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SUBSTANCE USE AND PHYSICAL ACTIVITY AFTER
THE COVID-19 PANDEMIC; ANALYSES OF
PREVALENCE AND ASSOCIATIONS AMONG
UNIVERSITY STUDENTS FROM SOUTH-EASTERN
EUROPE

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**KONZUMACIJA PSIHOAKTIVNIH SUPSTANCI I
TJELESNA AKTIVNOST NAKON PANDEMIJE
COVID-19; ANALIZE POJAVNOSTI I POVEZANOSTI
KOD STUDENATA IZ JUGOISTOČNE EUROPE**

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ABSTRACT

The aim of this doctoral dissertation was to investigate the determinants defining the relationship between physical activity levels (PAL), participation in organized sports, and the consumption of the most common psychoactive substances (PAS) among university students in the post-pandemic period of COVID-19. In this regard, partial objectives were established: i) to examine the association of PAL and sports engagement with cigarette smoking; ii) to analyze the impact of physical movement and sports on (harmful) alcohol consumption; iii) to investigate the connection between PAL and sports factors with the simultaneous abuse of multiple substances (polysubstance use). This doctoral dissertation consists of three published scientific studies.

The participant sample comprised university students from Croatia and Bosnia and Herzegovina. All studies applied a cross-sectional design with systematic gender stratification of data. The following variables were utilized: PAL (assessed via the International Physical Activity Questionnaire - IPAQ), sports participation (current engagement, competitive success, and years of experience), and PAS consumption (assessed via the QSU questionnaire and the AUDIT scale), which included the frequency of cigarette smoking, harmful alcohol consumption, and simultaneous use of multiple intoxicants. Data were collected through digital platforms during the first two years following the lifting of pandemic restrictions.

Results of the first part of the research on the total sample did not confirm a statistically significant association between PAL and the frequency of cigarette smoking (OR=0.88, 95% CI: 0.75–1.05). Furthermore, gender-stratified analysis showed an absence of correlation among male students (OR=0.95) and female students (OR=0.90), as well as an insignificant association between sports participation and smoking habits in the first post-pandemic year. Results of the second part identified significant differences in PAL between groups reporting harmful drinking (HD) and those who did not, but exclusively among male students (t -test=2.16, p =0.02). Logistic regression confirmed a significant correlation between PAL and HD in male students (OR=1.41, 95% CI: 1.11–1.76), while no statistically significant association with HD was recorded for female students or regarding sports participation in either gender. Results of the third part showed that sports factors and PAL were not associated with simultaneous polysubstance abuse (smoking and alcohol) in male students. However, a statistically significant association was found among female students between high levels of competitive sports success and an increased risk of simultaneous consumption of harmful substances (OR=1.45, 95% CI: 1.11–1.98).

This research aimed to highlight the role of physical activity as a mechanism for psychological stabilization and health protection for students following the global crisis, taking into account the specific socio-cultural context of Southeast Europe.

In conclusion, this research arrived at the following insights: (i) PAL represents fundamental health capital, but its protective role varies depending on the type of substance and the student's gender; (ii) sports in the post-pandemic period act as a "double-edged sword" – encouraging smoking abstinence but potentially normalizing alcohol consumption through social rituals; (iii) among female students, high levels of competitive sports correlate with the occurrence of "risk convergence" in PAS consumption; (iv) prevention programs must be gender-tailored and focused on strengthening psychological resilience. These results suggest that physical literacy and targeted public health strategies should become an integral part of the higher education system to promote the overall well-being of young generations.

Key words: alcohol, gender stratification, physical activity level, post-pandemic period, prevention, psychoactive substances, public health, smoking, southeast Europe, sports participation, university students

SAŽETAK

Cilj ovog doktorskog rada bio je istražiti odrednice koje definiraju povezanost između razine tjelesne aktivnosti (RTA), sudjelovanja u organiziranom sportu i konzumacije najučestalijih psihoaktivnih tvari (PAS) kod studenata u razdoblju nakon pandemije COVID-19. U tom su smislu postavljeni parcijalni ciljevi: i) ispitati povezanost RTA i sportskog angažmana s pušenjem cigareta; ii) analizirati utjecaj kretanja i sporta na (štetnu) konzumaciju alkohola; iii) istražiti povezanost RTA i sportskih čimbenika s istovremenom zlouporabom više tvari (poli-supstancijalna uporaba). Ovaj se doktorski rad sastoji od tri objavljena znanstvena istraživanja.

Uzorak ispitanika sačinjavali su studenti sveučilišta iz Hrvatske i Bosne i Hercegovine. Sva istraživanja primijenila su transversalni presjek uz sustavnu rodnu stratifikaciju podataka. U radu su korištene sljedeće varijable: RTA (procijenjena međunarodnim upitnikom IPAQ), sudjelovanje u sportu (trenutačni angažman, natjecateljski uspjeh i staž), te konzumacija PAS-a (procijenjena upitnikom QSU i skalom AUDIT), koja je obuhvatila učestalost pušenja cigareta, štetnu konzumaciju alkohola i istovremenu uporabu više opojnih sredstava. Podaci su prikupljeni putem digitalnih platformi tijekom prve dvije godine nakon ukidanja pandemijskih ograničenja.

Rezultati prvog dijela istraživanja na ukupnom uzorku nisu potvrdili statistički značajnu povezanost između razine RTA i učestalosti pušenja cigareta ($OR=0,88, 95\%CI:0,75-1,05$). Nadalje, rodno stratificirana analiza pokazala je izostanak korelacije kod studenata ($OR=0,95$) i studentica ($OR=0,90$), kao i neznčajnu povezanost između sudjelovanja u sportu i navike pušenja u prvoj godini nakon pandemije. Rezultati drugog dijela istraživanja utvrdili su značajne razlike u RTA između skupina koje štetno konzumiraju alkohol (HD) i onih koje to ne čine, ali isključivo kod muških studenata ($t\text{-test}=2,16, p=0,02$). Logistička regresija potvrdila je značajnu korelaciju između RTA i HD kod studenata ($OR=1,41, 95\%CI:1,11-1,76$), dok kod studentica, kao i u slučaju bavljenja sportom kod oba spola, nije zabilježena statistički značajna povezanost s ŠTA-om. Rezultati trećeg dijela istraživanja pokazali su da sportski čimbenici i RTA nisu povezani s istovremenom zlouporabom više tvari (pušenje i alkohol) kod muških studenata. Međutim, kod studentica je utvrđena statistički značajna povezanost između visoke razine natjecateljskog uspjeha u sportu i povećanog rizika od istovremene konzumacije štetnih tvari ($OR=1,45, 95\%CI:1,11-1,98$).

Ovim se istraživanjem željelo ukazati na ulogu tjelesne aktivnosti kao mehanizma psihološke stabilizacije i zaštite zdravlja studenata nakon globalne krize, uzimajući u obzir specifičan društveno-kulturni kontekst jugoistočne Europe.

Zaključno, ovim se istraživanjem došlo do sljedećih spoznaja: (i) RTA predstavlja temeljni zdravstveni kapital, no njezina zaštitna uloga varira ovisno o vrsti tvari i spolu studenta; (ii) sport u post-pandemijskom razdoblju djeluje kao „mač s dvije oštrice“ – potiče apstinenciju od pušenja, ali kroz društvene obrede može normalizirati pijeње alkohola; (iii) kod studentica visoke razine natjecateljskog sporta koreliraju s pojavom „izjednačavanja rizika“ (risk convergence) u konzumaciji PAS-a; (iv) preventivni programi moraju biti rodno prilagođeni i usmjereni na jačanje psihološke otpornosti. Ovi rezultati ukazuju na to da bi tjelesna pismenost i ciljne javnozdravstvene strategije trebale postati sastavnim dijelom visokoobrazovnog sustava u svrhu promicanja opće dobrobiti mladih generacija.

Ključne riječi: alkohol, bavljenje sportom, javno zdravstvo, jugoistočna Europa, post-pandemijsko razdoblje, prevencija, psihoaktivne tvari, pušenje, razina tjelesne aktivnosti, rodna stratifikacija, studenti.

ABBREVIATIONS

BMI - Body Mass Index

PA – physical activity

PAL - Physical Activity Level

PAS - Psychoactive Substances

PTSD - Post-Traumatic Stress Disorder

SUM – substance use and misuse

MSUM – multiple substance misuse

STRUCTURE OF THE DISSERTATION

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- Lulić Drenjak J., Užičanin E., Zenić N.: Sport, physical activity and (harmful) alcohol drinking in university students during the first year after covid-19 pandemic: Gender-stratified cross-sectional study. (2023) *Polish Journal of Sport and Tourism*, 30(2), 15-2115 DOI: 10.2478/pjst-2023-0009
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1 INTRODUCTION

1.1 Theoretical framework for investigating physical activity and psychoactive substance use

Low levels of physical activity (PAL) and the consumption of psychoactive substances (PAS; cigarettes, alcohol, drugs) represent significant public health and social issues that demand a multidimensional analytical approach (Burke et al., 2022; Callak et al., 2022; Sheng et al., 2023; Sirdifield et al., 2020). These phenomena do not exist in isolation; rather, they frequently manifest as comorbid behavioral patterns that mutually reinforce one another, thereby hindering social integration processes and compromising the psychophysical integrity of the individual. Given that these phenomena are deeply intertwined, their effective mitigation requires a shift away from partial solutions toward a comprehensive understanding of the context in which these patterns develop. The importance of such an approach is highlighted by Callak et al. (2022), who emphasize that these challenges cannot be viewed separately from the family environment and specific social norms. The authors point out that the cultural adaptation of prevention programs, coupled with the active involvement of the family system, significantly increases efficacy in reducing risky behaviors among youth. In synergy with the promotion of physical activity, this approach creates a robust support network that directly addresses public health challenges, particularly in low- and middle-income countries where resources are often limited. Consequently, physical activity is established as the cornerstone of a healthier developmental environment, acting as a barrier against deviant behavioral patterns. Furthermore, a successful transition from a sedentary lifestyle to an active one, as well as a shift away from psychoactive substance use, presupposes an understanding of intrapersonal mechanisms. Sheng et al. (2023) emphasize that successful habit change among young people depends on their belief in their own capabilities and their decision-making processes, concepts explained in psychology through the Transtheoretical Model. These findings suggest that the issues of low physical activity levels and substance use should be addressed through interventions tailored to the individual's current motivation and readiness for actual habit change. By integrating these psychological predictors into preventive and curative programs, it is possible to more systematically encourage youth to abandon destructive habits, thereby directly minimizing cumulative public health risks.

The effectiveness of such interventions is further supported by the concept of physical literacy, which offers a comprehensive framework for connecting cognitive, affective, and physical domains. It acts as an internal resource that empowers youth to maintain an active lifestyle and reject psychoactive substance use (PAS) even under adverse circumstances (Gilić et al., 2022). While these psychological and kinesiological models explain the motivational readiness for change and the development of health capital, contemporary research goes a step further, providing a solid biological foundation for these processes through advanced genetic methods such as Mendelian randomization. In this way, efforts are made to precisely establish the causal relationship between movement and mental health, with results empirically confirming that objectively measured physical activity has a direct protective effect on reducing the risk of depression and cigarette smoking (Iob et al., 2023). The study emphasizes that the results heavily depend on how activity is measured. Specifically, the association is substantially clearer when utilizing devices for the objective measurement of movement (accelerometers) rather than relying on the participants' subjective self-reports. Furthermore, the research identifies the phenomenon of reverse causality in certain disorders, suggesting that the very nature of specific psychiatric conditions can dictate an individual's level of physical activity. These findings lend additional weight to the thesis that increasing physical activity is not merely a desirable habit, but an effective intervention strategy for combating addictive behaviors and depressive symptoms (Iob et al., 2023). Consequently, the scientific

paradigm is definitively shifting toward recognizing movement as a key biological factor in preserving mental health integrity and preventing PAS abuse.

