly chosen.

Upon informing the participants about potential risks and benefits, the investigators visited each faculty member and conducted participant testing through a semi-structured questionnaire distributed digitally. Participation in the study was voluntary, and the participants were informed that they had the option to refuse to participate and could choose not to answer all or part of the questionnaire. The investigators did not collect any identification data from the participants, and prior approval was obtained from the Ethical Board of the University of Split, Faculty of Kinesiology, before the investigation commenced. The necessary sample size was calculated

before the study, and it was determined that a sample size of 601 was required based on the CM prevalence previously reported for somewhat younger participants.

Variables

In this research, we examined PA, sport factors, and CM, in addition to gender (male, female, intersex) and age (in years). The data for all variables were gathered using questionnaires that had been proven to be reliable and valid for use in local languages in the area. Detailed information on the questionnaire metrics can be found in other sources (Gilic et al., 2021; Zenic et al., 2021; Zenic & Sattler, 2021).

Sports factors consisted of variables/questions asking participants about their participation in sports, competitive sport achievement, and time spent involved in sports. Participation in sports (including recreational – noncompetitive sport) was assessed by using a scale with options including "never participated," "yes, but quit," and "yes, currently participating." Competitive achievement was queried by one question using a 4-point scale ("never participated/competed", "local competition", "national competition", "national level success"). The duration of sport involvement was assessed using a scale consisting of 4 possible answers ("never participated", "<1 year", "1-2 years", "2-5 years", ">5 years").

To measure the PA level, a condensed version of the International Physical Activity Questionnaire (IPAQ) was used. Despite the availability of diverse PA questionnaires, we opted for the IPAQ primarily because it is designed to measure "health-related physical activity." The short version of the IPAQ has been widely used in various global studies and has consistently shown reliability and validity, even in local languages. It evaluates physical activity in leisure time, yard work, occupational activity, and transportation. The questionnaire covers walking, moderate-intensity activities, vigorous-intensity activities, and sitting (sedentary time), including the frequency and duration of each activity. In this study, we measured PAL as an indicator of energy expenditure in MetS.

Possible responses to the questions assessing CM included "never used", "tried several times but don't consume it currently", "I consume it occasionally", and "I consume it regularly". Participants were later grouped as "cannabis nonconsumers" (first two responses) or "cannabis consumers" (remaining responses) for the purpose of logistic regression calculation (please see Statistics for details).

Statistics

All variables were checked for normality of the distributions by the Kolmogorov–Smirnov test. Accordingly, descriptive statistics included calculations of means and standard deviations (for PA and age) and counts/frequencies and percentages (for remaining variables).

Differences between groups were established by t test for dependent samples (for parametric variables), and Mann–Whitney tests (for ordinal scales). The associations between predictors and CM as a binarized outcome (non-users vs. users) were evidenced by logistic regression calculations, with odds ratios (ORs) and 95% confidence intervals (95% CIs) reported. Since preliminary analyses of the differences between genders revealed significant differences in sport factors between males and females (please see Results for details), logistic regression analyses were sex stratified.

Statistica 13.5 (Tibco Inc. Palo Alto, CA, USA) was used for all calculations, and a p value of 0.05 was applied.

Results

Figure 1 shows descriptive statistics for age (Figure 1A) and physical activity levels (Figure 1B) across genders. No significant gender differences were established by t tests for independent samples for study variables (t-test =0.09, and 1.11, both p>0.05, for age and PA, respectively).