While these findings establish biological causality via genetic markers, the importance of an integrated approach - one that respects both biological and psychosocial determinants - is further underscored when analyzing populations under institutional or social supervision. Sirdifield et al. (2020) point out that PAS abuse and low physical activity levels (PAL) are often inextricably linked among individuals under community supervision (probation), representing a critical point of social exclusion. In this context, psychosocial factors such as social isolation and stigmatization, coupled with systemic deficiencies like a lack of structured support and resources, directly contribute to the maintenance of unhealthy lifestyles. Therefore, addressing these issues requires programs that simultaneously encompass addiction treatment and the promotion of physical activity, utilizing the latter as a crucial tool for successful rehabilitation and reintegration into society. Ultimately, the most severe forms of these public health challenges are observable in highly vulnerable groups, such as homeless youth. Research conducted by Burke et al. (2022) confirms alarmingly high rates of PAS abuse within this population, where low PAL further exacerbates already compromised psychophysical health. Among transition - age youth, these issues are frequently accompanied by neuropsychological dysfunctions, PTSD, and depression. Within this framework, the integration of structured exercise programs ceases to be a mere tangential activity and becomes a vital, core component of a holistic approach to addiction treatment. Such a comprehensive approach not only aids in alleviating neuropsychological difficulties but also in developing better coping mechanisms, which is crucial for the recovery of the most marginalized groups. The period of adolescence and emerging adulthood represents a critical developmental window during which the foundations for long-term health are established, while simultaneously opening a space for the manifestation of various risky behaviors. It is precisely in this stage that low PAL and PAS are recognized as pivotal public health challenges, resulting in a growing body of research focused on the prevalence and etiology of these phenomena (Callak et al., 2022; Sheng et al., 2023). Scientific interest is shifting from mere descriptive analysis toward a profound understanding of the factors that determine these behavioral patterns, with a specific emphasis on the distinction between protective mechanisms and risk factors.

The identification of protective factors forms the backbone of modern preventive strategies. The core idea of this approach is to identify variables that, even in the presence of adverse circumstances, mitigate the likelihood of low PAL and PAS use. In this context, Callak et al. (2022), in their review paper, emphasize the role of family connectedness and culturally adapted interventions. The authors highlight that the role of the family extends beyond mere supervision; it serves as a primary source of support where the adoption of positive norms fosters a predisposition toward physical activity and resilience against PAS abuse. Sheng et al. (2023) point out that the resilience of young people depends on their cognitive patterns and decision-making processes, which are key components of behavioral change. A high level of belief in one's own capabilities (self-efficacy) and deliberate decision-making act as powerful protective factors. These enable youth to persevere in an active lifestyle, despite social pressures that encourage PAS consumption.

Conversely, a systematic examination of risk factors is essential to identify specific groups in need of targeted interventions. Sirdifield et al. (2020) warn of systemic deficiencies, such as a lack of structured social support and community resources. These failures are inextricably linked to a decline in physical activity and an increase in PAS abuse among individuals under supervision following institutional release. Such findings suggest that social isolation and systemic shortcomings serve as a catalyst for the development of unhealthy lifestyle habits. Particularly alarming data regarding risk factors are presented by Burke et al. (2022) in their analysis of transition-age youth. Within this population,

neuropsychological difficulties are frequently intertwined with symptoms of PTSD and depression. This creates a vicious cycle of low PAL and increasing dependence on PAS, which serves as a maladaptive coping mechanism for stress (Burke et al., 2022).

In addition to the aforementioned psychosocial factors, the early initiation of substance use plays a crucial role in shaping these negative patterns, as confirmed by research findings among youth in Chile (Vilugrón et al., 2022). According to the authors, the early onset of smoking and alcohol consumption clearly points to subsequent low PAL, as well as to the development of a wide range of risky behaviors, including poor diet and suicidal ideation. This interplay of risk factors suggests that early contact with psychoactive substances can permanently impair motivation for a healthy lifestyle. Consequently, the age of onset into the world of substance use becomes a decisive factor for future health (Vilugrón et al., 2022).

In conclusion, research focusing on at-risk youth populations aims to better identify the specific needs of those who are most vulnerable. Understanding the links between personal psychological traits and broader social influences enables the development of holistic programs. Rather than merely targeting the outward signs of the problem - such as physical inactivity or PAS use - these programs seek to address their root causes.

In the Republic of Croatia and the wider region (Southeastern Europe), research interest in the phenomena of PAL and PAS has resulted in numerous scientific papers that have significantly contributed to the understanding of these issues within the adolescent population. Previous studies, led by authors such as Zenić et al. (2015, 2021), have successfully addressed key questions regarding prevalence, as well as the specific sociodemographic determinants that shape the health patterns of youth in this region.

Particularly significant are the findings indicating a complex relationship between sports participation and alcohol consumption. A longitudinal study conducted by Zenić et al. (2021) on younger adolescents in Bosnia and Herzegovina revealed a specific dynamic: while physical activity is generally considered a protective factor, a positive correlation with alcohol consumption was recorded in certain sporting contexts. These results suggest that sport does not act as a universal preventive tool; rather, its role depends on the social environment within sports clubs and peer groups, highlighting the need for a nuanced approach when designing prevention programs.

Furthermore, research has shed light on differences in risk factors with respect to urbanicity and gender. A study by Zenić et al. (2015a) on the prevalence of PAS among rural and urban adolescents pointed to community characteristics as a determinant of risky behavior. The results suggest that the availability of substances, as well as differing levels of social control in urban versus rural environments, necessitate locally tailored interventions. In parallel, an analysis focusing on Bosniak adolescents (Zenić et al., 2015b) further emphasized gender differences, demonstrating that boys and girls do not always share the same risk factors or the same motives for PAS consumption. Among boys, consumption is frequently associated with social status and extraversion, whereas different psychosocial predictors were identified among girls. This confirms the necessity of gender-specific analyses in research focusing on the emerging adulthood population.

Previous findings have established a solid foundation for understanding adolescence as a period in which factors such as sports participation, place of residence, and gender identity are crucial in shaping health outcomes. Although prior research has relatively successfully addressed questions regarding prevalence and identified the fundamental determinants of these behaviors during adolescence, it has simultaneously opened pathways for further analysis regarding the stability of these patterns during

emerging adulthood, particularly in light of newly emerging social circumstances. Building precisely upon these foundations, this dissertation aims to expand the focus from adolescence to emerging adulthood, exploring how these previously identified factors transform or persist within a changing social and epidemiological environment.

1.2 COVID-19 Pandemic and Lifestyle Changes

The global health crisis caused by the COVID-19 pandemic resulted in unprecedented changes in the daily functioning of humanity. Although primary research efforts were initially focused almost exclusively on the clinical presentation, pathogenesis, and epidemiological parameters of the virus - as confirmed by bibliometric analyses of the first thousand publications (Yu et al., 2020) - it soon became apparent that mobility restriction measures were generating a series of profound and long-term negative consequences on health and lifestyle. This shift in the research paradigm is visible through the subsequent expansion of papers in the social sciences, which sought to fill the gap in understanding the non-medical effects of the crisis (Roychowdhury et al., 2022). A bibliometric insight into more than nine thousand papers in this field reveals that following the initial dominance of medical topics, psychosocial issues, quality of life, and population mental health emerged as key research trends (Roychowdhury et al., 2022). It was precisely within this new research framework that an understanding of the depth of the pandemic's secondary implications crystallized, manifesting most clearly through a drastic reduction in PAL, changes in dietary habits, and the intensification of risky behaviors. This interplay of negative factors confirmed that the true public health challenge extended beyond the viral infection itself, demanding a holistic approach to recovery that actively addresses long-term disrupted lifestyle habits.

Concurrently, a systematic literature review conducted by Stockwell et al. (2021) provides crucial empirical evidence of a dramatic global decline in PAL across almost all population groups during the restriction periods. The authors argue that the closure of sports facilities, restricted access to public spaces, and the transition to remote work and schooling directly caused an increase in sedentary lifestyles. This alteration of daily routines induced a "secondary pandemic" of metabolic and cardiovascular difficulties. Although these were not directly caused by the SARS-CoV-2 virus, they represent a direct consequence of the measures implemented to contain the epidemic (Stockwell et al., 2021).

In this context, Musa et al. (2023) warn of the emergence of an "invisible pandemic" of non-communicable chronic diseases, emphasizing how social isolation and mobility restrictions triggered abrupt changes in behavior. Their work documents that alongside a drastic decline in physical activity, factors such as unhealthy diet, sleep disturbances, and heightened stress -combined with increased tobacco and alcohol consumption - directly contributed to the rising global burden of non-communicable diseases (Musa et al., 2023).

In addition to reduced mobility, the isolation period profoundly affected dietary habits and body mass, which is elaborated in detail by Robinson et al. (2021). Their research indicates that psychological pressures induced by the lockdown, such as chronic stress and boredom, coupled with restricted access to exercise spaces, led to an increased consumption of high-calorie foods. The results demonstrated a significant increase in the body mass index (BMI) of the participants, suggesting that lifestyle changes during the pandemic laid the foundation for a long-term deterioration of public health parameters related to obesity. These findings support the thesis that measures to prevent the spread of the virus

simultaneously compromised quality of life through the adoption of unhealthy crisis coping mechanisms (Robinson et al., 2021).

Children and adolescents constitute a particularly vulnerable group in this context, as their developmental needs for socialization and movement were abruptly disrupted. In their review paper, Panchal et al. (2021/2023) document the devastating impact of lockdowns on youth mental health, recording an alarming increase in symptoms of anxiety, depression, and a profound sense of loneliness. The disruption of school routines and the absence of direct social contact not only resulted in immediate psychological distress but also potentially left lasting scars on the neuropsychological development of younger generations. This indirect consequence of pandemic measures highlights the necessity of a comprehensive understanding of health, which entails not only the absence of disease but also the preservation of psychosocial integrity under crisis conditions (Panchal et al., 2021). In this sense, sports participation and physical activity experienced a significant regression; research confirms that changes in movement levels were conditioned not only by physical barriers but also by an increase in daily hassles that disrupted the motivational mechanisms of the general population (Hargreaves et al., 2021). This negative trend was particularly pronounced among children and adolescents, whose physical activity levels heavily depend on structured environments such as schools and sports clubs. A systematic literature review conducted by Do et al. (2022) confirms a general decline in movement within this population, concluding that home-based exercise and digital platforms failed to fully compensate for the absence of organized sports. Furthermore, Elliott et al. (2021) warn that the disruption of sports activities extends beyond a mere reduction in motor skills; the loss of the competitive context and social connectedness within the club created a risk of long-term dropout from sports among youth, thereby jeopardizing their health habits in adulthood.

Parallel to the decline in physical activity, the pandemic also initiated shifts regarding psychoactive substance (PAS) use. The general population, faced with uncertainty and stress, frequently resorted to alcohol and tobacco as maladaptive emotion regulation strategies, which was further linked to a deterioration in overall nutritional status and an increase in body mass (Sidor & Rzymiski, 2020). These trends were additionally compounded by the specific circumstances of the lockdown; namely, alongside chronic stress and future anxiety, the absence of time spent in environments with standard consumption bans, coupled with a sudden surplus of "free time," created an environment conducive to more frequent and uncontrolled recourse to psychoactive substances (Aronowitz et al., 2022; Schweinhart et al., 2023). An analysis of global trends reveals that early responses to the crisis were largely reactive. States faced a difficult challenge: how to contain the spread of the infection while simultaneously maintaining access to essential addiction prevention and treatment programs (Aronowitz et al., 2022). Concurrently, a marked increase in emotional distress was recorded, which directly correlated with the intensification of PAS abuse, particularly in populations facing additional social pressures and compromised safety within the household (Schweinhart et al., 2023). The loss of external control over daily life led many to seek solace in psychoactive substances, utilizing them as a harmful way of coping with trauma and uncertainty. Ultimately, these changes indicate that isolation and hindered access to assistance led to permanent behavioral changes, necessitating new support models that primarily focus on the psychological stability of the individual.

Overall, the COVID-19 pandemic by no means represented merely an immediate threat to biological survival; rather, it triggered a profound transformation of lifestyle habits on a global scale. This accumulation of negative behaviors - ranging from a drastic decline in PAL to the abuse of psychoactive substances in isolation - has created a complex web of factors that directly compromise the psychophysical health of youth. It is evident that reduced mobility, dietary disturbances, and compromised mental health no longer function as isolated issues, but rather as interconnected public

health challenges. It is precisely this causal intertwining of risks that dictates an urgent need for the development of new preventive models tailored to the post-pandemic period. Future prevention programs must encompass all aspects of young people's lives, simultaneously addressing the lack of movement and the consumption of harmful substances, while mandatory care is dedicated to their mental health. A systemic approach to these phenomena will be crucial for mitigating the long-term consequences of the crisis and ensuring healthier developmental patterns for younger generations in the coming years.

In this context, the results of prospective analyses in the region indicate that pre-pandemic sports participation played the role of a powerful protective factor; however, concurrent prior habits of PAS consumption also significantly determined activity levels during the lockdown itself (Gilić et al., 2021). Among older adolescents, those who had previously been active within the sports system maintained continuity of movement more easily, whereas substance abuse acted as a barrier that further deepened sedentary lifestyles in isolation. These findings suggest that resilience to crisis situations largely depends on an individual's previously acquired health capital. Within this framework, the concept of physical literacy emerges as a key foundation for the long-term maintenance of health and the prevention of risky behaviors under unstable conditions. Research by Gilić et al. (2022) confirms that adolescents with more developed cognitive and emotional capacities possess objectively better physical fitness, which indicates that fostering intrinsic motivation and a deeper understanding of the purpose of movement builds lasting positive attitudes toward an active lifestyle.

Although the aforementioned study primarily focuses on motor and cognitive outcomes, its results suggest that such literacy can act as an essential barrier against reverting to a sedentary lifestyle and potential psychoactive substance use, even when external support systems, such as sports clubs, become inaccessible due to restrictions. Integrating this concept into high school curricula empowers youth to make informed decisions about their own health, rendering them more resilient to future public health challenges. Ultimately, understanding these behavioral determinants enables the design of more effective strategies that connect the education system, sports participation, and primary prevention into a coherent whole that addresses the challenges of the post-pandemic period.

1.3 Problem

From the preceding literature review, it is clear that insufficient PAL and PAS consumption represent major social and public health issues. On the other hand, within the domestic and broader regional context, there is a noticeable lack of studies that have systematically investigated these problems during late adolescence and emerging adulthood - specifically among the university student population. This issue is of paramount importance because students are exposed to specific psychosocial pressures that directly impact their lifestyle habits.

The relevance of this problem is confirmed by Campbell et al. (1992), who, in earlier research, pointed to a high level of perceived stress among undergraduate students. Their findings suggest that the academic environment inherently generates significant pressure, with students reporting stress levels that exceed ordinary life difficulties. The authors emphasize that such conditions often remain unrecognized within institutional frameworks, even though they directly undermine individual well-being. The study demonstrated that perceived stress is not an isolated incident, but rather a continuous state that accompanies students throughout their higher education. Ultimately, Campbell et al. conclude that high stress levels at this age necessitate a strategic approach to prevention in order to avoid long-term negative outcomes.

A more contemporary context of this issue, particularly in light of global crises, is provided by Aslan and Cinar (2022) in their study on Turkish university students during the second wave of the pandemic. They highlight that these extraordinary circumstances led to an alarming prevalence of anxiety, depression, and PTSD symptoms among the student population. The authors argue that social isolation and the transition to distance learning drastically reduced students' capacity to cope effectively with stress. Their results indicate that psychological disorders are the primary predictors of adopting unhealthy behavioral patterns during times of crisis. They specifically warn that a lack of direct social support creates a fertile ground for long-term behavioral disorders. In conclusion, Aslan and Cinar emphasize the necessity of introducing systemic mental health support programs as an integral part of higher education.

In this context, research conducted among students in Wuhan provides concrete evidence of the protective role of physical activity, indicating that the quality of physical activity directly and positively predicts the level of subjective well-being during crisis periods (Yuan & You, 2022). The authors point out that regular exercise can effectively mitigate the negative psychological effects of the pandemic, acting as a barrier against distress affecting specific groups of students. The importance of moderate-to-vigorous physical activity is particularly emphasized, as such habits are associated with strengthening resilience and maintaining a positive attitude during a crisis. These findings suggest that physical activity is not merely a matter of personal choice or a simple habit, but a key tool for preserving students' mental health under conditions of social isolation (Yuan & You, 2022). The long-term persistence of these trends is confirmed by Helmer et al. (2025), who, 20 months after the onset of the pandemic, identified a strong link between depressive symptoms, low activity levels, and an increase in smoking and cannabis use. Their findings on a large sample of students indicate that compromised mental health directly impairs established healthy habits, making students more susceptible to developing addictions. The authors therefore emphasize that contemporary university prevention programs must simultaneously address both psychological issues and unhealthy lifestyles to prevent detrimental behavioral patterns from becoming permanent habits (Helmer et al., 2025). A specific insight into this issue is provided by Guillot et al. (2024), who investigated alcohol consumption habits among student-athletes during the pandemic, warning of the risks associated with the disruption of regular training processes. Their results indicate that the loss of a structured sports routine and competitive context can trigger increased recourse to alcohol as a maladaptive mechanism for coping with isolation. This confirms that even populations with traditionally high PAL are not immune to negative behavioral changes under the influence of crisis circumstances (Guillot et al., 2024).

Among youth and the student population, the pandemic led to a specific transformation in the context of consumption; while social drinking was reduced, an increase in drinking in isolation was recorded (Jackson et al., 2021). Students who utilized alcohol to alleviate loneliness and anxiety developed riskier consumption patterns, which, in synergy with low physical activity levels, creates a dangerous synergistic effect on their psychophysical health.

Alongside changes in alcohol consumption patterns, research also confirms significant initial impacts of the pandemic on the use of tobacco and related products among the student population (Maheta et al., 2025). A study conducted among university students in California indicates that stress and changes in the social environment led to the reinforcement, and even intensification, of smoking habits within a segment of the population. The authors emphasize that the transition to distance learning and the "loss" of the campus as a place of social interaction modified the frequency and context of tobacco use. It is particularly concerning that youth who faced higher levels of psychological distress were more prone to more frequent recourse to cigarettes and e-cigarettes. These results suggest that tobacco products, similar to alcohol, serve as a maladaptive mechanism for mitigating negative emotional states induced by the

crisis. This further deepens the gap in health outcomes, given that smoking frequently occurs in combination with low physical activity levels, creating a joint (cumulative) risk for the cardiovascular and respiratory health of youth. Ultimately, the findings of Maheta et al. (2025) underscore the need for specific public health interventions that will address smoking within the broader framework of students' mental health and physical inactivity in the post-pandemic period.

The synergy of these findings indicates that the student population is highly vulnerable, as high stress levels correlate with a decline in PAL and increased PAS consumption. This combination of factors renders university students a high-risk group in which short-term coping mechanisms transform into permanent health risks (Aslan & Cinar, 2022; Campbell et al., 1992).

There is no doubt that COVID-19 caused a series of negative consequences on human life and health globally, among which reduced PAL and increased PAS consumption must certainly be recognized. However, it can be noted that such studies rarely encompass the student population, and to the author's knowledge, no study has investigated this problem systematically within the region of Southeastern Europe. According to global statistics, this region is highly vulnerable, as cigarette and alcohol consumption rank at the very top of European levels (Molinaro et al., 2020).

The ESPAD Report (2019) confirms that youth in Southeastern European countries display significantly higher levels of availability and early initiation of PAS use compared to the European average. The authors emphasize that cultural patterns regarding the acceptability of alcohol and tobacco consumption are deeply rooted in this region, which creates a specific preventive challenge. The findings indicate that the high prevalence of smoking among adolescents in these countries often persists into later developmental stages, directly compromising the long-term health status of the population. Additionally, the report warns of a trend toward the high availability of new psychoactive substances, which, in combination with traditional alcohol consumption habits, creates a cumulative public health risk. Precisely because of these specific epidemiological indicators, it is essential to investigate how the crisis conditions of the pandemic have further modified the already critical behavioral patterns in this part of Europe. Therefore, this research aims to bridge the research gap by analyzing the status among university students in Croatia and Bosnia and Herzegovina.

1.4 Study aims and hypotheses

The aims of this investigation were as follows

- to examine correlations between physical activity levels (PAL), and cigarette smoking among university-level students in the period after the COVID-19 pandemic
- to evaluate gender-specific associations that may exist between sport participation and PAL (independent variables), and alcohol consumption (dependent variable) among college/university students during the first post-pandemic year of the COVID-19 pandemic
- to evaluate the gender-specific associations between PAL, sport participation, and concurrent substance use and misuse among college students from southeastern Europe in the first post-pandemic year

Accordingly, study hypotheses were:

- H1: Lower physical activity would be associated with higher tendency toward cigarette smoking.
- H2: Higher alcohol consumption will be associated with (i) sport participation, and (ii) higher PAL in college/university level students.
- H3: Higher PALs and sport participation would be associated with a lower likelihood of concurrent SUM, irrespective of gender.

2 ORIGINAL STUDIES

- 2.1 **Study 1:** Lulić Drenjak, J., Pehar, M., Užičanin, E., Kontić, D., & Zenić, N. (2023) *Physical activity, sport participation, and cigarette smoking in university students after COVID-19 pandemic; Cross sectional analysis of the associations in south-eastern Europe. Montenegrin Journal of Sports Science and Medicine*, 19(1), 61-68. <https://doi.org/10.26773/mjssm.230308>



Montenegrin Journal of Sports Science and Medicine (MJSSM) is indexed in: Web of Science (ESCI), Scopus, DOAJ, SCImago, SPORTDiscus, Index Copernicus, Google Scholar, Crossref, ROAD, SHERPA/RoMEO, NLM Catalog, J-Gate.

Physical activity, sport participation, and cigarette smoking in university students after COVID-19 pandemic; Cross sectional analysis of the associations in south-eastern Europe

ABSTRACT

Cigarette smoking (CS) and low physical activity levels (PAL) are known to be risk factors for cardiovascular diseases. However, few studies have examined the associations between these factors in population of university students, and, to the best of our knowledge, no study examined this issue in period after the COVID-19 pandemic, despite the detrimental social and health consequences of the pandemic.

The aim of this cross-sectional study was to examine associations between sport-participation, PAL and CS among university-level students in the period after the COVID-19 pandemic.

Participants included 761 students (411 females) from three universities in Bosnia and Herzegovina and Croatia, who were tested using semi-structured anonymous questionnaires at the beginning of the 2022/2023 academic year. Questions included queries on sociodemographic characteristics, CS, PAL, and sport-participation. Differences between genders were established by Chi-square test and gender-stratified logistic regressions were calculated to evaluate the associations between sport-participation and PAL, with binomized CS (smoking vs. non-smoking).

One third of participants were daily smokers. Logistic regression showed no correlation between PAL and smoking prevalence for total sample (OR = 0.88, 95%CI: 0.75-1.05), males (OR = 0.95, 95%CI: 0.41-1.45), or females (OR = 0.90, 95%CI: 0.54-1.52). In addition, sport participation was not significantly associated with smoking.

Results did not prove that of sport and physical exercising are a way of reducing the likelihood of smoking; this finding could be a characteristic of the studied sample of participants, but could also be related to the period that was observed (the first year after the COVID-19 pandemic). Further studies examining the associations between PAL/sport participation and other types of substance misuse are warranted.

INTRODUCTION

Physical activity is defined as any movement of the human body produced by skeletal muscles that requires energy expenditure (Caspersen, Powell, & Christenson, 1985); it comes in different forms and intensities, such as sports and structured exercise, fundamental movement skills, active play, leisure activities (walking, biking, dancing), active transport and household activities (Caspersen et al., 1985). Consistent and appropriate physical activity has numerous benefits. It develops a healthy cardiovascular and musculoskeletal system, neuromuscular coordination, movement control, and metabolic health, and assists in maintaining a healthy body weight (Hallal, Victora, Azevedo, & Wells, 2006; Whooten, Kerem, & Stanley, 2019).