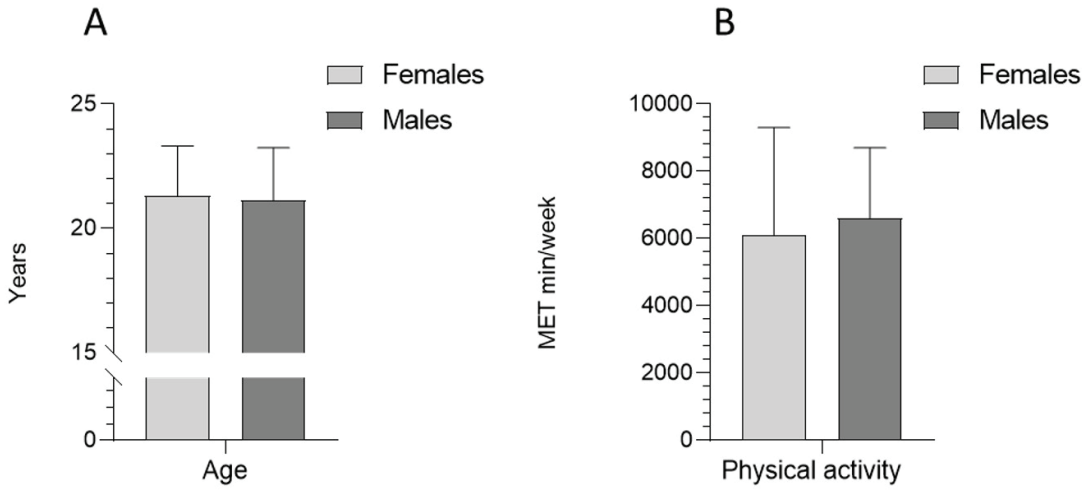

FIGURE 1. Descriptive statistics across genders (data are given as means ± standard deviations) for age (Figure 1A), and physical activity (Figure 1B)

Descriptive statistics for sport factors and CM, together with differences between males and females are presented in Table 1. Males were more often involved in sports (including recreational/noncompetitive sports) (MW=9.36, p<0.001), had more experience in competitive sports (MW=11.15, p<0.001), and achieved better competitive sport results than females (MW=8.21, p<0.001). Moreover, no significant difference between males and females was found for CM (MW=1.00, p=0.18).

According to logistic regression, competitive sport result was significantly associated with CM, with a lower likelihood of CM in males who achieved better success in sports (OR=0.87, 95% CI: 0.77–0.94). Logistic regression revealed a lower likelihood of CM in females who had greater PA (OR=0.79, 95% CI: 0.59-0.97) (Figure 2).

Table 1. Descriptive statistics (F – frequencies, % - percentages), and Mann Whitney differences between males and females in study variables

	Total		Males		Females		Mann Whitney	
	F	%	F	%	F	%	Z test	p
Participation in sports (including recreational/noncompetitive sports)								
Yes, still participating	112	17.2	86	27.0	25	8.2		
Yes, but quit	286	44.0	168	52.8	115	37.6		
No, never	232	35.7	64	20.1	166	54.2		
Missing	20	3.1	0	0.0	0	0.0	9.36	0.001
Experience in competitive sports								
Never participated in competitive sports	161	25	31	10	130	42		
< 1 year	124	19.1	52	16.4	70	22.9		
2-5 years	205	31.5	123	38.7	78	25.5		
> 5 years	139	21.4	112	35.2	27	8.8		
Missing	21	3.2	0	0.0	1	0.3	11.15	0.001
Competitive achievement in sport								
Never participated/competed	333	51	120	38	212	69		
Local competitions	247	38.0	159	50.0	83	27.1		
National competitions	40	6.2	30	9.4	10	3.3		
National level success	9	1.4	9	2.8	1	0.3		
Missing	21	3.2	0	0.0	0	0.0	8.21	0.001
Cannabis misuse								
Never	321	49.4	163	51.3	141	45.8		
Tried several times	214	32.9	91	28.6	118	38.3		
I consume it occasionally	60	9.2	41	12.9	17	5.5		
I consume it regularly	46	7.1	23	7.2	23	7.5		
Missing	9	1.4	0	0.0	9	2.9	1.00	0.180

Note that participants who specified intersex were not included in analyses of the differences due to small number of frequencies

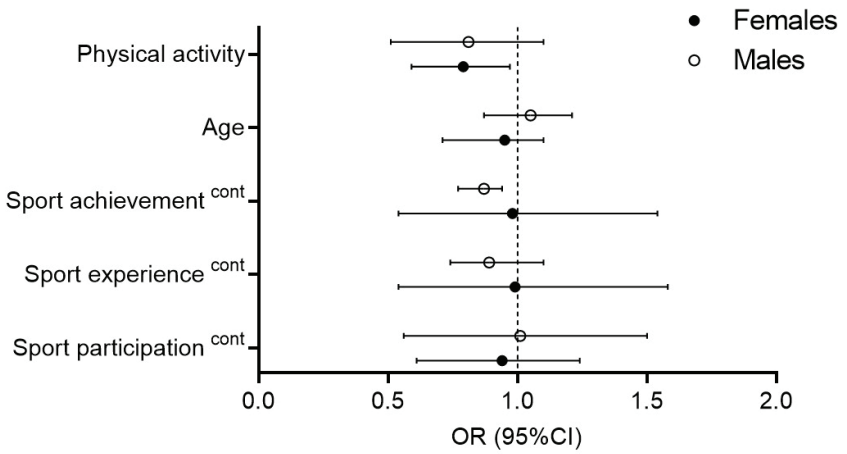

FIGURE 2. Logistic regression results for binarized outcome – cannabis misuse for males and females (cont denotes variables considered as continuous for the purpose of regression calculation)

Discussion

There are two important findings with regard to the study aims. For males, a lower likelihood of CM was found for those students who achieved greater sport success. For females, a higher PAL was associated with a lower likelihood of CM. Therefore, our initial study hypothesis could be accepted.