Another important benefit of being physically active is that physical activity generally leads to adopting other healthy behaviors (i.e., healthy diet and avoiding tobacco, alcohol, and drugs) and social development and integration (Daskalopoulou et al., 2017). Collectively, an appropriate level of physical activity during adolescence and early adulthood (A and EA) contributes to the development and maintenance of a healthy adult lifestyle (Telama, 2009). Unfortunately, there is a lot of concern about the incidence of physical inactivity in the period of A and EA and >80% of adolescents worldwide do

not meet the recommended guidelines of 60 minutes of moderate-to-vigorous physical activity a day; in early adulthood (age 18–21), the situation is even worse (Guthold, Stevens, Riley, & Bull, 2020).

Despite a decrease in prevalence globally, smoking remains the most common type of substance misuse in the world (Vink & Boomsma, 2011). Specifically, statistics and national data on substance use and abuse in the territory of south-eastern Europe and former Yugoslavia show that the prevalence of smoking is high (Modric, Zenic, & Sekulic, 2011; D. Sekulic, M. Ostojic, Z. Ostojic, B. Hajdarevic, & L. Ostojic, 2012). Identifying protective and risk factors related to smoking will allow public health authorities to define specific and targeted preventive campaigns to emphasise and encourage these protective factors and to control risk factors (Kaleta, Korytkowski, & Makowiec-Dabrowska, 2013; D. Sekulic et al., 2012).

One potential protective factor against smoking is physical activity and sport participation (Grogan et al., 2022). However, physical activity (physical exercising) has not been consistently validated as a buffering factor against cigarette smoking, specifically among A and EA. While some studies have indicated that sports and physical activity are protective, other studies have shown an increased likelihood of smoking among individuals who practice sports (Guo, Reeder, McGee, & Darling, 2011; Rodriguez Garcia, Lopez Villalba, Lopez Minarro, & Garcia Canto, 2013; D. Sekulic et al., 2012).

The rapid spread of a novel coronavirus led to the declaration of the COVID-19 pandemic on March 11th, 2020 (Cucinotta & Vanelli, 2020). The main strategy for controlling the COVID-19 pandemic was the implementation of social distancing measures, which included the closures of schools, universities, cafe bars, restaurants, sports–recreational facilities and clubs, and other places of social gathering (Bedford et al., 2020). Such restrictions led to decreased opportunities for movement and studies regularly reported a decrease in physical activity levels (PAL) as a result of imposed social distancing measures and lockdown during the COVID-19 pandemic (Caputo & Reichert, 2020; Castañeda-Babarro, Arbillaga-Etxarri, Gutiérrez-Santamaría, & Coca, 2020; Giustino et al., 2020). Such a decline in PAL represents a major health concern, as even a small reduction of PAL can result in serious health consequences (Narici et al., 2020).

In the meantime, studies showed an increase in the cigarette smoking during the pandemic period. For example, a Californian study confirmed higher use of cigarettes during lockdown, which was explained by increased stress, changes in workplace, and increased opportunities for smoking or vaping (Gonzalez, Epperson, Halpern-Felsher, Halliday, & Song, 2021). Supportively, another US study noted an increase in smoking during the COVID-19 pandemic a the sample of adults from vulnerable populations, indicating unemployment and anxiety as factors which could contribute to greater risk of tobacco use (Wiley et al., 2023). Finally, a very comprehensive UK study discussed increased smoking as a coping mechanism to deal with anxiety, boredom, stress, and anger during the COVID-19 lockdown (Grogan et al., 2022).

It is globally accepted that low physical activity levels and cigarette smoking present serious health-threatening behaviors. In the period of the COVID-19 pandemic, physical activity decreased, whereas cigarette smoking increased. It is theorized that physical activity could be protective against cigarette smoking, but, to the best of our knowledge, no study has examined this issue, considering previously specified changes in patterns of physical activity and cigarette smoking in the period after the COVID-19 pandemic. As a result, the aim of this study was to examine correlations between physical activity levels, and CS among university-level students in the period after the COVID-19 pandemic. Initially, we hypothesized that lower physical activity would be associated with higher tendency toward cigarette smoking.

METHODS

Participants

Participants in this study were university students aged from 18 to 21 years ($n = 761$, 411 females) from three universities in south-eastern Europe: one University from southern Croatia ($n = 156$; 81 females; aged 20.11 ± 3.1 years), one university from northern Croatia ($n = 373$, 229 females; aged 20.98 ± 2.2 years), and one university from Bosnia and Herzegovina ($n = 232$, 101 females; aged 21.32 ± 2.9 years). The sample size was calculated on the basis of (i) the number of students at each University for the 2020 school year, (ii) a previously reported prevalence of appropriate PAL in Croatian, and Bosnian and Herzegovinian adolescents of 30% during the COVID-19 pandemic, (iii) a confidence level of 95%, and (iv) a margin of error of 5%. The required sample size was 784. The sampling was performed by the multi-stage cluster sampling method. First, in each studied university, faculties (note that faculties are constitutional units of the universities in the studied region) were grouped into two clusters, according to size (i.e., small and large faculties). Next, one-half of faculties in each cluster was selected randomly. Finally, in each of the selected faculties, one group was tested in each academic year. Collaborating partners in each studied university visited faculties, explained the aims of the study to faculty authorities, and organized the dissemination of the consent forms. Only students who provided written consent were included in the study. All participants were informed about the study aims, risks, and benefits, that participation was voluntary and that no personal information would be known outside of the project personal. The study was approved by Ethical Board of the Faculty of Kinesiology, University of Split, Croatia.

Variables

Variables in this study were gender (male, female, intersex) and age of participants, academic year (school year), physical activity level (PAL), sport participation, and cigarette smoking.

Cigarette smoking was evidenced on a five-point scale including “never smoked”, “quit”, “from time to time, but not daily”, “daily cigarette or two”, “daily smoking more than 2 cigarettes”. For statistical purposes participants were grouped as “non-smokers” (first three responses) and “daily smokers” (last two responses). Sport participation was assessed on a three-point scale that consisted of the answers “never participated in sport”, “quit”, “currently participating”. These scales have previously been used in studies in the region and have been confirmed as being reliable and valid (Maric, Bianco, Kvesic, Sekulic, & Zenic, 2021; D. Sekulic et al., 2017; Zenic et al., 2017).

The assessment of PAL was carried out by the short version of the International Physical Activity Questionnaire (IPAQ) (Fogelholm et al., 2006; Hagstromer, Oja, & Sjostrom, 2006). The IPAQ was developed to measure health-related physical activity. The short version of the IPAQ has been tested extensively and is now used in many international studies. In brief, IPAQ assesses physical activity undertaken across leisure time, domestic and gardening (yard) activities, work-related and transport-related activity; it also asks about three specific types of activity undertaken (walking, moderate-intensity activities and vigorous-intensity activities) and about sitting, in terms of its frequency and duration. Although the IPAQ calculates the energy expenditure in METs, for the purpose of this study, participants were grouped into three groups, (i) inactive, (ii) minimally active, and (iii) health-enhancing physical activity (HEPA) active, as previously suggested (Fogelholm et al., 2006).

Testing was done using a digital platform. All participants scanned the printed QR code with their smartphones, which directed them to Google form containing the questionnaire. Testing was done during school hours in the presence of one of the investigators (authors of the study).

Statistics

All variables were checked for normality by the Kolmogorov–Smirnov test. Consequently, means and standard deviations were calculated for age, while frequencies and percentages were calculated for remaining variables.

To evaluate differences between universities in the categorization of PAL and cigarette smoking, a Chi-square test was performed. Analysis of variance was used to establish the differences in age. To evaluate correlations between (i) PAL and binomized cigarette smoking, and (ii) sport participation and binomized cigarette smoking, logistic regressions were calculated, and odds ratio and 95% confidence intervals (CI) were reported. Analysis of differences and correlations was done on the total sample, and then separately for males and females (owing to small number of responses, the calculations were not done separately for intersex).

Statistica 13.5 (Tibco Inc., Palo Alto, California, USA) was used for all calculations, and the p-level of 95% was applied.

RESULTS

There was no difference in the age of the participants between the three studied universities (F-test = 1.01, $p > 0.05$).

Descriptive statistics for smoking prevalence are presented in Table 1 (total sample), Table 2 (males), and Table 3 (females). In brief, almost one third of studied university students are daily smokers. The prevalence of daily smoking is similar across genders (32%–38% in males, and 30%–39% in females). Chi-square did not reveal significant differences between universities in smoking prevalence for total sample (chi-square = 9.36, $p = 0.16$), males (chi-square = 5.83, $p = 0.44$), or females (chi square = 8.94, $p = 0.17$).

Table 1. Smoking prevalence in studied university students (total sample) with Chi square differences among studied Universities (F – frequencies; % - percentages)

	Croatia South		Bosnia and Herzegovina		Croatia North	
	F	%	F	%	F	%
Never smoked	48	31	78	34	96	26
Quit	16	10	21	9	23	6
From time to time, but not daily	50	32	77	33	142	38
Daily smoking	42	27	56	24	111	30
Chi square: 9.36; $p = 0.15$						

Table 2. Smoking prevalence in studied university students (males only) with Chi square differences among studied Universities (F – frequencies; % - percentages)

	Croatia South		Bosnia and Herzegovina		Croatia North	
	F	%	F	%	F	%
Never smoked	18	25	37	28	30	21
Quit	5	7	8	6	5	4
From time to time, but not daily	25	32	46	38	51	35
Daily smoking	27	36	37	28	58	40
Chi square: 5.83; p = 0.44						

Table 3. Smoking prevalence in studied university students (females only) with Chi square differences among studied Universities (F – frequencies; % - percentages)

	Croatia South		Bosnia and Herzegovina		Croatia North	
	F	%	F	%	F	%
Never smoked	30	37	40	39	68	30
Quit	11	13	13	13	18	8
From time to time, but not daily	25	32	29	30	90	39
Daily smoking	15	18	19	18	53	23
Chi square: 8.94; p = 0.17						

Distribution of the PAL results across the universities are presented in Table 4 (total sample), Table 5 (males), and Table 6 (females). About 50% of participants reached recommended PAL, with no significant differences between universities (chi-square = 1.13, p = 0.88). However, males are evidently more physically active than females, with 57%–60% of males - reaching recommended PAL; whereas only 39%–42% of females had sufficient PAL. Differences between universities were not established (none of the chi-square calculations reached statistical significance).

Table 4. Physical activity of the studied participants (total sample) with Chi square differences among studied Universities (F – frequencies; % - percentages)

	Croatia South		Bosnia and Herzegovina		Croatia North	
	F	%	F	%	F	%
Inactive	31	20	41	18	77	21
Minimally active	48	31	70	30	116	31
Health enhancing physical activity	77	49	121	52	180	48

Chi square: 8.94; p = 0.17						
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Table 5. Physical activity of the studied participants (males only) with Chi square differences among studied Universities (F – frequencies; % - percentages)

	Croatia South		Bosnia and Herzegovina		Croatia North	
	F	%	F	%	F	%
Inactive	19	15	20	15	26	18
Minimally active	26	28	33	25	36	25
Health enhancing physical activity	29	57	78	60	82	57
Chi square: 0.46; p = 0.97						

Table 6. Physical activity of the studied participants (females only) with Chi square differences among studied Universities (F – frequencies; % - percentages)

	Croatia South		Bosnia and Herzegovina		Croatia North	
	F	%	F	%	F	%
Inactive	12	26	26	26	55	24
Minimally active	22	35	33	32	82	36
Health enhancing physical activity	48	39	42	42	92	40
Chi square: 9.23; p = 0.06						

Figure 1 presents results of the logistic regressions calculated between PAL and sport participation as correlates of cigarette smoking.

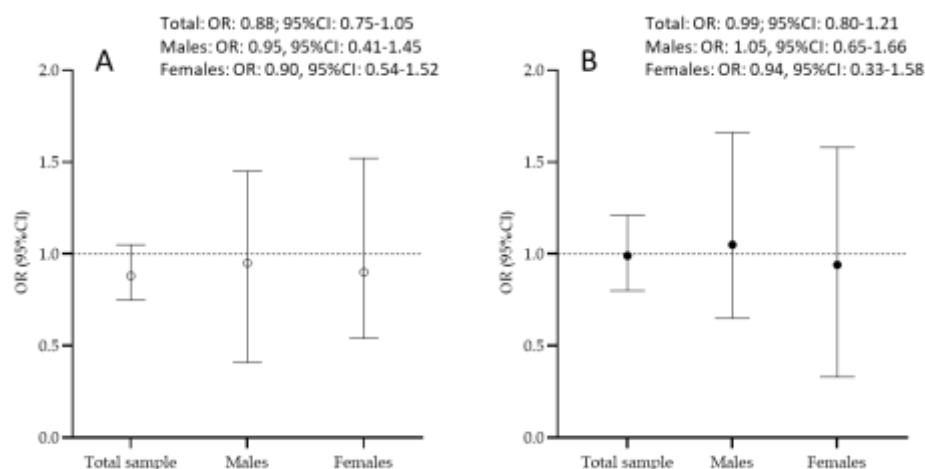


Figure 1. Logistic regression results; correlations between (A) physical activity levels, and (B) sport participation with binomized cigarette smoking (smoking vs. non-smoking) in university students for total sample and gender stratified (OR – Odds Ratio, 95%CI – 95% Confidence Interval)

Logistic regression showed no correlation between PAL and smoking prevalence for total sample (OR = 0.88, 95%CI: 0.75-1.05), males (OR = 0.95, 95%CI: 0.41-1.45), or females (OR = 0.90, 95%CI: 0.54-1.52) (Figure 1A). Also, no significant associations were found between sport participation and cigarette smoking (Total sample: OR = 0.99, 95%CI: 0.80-1.21; Males: OR = 1.05, 0.65-1.66; Females: OR = 0.88, 95%CI: 0.33-1.58) (Figure 1B).

DISCUSSION

This study aimed to evaluate the association of PAL and sport participation with cigarette smoking in university students. Results showed that neither PAL nor sport participation are associated with prevalence of smoking in the studied university students. Therefore, our initial study hypothesis was not confirmed. Before discussing this issue, we will briefly look at the PAL results for university students.

For the last couple of years, interest about physical activity and PAL in the countries of southeastern Europe has increased, but studies have mostly investigated children and adolescents (Gilic, Ostojic, Corluka, Volaric, & Sekulic, 2020; D. Sekulic, Rodek, & Sattler, 2020; Stefan, Kasovic, & Zvonar, 2020). This trend was particularly evident during the period of COVID-19, when authors published series of studies examining the changes in PAL which occurred as a result of lockdown among adolescents, and the factors that were correlated with these changes (Geets Kesic et al., 2021; Gilic et al., 2020; Gilic, Zenic, Separovic, Jurcev Savicevic, & Sekulic, 2021; D. Sekulic et al., 2021). However, it seems that this issue has rarely been examined in a population of university students, and therefore our results are hardly comparable to those other reports in the region before the COVID-19 pandemic.

The closest comparison that could therefore be done is with the results of high school students, their PAL being established by same measurement tool that we used in this study. Ajman et al. evaluated the PAL of high school students, and showed 59% of high-school students to be sufficiently active, which is more than we established herein (note that 50% of our participants reached sufficient PAL) (Ajman,

Novak, & Mišigoj-Duraković, 2019). Furthermore, 54% of high school girls reached appropriate PAL, whereas, in our study only, 39% females were at that level; the difference is similar for boys/males (65% vs. 57% in high-school and university students, respectively) (Ajman et al., 2019). Although samples of participants observed in Ajman's investigation and our own are not absolutely identical, some explanations could be offered for the evident differences.

First, one of the important determinants of PAL in adolescence is (mandatory) physical education (PE) classes in high school. Although the PE curriculum in the territory is often criticized for being insufficient in frequency, it still provides an important source of physical activity in the elementary and high-school education period (until the age of 18 years)(Škegro & Čustonja, 2014). Meanwhile, PE is only sporadically included in university curricula in Croatia and Bosnia and Herzegovina, the countries we studied in this investigation (Bagarić, Špehar, & Zvonarek, 2005; Caput-Jogunica¹, Neljak, & Čurković¹, 2013). Unfortunately, the number of universities that provide opportunity for their students to be physically active is also decreasing, although some examples of good practice emerge (Onofre et al., 2012). Taking this into account, the difference between PAL in high-school students and university students is easily explainable.

The second explanation is related to the period when this investigation was done: the first year after the COVID-19 pandemic (note that during 2022, when study was undertaken, the pandemic was not officially over, but generally there were no strict lockdowns in the studied countries). In brief, studies in the region regularly confirmed a decrease in PAL as a result of the COVID-19 pandemic and the imposed measures of social distancing (Geets Kesic et al., 2021; Gilic et al., 2021; D. Sekulic et al., 2021). It is well known that physical activity is a habitual behavior and that good habits should be developed (Saris, 1986). Therefore, it is logical to expect that those individuals who decreased their PAL during the period of COVID-19 pandemic did not adopt behaviors of increased physical activity, in the first year after the pandemic, and consequently did not reach pre-pandemic PAL.

For more than 50 years a clear link between cigarette smoking and lung cancer has been known, but smoking still remains the most prevalent type of substance misuse in the world (Hecht, 2002; Organization, 2018). The territory of south-eastern Europe is particularly endangered in this regard, and studies regularly show alarmingly high numbers for smoking in the region (Mayer et al., 2015; Milosevic Georgiev, Kotur-Stevuljevic, & Krajnovic, 2019; Samardzic, Marvinac, & Prlic, 2009). The high prevalence of smoking in ex-Yugoslav territories is mostly explained by (i) culture and traditional background, (ii) lack of a clear ban of smoking in public places in most of the territory, and (iii) relatively cheap tobacco products (Idrizovic, Zenic, Tahirajl, Rausavljevic, & Sekulic, 2015). Therefore, the high levels of smoking prevalence in our sample are not surprising and are in line with previous reports (Idrizovic et al., 2015; D. Sekulic et al., 2017; Zenic et al., 2017). For the purpose of this study, the lack of association between sport and physical activity and smoking behaviors in university students is more important.

Sport and physical-activity in general are associated with pro-social behavior (De Martelaer & STRUYVEN, 2012; Florić & Ninković, 2013). Moreover, cigarette smoking directly alters physical capacities, which are important factors in active participation in sport and physical exercise (Mundal et al., 1997). Logically, it would be expected that those individuals who practice sport and are physically active will be less oriented toward cigarette smoking. However, findings on that matter are not straightforward. In some cases, authors have confirmed lower prevalence of smoking in those who practice sports (and consequently were more physically active), whereas other studies have shown higher smoking rates in athletic samples (Guo et al., 2011; Rodriguez Garcia et al., 2013; D. Sekulic et al., 2012). Therefore, even our results of a non-significant association between PAL and sport-participation and smoking in university students are not as surprising as it may appear at first glance.

The first explanation for the lack of a correlation is related to the social character of sport and physical exercise, especially in the period of early adulthood (i.e., university students). It cannot be ignored that sport participation and general activities that increase PAL (i.e., fitness centers) are “social activities”. Therefore, social gatherings are common, especially after participation (i.e., after sport games or exercising in fitness centers). These gatherings often happen in bars and restaurants, where different kinds of substances are consumed. As previously stated, cigarette smoking is not strictly prohibited in public places in the region (Maric et al., 2021). Therefore, physical activity increases the overall possibility of smoking, irrespective of the fact that sport itself should present a certain barrier against smoking as an unhealthy behavior. What additionally aggravates the possibility of smoking is the fact that the sport participants in the studied age group are rarely “competitive athletes”, since, in the previous period of life (i.e., 17–18 years of age), a significant drop-out from competitive sports occurs. As a result, it is not likely that university students who participate in sports will be concerned about the eventual negative consequences of smoking on their physical capacities and the deterioration in their sport-performance.

A second explanation is again related to the period when our participants were tested. As mentioned earlier, the COVID-19 pandemic introduced numerous negative changes to everyday life and habits, globally. One of such negative change was an increase in substance misuse, including increased figures of smoking cigarettes (Gonzalez et al., 2021; Wiley et al., 2023) . This is indirectly confirmed even in our study: the numbers of daily smokers in our study are somewhat higher than previously reported numbers for similar age groups in the region (Zenic et al., 2017). Similar to previously discussed changes in PAL as a result of the pandemic, (negative) changes in smoking habits are hard to reverse immediately after the pandemic stopped. Moreover, as we know that smoking is an addiction, it is unreasonable to expect that people who smoked during the pandemic period will quickly get rid of the habit.

Limitations and strengths

The main limitation of the investigation comes from the fact that it is cross-sectional study. Therefore, although associations can be evaluated, causality remains unclear. Therefore, in future studies a prospective approach is needed. In addition, this study examined one specific sample of participants, university students, and therefore the generalizability of the findings is limited solely to similar samples. However, the sample was selected intentionally simply because of the fact that university students are an understudied population with regard to PAL and substance misuse.

This is one of the first studies examining the PAL and smoking behaviors in the period after the COVID-19 pandemic, and is probably the first one to investigate the associations between PA/sport participation and smoking in university students in south-eastern Europe. Furthermore, the fact that we observed participants from two countries is another important strength of the investigation.

CONCLUSION

Our results suggest that the COVID-19 pandemic and its imposed measures of social distancing resulted in similar changes in PAL and smoking in Croatia and Bosnia and Herzegovina, at least as far as university students are concerned. This was not surprising, considering the similarity of (i) cultural and traditional frameworks in the studied countries (which almost certainly resulted even in a similar prevalence of smoking), (ii) public health policies (no strict prohibition of smoking in public places),

and (iii) status of physical education at the universities, the role of sport and the acceptance of recreational physical exercising in the studied countries.

Despite our initial considerations, PAL/sport participation was not associated with cigarette smoking in university students in the post-pandemic year. The most likely reasons for the lack of correlation could be found in (i) the social nature of sport participation in this age group and (ii) negative changes in PAL and smoking which occurred during the pandemic years. However, it must be mentioned that figures (and associations) could change, and therefore future studies are warranted.

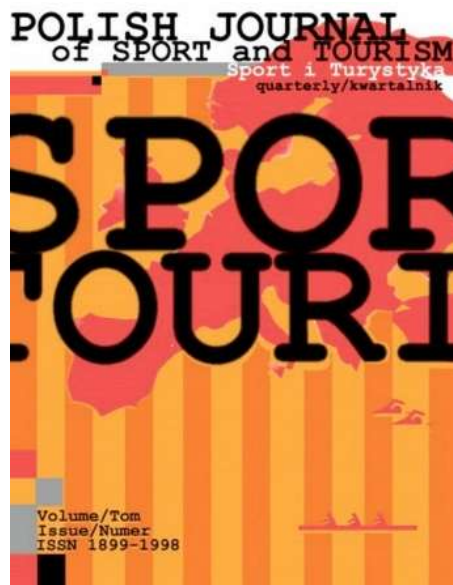
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- 2.2 **Study 2:** *Lulić Drenjak J., Užičanin E., Zenić N.: Sport, physical activity and (harmful) alcohol drinking in university students during the first year after covid-19 pandemic: Gender-stratified cross-sectional study. (2023) Pol. J. Sport Tourism, 30(2), 15-2115 DOI: 10.2478/pjst-2023-0009*



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Sport, physical activity and (harmful) alcohol drinking in university students during the first year after COVID-19 pandemic; gender stratified cross-sectional study

Abstract

COVID-19 pandemic increased consumption of alcohol (including harmful drinking – HD), and decreased physical activity levels (PAL) globally, but there is an evident lack of studies examining the problem in post-pandemic period.

This study aimed to evaluate gender-specific associations between sport participation and PAL (independent variables), and HD (dependent variable) among college/university students during the first post-pandemic year of the COVID-19 pandemic.