A lower likelihood of cannabis misuse in males who achieved more competitive results in sports

As specified in the introduction, studies have investigated the association between sport participation and CM, but the findings are inconsistent (Thompson et al., 2020). With regard to those studies where a certain protective effect of (competitive) sport participation against CM was noted, the authors

highlighted several factors that are transferable to our study as well, irrespective of the fact that we did the study in the first postpandemic year. However, although the literature provides numerous explanations for the possible background of the studied association, some of the theories are not applicable to our study, simply because of contextual factors (i.e., investigations of college/university athletes in the USA preparing for professional careers in their sport and studies where college/university athletes were directly interested in achieving scholarships). Therefore, in further discussion, we will focus on structured lifestyles and social environments, stress management, and health and performance issues, as factors influencing sport participation and sport success, on CM.

Student athletes often follow a rigorous schedule that includes practices, workouts, and games, leaving less free time for substance misuse, including CM. The discipline required to maintain such a schedule may also discourage CM. Although studies on college/university athletes are relatively rare in southeastern Europe, some recent investigations confirmed such findings in older adolescents. For example, a study on Croatian high school students revealed competitive achievement in sports as a protective factor against multiple substance misuse and explained this finding specifically by the necessity of upholding self-discipline in (more) successful athletes, irrespective of the sport type (Zenic & Sattler, 2021). Additionally, the social circles of athletes often emphasize teamwork, goal setting, and mutual support, creating an environment less conducive to drug misuse. Peer pressure within these groups can also work against CM. In other words, successful athletes are well aware that their irresponsible behavior directly translates to team success. It is clear that those who do not fit into teamwork are unlikely to be successful simply because they will not be a part of the team (Carron et al., 2002).

College/university-level education is highly stressful, which might lead to the use of substances such as CM as a coping mechanism (Noel & Cohen, 1997). On the other hand, participation in sports can serve as an outlet for stress and anxiety. Specifically, studies have shown that sports involvement, is associated with lower levels of stress and improved psychological well-being among various populations (Barney et al., 2014; Kanters, 2000). Physiologically, sport involves physical exertion, which can help reduce stress hormones such as cortisol while also stimulating the production of endorphins, which are known as natural painkillers and mood elevators. Psychologically, focusing on games/competition diverts attention away from sources of stress, allowing individuals to escape from their worries. Finally, setting and achieving goals in sports can provide a sense of purpose and accomplishment. This sense of progress and achievement can counteract feelings of stress and help individuals maintain a positive mindset (Hackfort & Schinke, 2020). The stated mechanisms of positive influence are even more understandable in more successful athletes (note that we are discussing the association between high sport achievement and lower CM), simply because of their devotion to sport of interest.

Finally, we cannot underestimate the negative impact of CM on health and, consequently, on (deteriorated) athletic performance. Athletes are generally more conscious of their health and the impact of substances such as cannabis on their physical performance. Regardless of the type of sport, CM is frequently connected to potentially negative health effects and therefore has a negative influence on sport results. Concerns about the negative effects on stamina, coordination, and overall fitness logically deter CM among athletes. Even short-term acute cannabis consumption has been shown to decrease physical work capacity, impair coordination, and increase heart rate and myocardial oxygen demand (Charron et al., 2020). It must be noted that there is actually no evidence that CM has negative effects on strength, and therefore, athletes involved in some specific sports do not have strict performance-related boundaries against CM. However, we have no intention to indicate that "health and performance issues" are the most important reason, but rather to say that this is one of the possible explanations for the lower likelihood of CM in successful college/university athletes.

A lower likelihood of cannabis misuse in females with greater physical activity

Although our results did not show a direct association between PA and CM in males, higher PA was associated with a lower likelihood of CM in females. Studies have reported similar relationships between PA and different types of substance misuse, with inconsistent findings when alcohol and/or cigarettes were used as criteria (Gilic et al., 2021; Zenic et al., 2021). On the other hand, studies that observed illicit drug misuse (including CM) as an outcome revealed relatively consistent results. For example, one study reported that physical inactivity in adolescence predicts subsequent illicit drug use even when controlling for familial factors (Korhonen et al., 2009). However, it seems that the association between PA and the use of illicit drugs cannot be simultaneously translated to an association between sport participation and CM since some studies revealed a greater risk for earlier initiation of CM for female adolescent athletes (Bjelica et al., 2016). Regardless of the previous results, the association between greater PA and lower CM in females can be explained by several interconnected factors, including physiological, psychological, and social factors.