The participants were college/university students, aged 18 to 21 year (n = 788, 409 females) from Croatia and Bosnia and Herzegovina. They were tested on socio-demographic factors, HD (using the AUDIT scale), sport-participation and PAL (using the IPAQ questionnaire). Analysis of variance, Chi square test, and t-test for independent samples was used to evaluate differences, while logistic regression with dichotomized criterion (HD vs. non-harmful drinking - NHD) was calculated to establish associations between independent and dependent variables.

T-test indicated significant differences between HD and NHD in PAL (t-test = 2.16, p = 0.02), but only in males. Also, logistic regression indicated significant correlation between PAL and HD in males (OR: 1.41, 95%CI: 1.11-1.76), while no association was evidenced: (i) between sport participation and HD (in both males and females), and (ii) between PAL and HD (in females).

Results indicated that overall increase of PAL could be helpful in decreasing the HD among college/university students, but to evaluate it more specifically prospective analyses are needed.

Key words: post-pandemic, students, physical activity, participation in sport, substance misuse

Introduction

The COVID-19 pandemic which was declared at the beginning of the 2020 dramatically influenced all aspects of life all around the globe (Romero-Ramos, Romero-Ramos, & Suarez, 2021; Damir Sekulic, Blazevic, Gilic, Kvesic, & Zenic, 2020). The most important change in everyday life and habits happened because of the imposed measures of social distancing and lockdown (Klonova et al., 2022; Zenic et al., 2020). Numerous studies confirmed that such measures directly contributed to decrease of physical activity levels (PAL), and increased the likelihood for misuse of different psychoactive substances (substance misuse – SUM), such as smoking, and alcohol drinking (Clemente-Suárez et al., 2022; Schmidt et al., 2021). From the perspective of public health, this is important because of the two main reasons. First, proper PAL is known to be associated with better cardiovascular health, as a one of the main determinants of health status, but also - overall quality of life (Zenic et al., 2020). Second, SUM is directly connected with numerous detrimental health- and social-consequences (delinquency, criminal, addiction) and is one of the most important social- and public-health concerns worldwide (Zenic, Terzic, Rodek, Spasic, & Sekulic, 2015)

Alcohol is second most common psychoactive substance used in the world today, and negative consequences of alcohol drinking are widely known (White, 2020). In brief, alcohol consumption negatively affects brain function (by interfering with the brain's communication pathways, consequently changing mood, behavior, and coordination), (ii) heart function (causing cardiomyopathy, arrhythmias, stroke and high blood pressure), (iii) liver function (causing fatty liver, alcoholic hepatitis, fibrosis, and cirrhosis), (iv) pancreases (causing pancreas to produce toxic substances that can eventually lead to pancreatitis, and (v) cancer (alcohol drinking can cause several types of cancer) (White, 2020). Therefore, public health authorities, and society as a whole are highly concerned on finding the ways to reduce the consumption of alcohol across all age-groups (Loy et al., 2021).

Accordingly, special attention is paid on identification of the factors which could be positively or negatively associated with alcohol drinking (Cerkez, Culjak, Zenic, Sekulic, & Kondric, 2015; Denault & Poulin, 2018). In such way, it would be possible to identify the potentially vulnerable groups, but also to find eventual protective factors against alcohol drinking in specific population clusters (i.e. age groups, people of specific-socioeconomic status, -scholastic level). The youth and young adults are particularly important groups in such investigations. Namely, while alcohol drinking is addiction, preventing excessive alcohol drinking should be done in age when alcohol drinking habits are actually “developed”, with special emphasis on a problem in the regions and countries where alcohol drinking is common, and figures of excessive drinking are high (Devcic et al., 2018; Zenic et al., 2015).

Sport and PAL are directly connected, and it is well known that people who are engaged in sports have higher PAL (Trudeau & Shephard, 2008). Moreover, studies confirmed associations between PAL and sport, and numerous health-related behaviors. For example, while examining 11.631 high-school students, US authors concluded that low PAL was associated with higher rates of cigarette smoking, marijuana use, lower consumption of fruits and vegetables, and greater screen time (watching television) (Pate, Heath, Dowda, & Trost, 1996). Supportively, male sport-participants reported more fruit and vegetable consumption, and were less likely to report SUM; while female athletes consumed more vegetables, and reported less sexual intercourse than non-athletic females (Pate, Trost, Levin, & Dowda, 2000). However, associations between sport and alcohol are not clear. In short, while it is generally considered that sport participation and higher PAL should be observed as protective factors against alcohol use, studies frequently did not evidence association between alcohol drinking and sport/PAL, while some authors even confirmed higher likelihood for earlier initiation, and more harmful alcohol drinking in athletic samples (Cerkez et al., 2015; Devcic et al., 2018; Zenic et al., 2019).

It is clear that COVID-19 pandemic and imposed measures of social distancing negatively influenced health behaviors in various age groups, including (i) decrease of the PAL (mainly due to lockdown and prohibition of organized sport participation), and (ii) increase in alcohol consumption (Clemente-Suárez et al., 2022; Schmidt et al., 2021). Also, there is an evident interest of studying possible associations between PAL and sport participation, and alcohol drinking in order to evidence sport and PAL as factors of possible influence on alcohol consumption. However, there is an evident lack of studies which examined the association between sport and PAL, and alcohol consumption (i) immediately after the COVID-19 pandemic (knowing the previously specified negative effects of lockdown), and (ii) in college/university students (knowing the fact that they are older than 18 years and therefore may purchase alcohol legally, while this period of life is highly stressful and often accompanied with high alcohol consumption) (Ramón-Arbués et al., 2020; Watson, Jordan, & Madson, 2020).

Consequently, the aim of this study was to evaluate gender-specific associations that may exist between sport participation and PAL (independent variables), and alcohol consumption (dependent variable) among college/university students during the first post-pandemic year of the COVID-19 pandemic. Based on results of previous studies we hypothesized that higher alcohol consumption will be associated with (i) sport participation, and (ii) higher PAL in college/university level students.

Materials and methods

Participants

In this study the sample of participants comprised college/university students, aged 18 to 21 year ($n = 788$, 409 females). All of them were full-time students from Universities in Croatia and Bosnia and Herzegovina. Multi-stage sampling was performed to select the subjects from three convenient Universities, where investigators were engaged as teachers. Faculties as main organizational units of the Universities were divided into “large” and “small” according to number of students. In the next phase, 50% of faculties in each group was randomly selected. In order to cover all academic years, one year was tested in each of the selected faculties. The tested students in each academic year was randomly selected, meaning that we had no specific requirements with regard to educational program we intend to observe in our sample. After informing participants about potential risks and benefits, investigators visited each faculty and tested the participants by semi-structured questionnaire, which was disseminated over digital platform. Participation in the investigation was voluntary, and participants were informed that they can refuse to participate, and to leave the part or full questionnaire unanswered. No identification was collected from participants, and approval of *** hidden for reviewing *** was obtained prior to investigation. Prior to study, the necessary sample size was calculated, and required sample size was 702 (calculated on the basis of the harmful drinking prevalence reported previously for somewhat younger participants (please see later for details on variables), confidence level of 95% and error margin of $p < 0.05$).

Variables

Apart from gender (male, female, intersex), and age (in years), in this study we observed academic year of the study, PAL, participation in sports, and consumption of alcohol. All variables were collected by previously used questionnaires which were found to reliable and valid for testing in local languages in the region, and specific details on metrics of the questionnaires are available elsewhere (Cerkez et al., 2015; D. Sekulic, Bjelanovic, Pehar, Pelivan, & Zenic, 2014; Zenic et al., 2015)

Participation in sports was evidenced using the scale that consisted of following answers “never participated in sport”, “yes, but quit”, “yes, currently participating”. For statistical purposes results were later grouped into “not participating” (first two responses) and “participating in sports”.

Short version of the International Physical Activity Questionnaire (IPAQ) was used to evidence the PAL (Fogelholm et al., 2006; Hagstromer et al., 2006). Although different types of questionnaires of PAL exist, we decided to use IPAQ mostly because this measurement tool was intended to evidence so called “health-related physical activity”. Also, the here applied IPAQ short version is used so far in many studies globally, while its reliability and validity is repeatedly confirmed, even in local languages (Ćosić Mulahasanović, Nožinović Mujanović, Mujanović, & Atiković, 2018; Martinovic et al., 2021). In brief, IPAQ assesses physical activity undertaken during leisure time, yard activities, work-related activity, and transport. IPAQ contains questions about walking, moderate-intensity activities and vigorous-intensity activities, and sitting (sedentary time), with regard to frequency and duration of each observed activity itself. In this study we observed PAL as energy expenditure in METs.

The Alcohol Use Disorders Identification Test (AUDIT) was used to evaluate alcohol consumption (Williams, 2014). This measurement tool consists of 10 testing items with scores ranging from 0 to 4, which results in theoretical range of 0 to 40. Apart from raw score, the results were additionally observed divided into “harmful drinking” (HD; scores of 11 or above) and “non-harmful drinking” (NHD; scores below 11), as suggested previously, in order to allow meaningful comparison with previous studies done in the region (Cerkez et al., 2015; Devic et al., 2018), and to allow calculations of the associations with regard to dichotomized criterion variable.

Statistics

Kolmogorov Smirnov test was used to evaluate the normality of the distributions for all variables, and means and standard deviations were calculated for age, AUDIT raw score and IPAQ. Meanwhile frequencies and percentages were calculated for remaining variables.

Differences between groups in categorical variables were calculated by Chi square. Analysis of variance (ANOVA), with consecutive post-hoc test was calculated to establish the differences among academic years in parametric variables. T-test for dependent samples was calculated to establish the differences between HD and NHD. Finally, logistic regression with sport participation and PAL as independent variables was calculated to evidence the association between independent variables (age, academic years, sport participation, and PAL) and bimomized outcome (HD (coded as 1) vs. NHD (coded as 2)), with Odds Ratio (OR), and 95% Confidence Interval (CI) reported. Analyses of the differences and associations were stratified for gender.

Statistica ver 13.5 (Tibco Inc. Palo Alto, California, USA) was used for all analyses, and p-level of 0.05 was applied.

Results

Figure 1 presents AUDIT scores (1A), and PAL (1B) across age groups (academic years) in total sample, and separately for males and females. As evidenced, AUDIT score slightly increases from 1st (total: 8.11±3.44; males: 12.11±5.01; females: 4.2±3.1) to 5th year (total: 8.01±5.11; males: 14.11±5.67; females: 4.1±4.01) of college/university education, but significant differences are evidenced only for males (significant post-hoc differences at $p < 0.05$ between 1st and 4th academic year). Meanwhile, PAL

slightly decreases from 1st (total: 6011±3444; males: 6321±5231; females: 5677±5111) to 5th academic year (total: 5500±4903; males: 5991±5054; females: 5333±4980), but with no significant ANOVA difference.

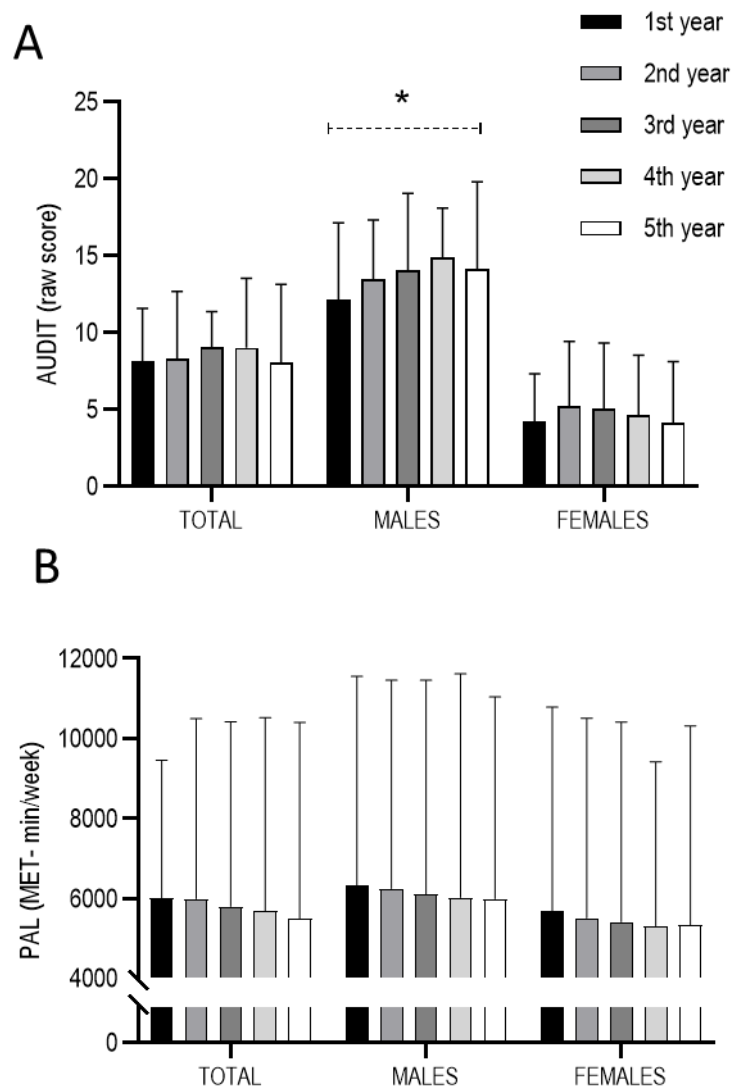


Figure 1. Alcohol Use Disorder Test (AUDIT) scores (A), and physical activity levels - PAL (B) across academic years with significance of the differences (* denotes significant differences at $p < 0.05$).

Figure 2 presents distribution of sport participation across academic years. Generally, less than 8% of all university/college students are involved in some form of competitive sports (Figure 2A). The percentage is somewhat higher in males (9% to 15% involved) (Figure 2B), than in females (0.3% to 4% involved in competitive sports) (Figure 2C). Chi square calculation did not reveal any difference among sport participation across different academic years of students (Chi square: 1.12, 2.43, and 1.89; all $p > 0.05$, for total, males, and females, respectively).

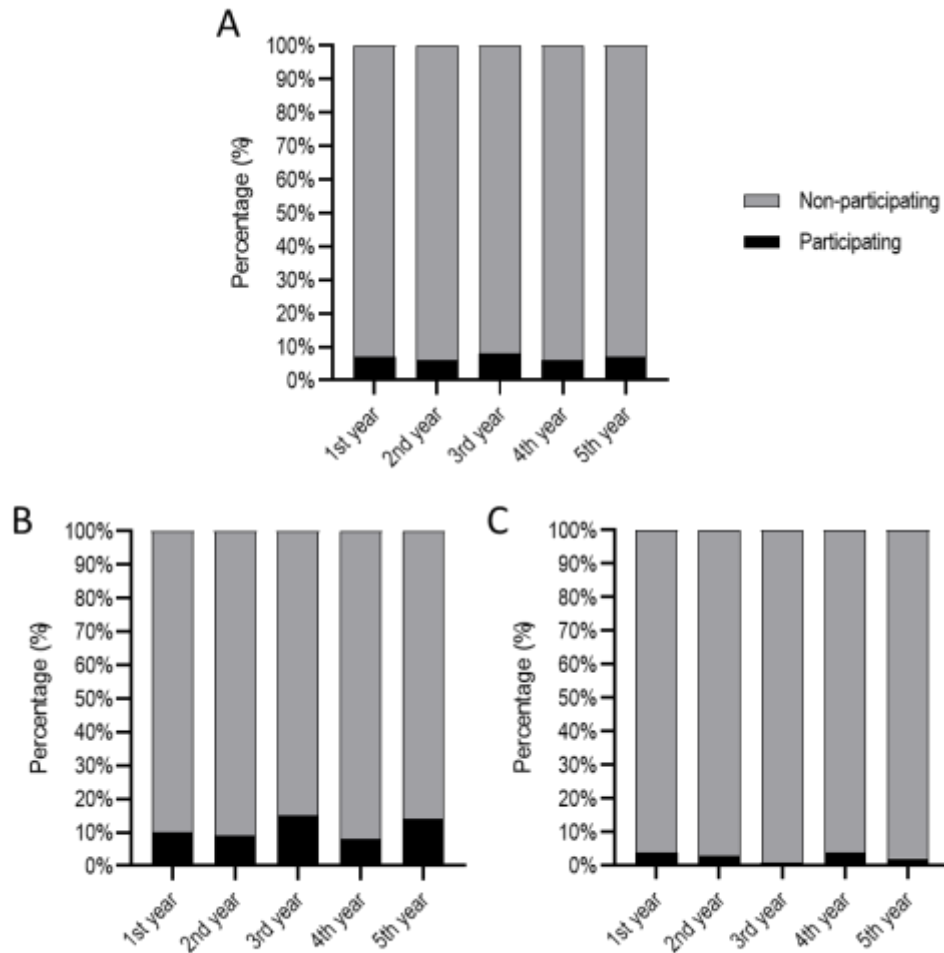


Figure 2. Participation in sport across academic years for total sample (A), in males (B), and in females (C)

Due to evident differences in sport participation and alcohol consumption between males and females (please see previous results), further analyses were done only gender-stratified and not for total sample (note that intersex was reported only in few cases per academic year, and therefore was not included in further analyses). Also, in further analyses subsamples were not observed according to their academic years, since previous analyses did not evidence strong differences among academic years.

Figure 3 presents distribution of the male (A), and female participants (B) according to HD and sport participation. In short, HD is distributed evenly across two observed categories with regard to occurrence of HD (43% of the male sport participants practice HD, vs. 41.5% non-participants who practice HD). In females, somewhat higher percentage of those who practice HD were actively involved in sports, than it was the case among those who don't practice competitive sports (28% vs. 22%, respectively), but Chi square calculation did not reach statistical significance neither in males nor in females (Chi square: 0.8 and 2.1; $p > 0.05$ for males, and females, respectively).

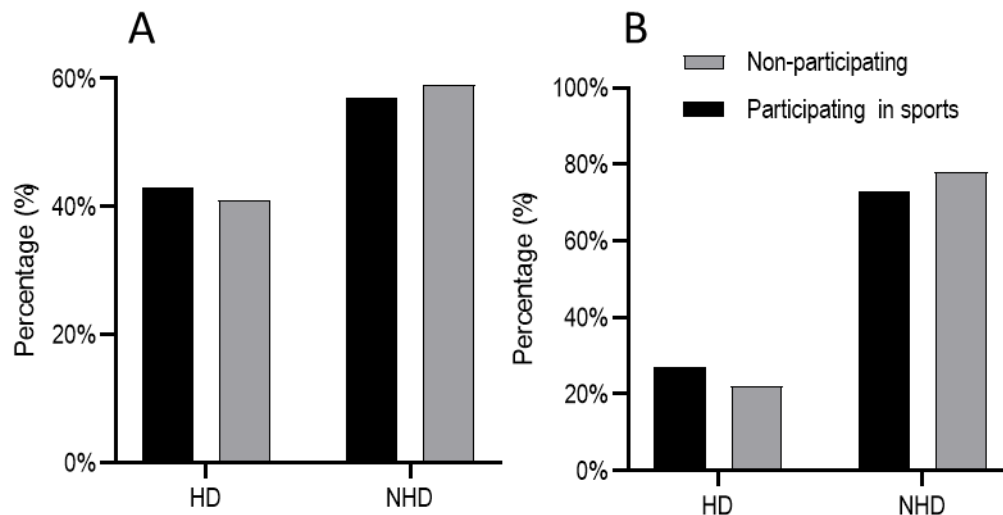


Figure 3. Distribution of participants involved in harmful drinking (HD), and those non-involved in harmful drinking practice (NHD) according to their sport-participation in males (A), and females (B)

Differences between groups based on HD practice in their PAL are presented in Figure 4. Evidently, males who are involved in HD had lower PAL, than their NHD peers (t -test = 2.16, p = 0.02). Meanwhile, no significant difference was found for females (t -test = 1.10, p = 0.35).

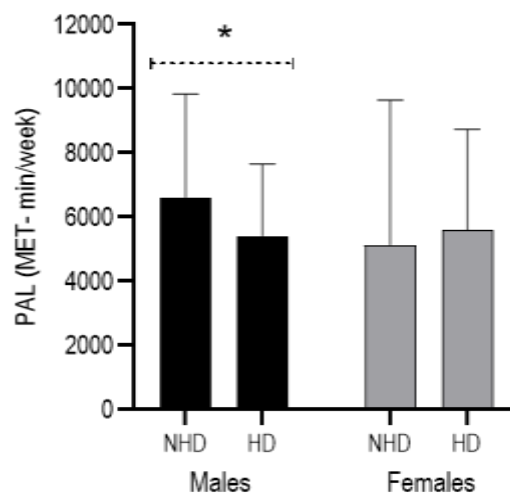


Figure 4. Differences in physical activity levels (PAL) across groups of participants according to their harmful drinking (HD) or non-harmful drinking practice (NHD) (* denotes significant t -test differences)

Figure 5 presents results of logistic regression calculation for binarized criterion (NHD vs. HD) in males and females. In brief, PAL was found as the only significant predictor of HD/NHD practice in

males, with higher likelihood of NHD in college/university students who reported higher PAL (OR: 1.41, 95%CI: 1.11-1.76).

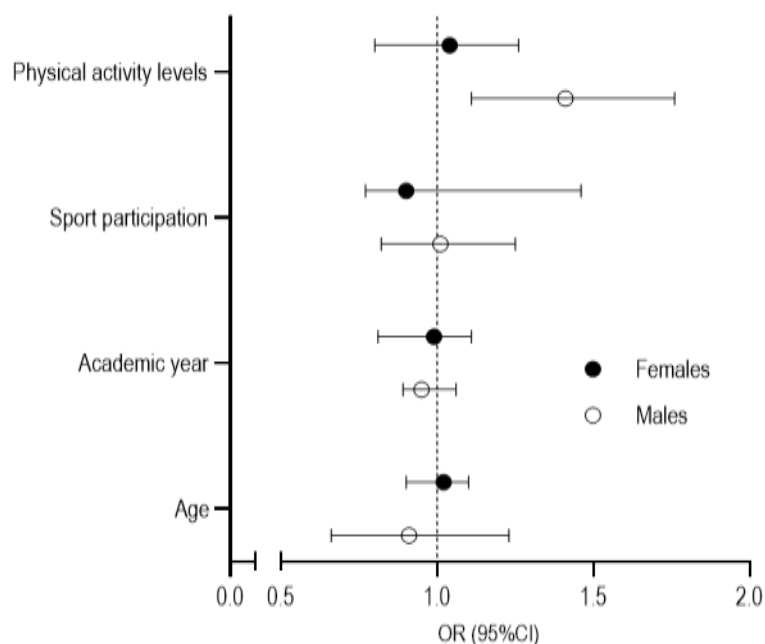


Figure 5. Logistic regression results; association between independent variables and binarized outcome (harmful drinking vs. non-harmful drinking) for males and females (OR – Odds Ratio, CI – Confidence Interval)

Discussion

There are two most important findings with regard to study aims. First, PAL is significantly correlated to alcohol drinking among male students. Second, no association between sport and PAL, and alcohol drinking was found in females. Therefore, we cannot confirm our initial study hypothesis. Before discussing the main findings in more details, we will briefly overview the prevalence of alcohol drinking in studied participants.

Although this is one of the first studies in the region where prevalence of drinking was examined in college/university students, we may compare the results with previous reports globally, and results obtained on somewhat younger participants in the region. In general, studies done so far, as well as European official reports on SUM (ESPAD), confirmed high numbers of drinking in the region of southeastern Europe (territory of former Yugoslavia), with 31-33% of older adolescents who practice HD (Cerkez et al., 2015; Devcic et al., 2018). As it is evident from our data, HD is evidenced in 35% participants (41% males and 22% females). Therefore, it seems that numbers of those who reported HD in our sample are not much higher than numbers previously reported for somewhat younger participants from the region (Cerkez et al., 2015; Devcic et al., 2018). Considering that this study was done in the first year after COVID-19 pandemic, and that we studied somewhat older population, one can argue that

this was not expected (i.e. young adults should drink more than adolescents, while COVID-19 pandemic increased drinking rates globally). The possible explanation is briefly discussed in the following text.