Cannabis is often used as a mood enhancer due to its psychoactive properties, primarily attributed to its active compounds, including tetrahydrocannabinol (THC) and cannabidiol (CBD) (Ashton, 2001). In brief, THC activates the brain's reward system by stimulating the release of dopamine, a neurotransmitter associated with pleasure. Moreover, CBD interacts with serotonin receptors, which play a role in mood regulation, potentially leading to improved mood stability. Physical activity stimulates the release of endorphins, which are natural mood lifters. This can reduce the need to seek external mood enhancers, including CM. This is confirmed in experimental studies that reported positive effects of PA on mood, with the greatest effect occurring when mood is depressed (Kanning & Schlicht, 2010). Since we studied young, relatively fit adults, it is important to note that experimental studies confirmed the improvement in the mood of fit and regularly physically active adults regardless of what form of physical activity is practiced (Myrna-Bekas et al., 2012). The previously explained mechanisms are logically transferred even to improved mental health, including reduced symptoms of depression and anxiety. Female students with better mental health are less likely to misuse substances in general, including cannabis.

Another mechanism of the potential influence of increased PA on the reduced likelihood of CM in females also deserves attention. Specifically, substance misuse, including CM, is known to be associated with poor self-perception and social

pressure. Meanwhile, regular PA can directly improve self-esteem and body image. Supportively, a US study confirmed that physical activity had inverse, indirect associations with symptoms of social phobia, generalized anxiety disorder, and obsessive-compulsive disorder that were expressed through its positive association with specific and global physical self-concept and self-esteem in college women (Herring et al., 2014).

It is also important to highlight that, as previously explained, physiologically based mechanisms are logically transferred to various social influences, which could also contribute to a lower likelihood of CM in female students with greater PA. First, positive peer relationships formed through PA can provide support and reduce exposure to peer pressure to use cannabis, while PA often occurs in structured environments with clear rules and expectations, which directly discourages CM. Second, regular participation in PA can encourage other healthy lifestyle choices, such as better nutrition and sleep habits, which are generally incompatible with CM. Finally, it should be noted that greater PA is correlated with enhanced executive functioning. In particular, PA has been shown to improve cognitive functions, such as decision-making and impulse control. Even in college-aged women, PA has been associated with enhanced cognitive function, particularly in areas such as working memory and attention (Bue-Estes et al., 2008). Improved executive functioning can help them resist temptation and make healthier choices, including avoiding CM.

Limitations and strengths

The first limitation of this study is its cross-sectional nature. Therefore, although some relationships could be intuitively interpreted, in some cases, the interpretation could be questioned. For example, irrespective of the previous discussion, it is possible that girls who do not consume cannabis are actually "more able" to be physically active, which consequently reverses the cause–effect relationship between variables. Additionally, this study observed specific sample of participants in specific period of time, and therefore, generalization of the results is possible only for similar samples.

This is one of the first studies in southeastern Europe where associations between PA and sport factors with CM were established. Additionally, the use of a gender stratification approach allowed us to interpret the results more accurately. Therefore, although not being the final word on a topic, we hope that this study will increase the knowledge on a field and initiate further research.

Conclusion

The lower incidence of CM among successful student male athletes can be attributed to several factors, including health and performance concerns, strict drug policies in competitive sports, and discipline and commitment. Currently, we cannot speculate which of these factors contributed to defined associations to a greater extent, but the lower CM in males who were successful in sports over the first postpandemic year highlights the necessity of promoting high-level sports at the college/university level.

The association between higher PA and lower CM in females is almost certainly multifaceted and involves improved mental and physical health, positive social interactions, and healthier lifestyle choices in physically active students. Regardless of the background, we can conclude that promoting PA during college/university education can be an effective strategy for reducing the risk of substance misuse. This is particularly important in this period of life, given the overall stress that young people experience during the period of college/university education.

This study was performed in the first postpandemic year. Knowing the negative trends of changes in PA and substance misuse during the pandemic period, this study actually supports previous findings on relatively complex relationships between the studied predictors and CM. Because they had been involved in sports and college/university education for more than 15 years, the authors of the study are aware that the associations between the studied factors are often (over)simplified. The findings of the study provide evidence that these relationships are complex and, to some extent, gender specific. Future prospective analyses are therefore needed to evaluate causality in more detail.

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Conflict of interest
The authors declare that there is no conflict of interest.

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