As already said, previous reports on drinking prevalence in this region observed older adolescents who were high school students at that moment (Cerkez et al., 2015; Devcic et al., 2018). Although their drinking behaviors are (only) 5-6% lower than those reported herein for college/university students in first year after pandemic, it must be emphasized that only minority of all adolescents who enroll high school later continue to college/university. Specifically, it is approximated that only up to 15% high-school students in the region advance with their education at college/university (Baketa & Kovačić, 2019). This is important to note since previous studies clearly confirmed that “college plans” of high school students are regularly found to be associated to lower SUM, including alcohol drinking (Kvesić, 2018). Second, previous studies confirmed relatively consistent correlations between higher scholastic achievement in high-school and lower SUM (Zenic et al., 2019). Since possible enrollment to college/university is significantly influenced by better scholastic achievement in high-school, this additionally explains our results.

PAL is found to be factor of influence on HD, with lower likelihood of HD in those male students who had higher PAL. While sport participation was not evidenced as factor associated to HD it is clear that in this study, PAL and sport participation should be considered as relatively independent covariates of HD. The explanations are not as simple, but from the authors’ perspective – logical. However, before discussing it further it is important to note that previous studies were inconsistent with regard to associations which may exist between participation in sports and alcohol drinking (Denault & Poulin, 2018; Elder, Leaver-Dunn, Wang, Nagy, & Green, 2000; Zenic et al., 2019).

For example, one study evidenced individual sport participation as protective factor against alcohol drinking among adolescent boys, but no association between sport and alcohol was evidenced in girls (Cerkez et al., 2015). Furthermore, in two-year prospective study authors did not evidence influence of sport/PAL on harmful drinking in 16-18 years adolescents (Zenic et al., 2019). In US samples, high-school sport participation was positively associated with alcohol use (Dawkins, Williams, & Guilbault, 2006), which was similar to findings in another study where sport participation was evidenced as risk factor for drinking alcohol in high-school (Eccles & Barber, 1999). Meanwhile, other studies evidenced some forms of sport participation as being protective against alcohol drinking (Denault & Poulin, 2018; Elder et al., 2000).

In explaining correlation between higher PAL and lower HD we must emphasize that the PAL of the studied participants is less likely to be a result of active participation in competitive sport, simply because only small proportion of college/university students are even engaged in such type of sports. Namely, college/university level education in the region rarely gives the possibility for regular involvement in competitive sport, and full-time students in the studied countries are only sporadically members of some competitive sport, no matter on type of sport (Caput-Joginica & Jazbec, 2021). This problem is recognized even from governmental bodies who intensively tries to find the way to stimulate college/university level education for competitive athletes (Caput-Joginica & Jazbec, 2021).

Our results clearly support previous discussion, since <8% of participants are current competitive athletes. Therefore, it is clear that (i) small proportion of our participants are involved in competitive sport, and (i) PAL of our participants is more a result of some recreational activity (i.e. exercising in fitness centers, and/or participation in other individual/group recreational programs). As a result, simply statistically (e.g. mathematically) it would be unexpectable that discrepancy of distribution across categories of sport participation (e.g. 90% vs. 10%), could result in some identifiable trend of association between sport participation and HD in studied students.

What aggravates the problem is the fact that among current athletes, alcohol drinking is not rare. Indeed, studies regularly confirmed high prevalence of alcohol drinking among competitive athletes (D. Sekulic et al., 2014). In our region this is additionally accentuated by the fact that alcohol drinking is very common in public gatherings, while such “social circumstances” are indispensable part of post-sport events. Even more, some specific sport cultures are characteristic for excessive alcohol drinking, and rates of alcohol drinking in some sport-societies sometimes even overcome alcohol consumption in non-sporting communities and events (D. Sekulic et al., 2014). Together with previous statistical/mathematical explanations, this explains the fact that sport participation is not correlated to alcohol drinking in our participants.

Contrary to sport participation, the PAL was found as protective factor against HD in males. While this study due to its cross-sectional nature can not clearly interpret the causality of the relationship. Namely, while it is possible that PAL reduces HD simply socio-psychologically (i.e. if you are physically active you avoid situations when alcohol is excessively consumed), it is also possible that those male students who practice HD are not physically active due to socio-cultural and psychological barriers) (Devic et al., 2018). However, since authors of the study are deeply involved in college/university education in the region we may offer one specific explanation of the found correlation.

As specified previously, PAL of the studied participants is actually a result of a “overall life style”, rather than solely a consequence of participation in competitive sport. The background of the higher PAL should be therefore found in other factors, such as active transport (i.e. walking and cycling), outdoor activities (i.e. mountaineering, hiking), exercising in fitness centers and/or participation in other recreational activities. Such physically demanding activities increase overall PAL and are all known as “activities of healthy lifestyle” (Loef & Walach, 2012). In most common words, “healthy lifestyle” is characterized by interest of general health, persons who adopt such lifestyle are certainly less oriented toward HD as well. However, it doesn’t mean that those people do not consume alcohol at all, especially if we consider that we studied countries where specific “Mediterranean type of drinking” is common (i.e. alcohol, mostly wine, is consumed regularly by meals, while intoxication is not socially accepted) (Damir Sekulic, Marko Ostojic, Zdenko Ostojic, Braco Hajdarevic, & Ljerka Ostojic, 2012).

For the end of discussion, we will briefly discuss the lack of correlation between sport and PAL, and HD in female students. As evident from our results, the PAL of the female participants was low. This is at least partially a result of negligible participation in competitive sports (girls quit sports mostly by the age of 16 years) (Pedišić, Rakovac, Bennie, Jurakić, & Bauman, 2014). Also, during college/university education in the studied countries there is no mandatory physical education classes (which significantly contributes to PAL in the previous age, over high-school education). Alarmingly low PAL in female students in the region is not a novel fact. For example, recent studies in Croatia and Bosnia and Herzegovina which studied changes in PAL among adolescents as a result of COVID-19 pandemic reported practically negligible decrease of PAL in high-school girls as a result of lockdown, which clearly points to low PAL among females initially (in pre-pandemic period) (Damir Sekulic et al., 2020). Putting it altogether, it is not surprising that such low PAL, and general lack of physical activity couldn’t even be correlated to HD.

This study is not without limitations, and the most important one comes from the cross-sectional nature of the investigation. Therefore, and as specified previously, causality can not be interpreted. Second, with regard to plausibility of the results, possible tendency toward “socially acceptable answers” is also expectable. However, this is less likely to happen, simply because study was strictly anonymous, and participants were older than 18 years. Finally, we observed students from only one region with specific templates of alcohol drinking (so called Mediterranean style of drinking), and results are generalizable only to similar samples of participants. Meanwhile, this is one of the first studies which examined the

association between PAL and sport, and alcohol drinking in college/university students in the post-pandemic period (first year after COVID-19 pandemic), which is probably the most important strength of the study because: (i) this age group is particularly endangered in SUM because of the stress imposed on them, and (ii) decrease of PAL, and increase of SUM-patterns during pandemic period.

Conclusion

The lack of correlation between sport-participation and PAL, and alcohol drinking in females is probably a consequence of alarmingly low participation in sport, and physical activities among females involved in college/university education in the studied countries. It altogether results in low PAL of female students, which should be observed as one of the most important findings of this study, irrespective of main objectives of the investigation.

College/university period is highly stressful, and increased alcohol consumption is frequent consequence of such psychological burden put on students. While sport-participation is not found as being significantly associated with HD in male students, it seems that overall increase of PAL could be helpful in decreasing the HD among them. Knowing the positive effects of increased PAL on overall health status, the fact that results confirmed theoretically positive influence of higher PAL on decrease of HD deserves special attention. However, in explaining the evidently complex associations, and cause-effect relationships between study variables, further prospective analysis are warranted.

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- 2.3 **Study 3:** *Drenjak, J. L., Blazevic, M., & Zenić, N. (2024). Analysis of the Relationships between Sport Participation, Physical Activity, and Concurrent Substance Misuse in College Students: A Gender-Stratified Analysis in the Post-Pandemic Period. Sport Mont, 22(1), 99-107. doi: 10.26773/smj.240214*



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Analysis of the Relationships between Sport Participation, Physical Activity, and Concurrent Substance Misuse in College Students: A Gender-Stratified Analysis in the Post-Pandemic Period

Abstract

The COVID-19 pandemic resulted in increased substance use and misuse (SUM). The period in which one undergoes college education is known to be associated with a greater risk of SUM, and there is a need for greater awareness of the risks associated with concurrent SUM in the post-pandemic years. The aim of this study was to evaluate the gender-specific relationships between physical activity levels (PAL), sport participation, and concurrent SUM among college students in the first post-pandemic year. The participants were college students from Croatia and from Bosnia and Herzegovina (n=398) who were tested on sport factors (involvement in individual and team sports, time of involvement, frequency of training, sport achievement), physical activity levels (PALs), and concurrent SUM (simultaneous consumption of cigarettes and alcohol) by using structured anonymous previously validated questionnaires immediately after the pandemic period. Sport factors and PALs were not significantly associated with concurrent SUM in the total sample or in male students. In female students, higher competitive achievement in sports was shown to be associated with the risk of concurrent SUM (OR=1.45, 95%CI:1.11-1.98). The results evidenced an increased risk of concurrent SUM in female students who achieved greater success in sports. Therefore, it seems that public health authorities should develop specific educational and preventive programs in female athletes. The timing of this study was in the first post-pandemic year could have at least partially influenced our findings.

Key words: substance use; sport participation; physical activity; healthy lifestyle; pandemic

Introduction

Despite its decreased prevalence, cigarette smoking (smoking) remains the leading type of substance misuse (SUM) globally (Flor, Reitsma, Gupta, Ng, & Gakidou, 2021). It is well known that smoking has a significant negative impact on health, leading to increased healthcare resource use, lower quality of life, and higher healthcare costs. It is a major cause of various diseases, including cancer, cardiovascular disease, and respiratory conditions, and it is associated with adverse effects on pregnancy and newborns (Flor et al., 2021). Smoking behavior is often related to stress, and the time in which one obtains a college education is considered a period of increased risk of heavy smoking (Fitzgeorge, Tritter, Fgan, Nagpal, & Prapavessis, 2018). In general, authors have emphasized the importance of psychological and socioenvironmental determinants of smoking behavior, and they have underscored the need for comprehensive smoking policies and effective education and prevention programs on college campuses (Fitzgeorge, Tritter, Fagan, Nagpal, & Prapavessis, 2018). In addition, factors influencing health-promotive behaviors, including self-efficacy and avoidance of environmental tobacco smoke were identified (Martinelli, 1999). Unsurprisingly, positive effects of policies of limiting smoking on college campuses on smoking rates and improved academic outcomes were reported (Cannonier et al., 2019).

Alcohol is considered the second most popular type of SUM in the world today (King et al., 2023). Unlike smoking, for which there is a clear consensus about the (exclusively) negative consequences of consumption, the consequences of alcohol consumption are not as straightforward. Collectively, it seems that mild consumption of alcohol is not recognized as a problem, but the likelihood of negative health consequences exponentially increases with higher rates of alcohol consumption. In brief, serious

problems related to alcohol dependence, including mortality, psychiatric conditions, and neurological deficits, are generally emphasized (Cargiulo, 2007), but some authors have noted that moderate consumption of alcohol can have beneficial effects, particularly in preventing heart thrombosis (Grønbaek, 2009). The impact of heavy drinkers' alcohol consumption on others' health and wellbeing is also a concern (Livingston, Matthews, Barratt, Lloyd, & Room, 2010). Last but not least, Rehm et al. provided a comprehensive overview of the causal impacts of alcohol consumption on various diseases and injuries and highlighted the need for further research to understand the nature of these relationships (Rehm et al., 2010). Again, this problem is particularly important among college students, since this period of life imposes significant stress on young people, and a higher likelihood of alcohol consumption is associated with higher levels of stress (Metzger et al., 2017).

Two factors that have been frequently observed to be protective against SUM are physical activity (physical exercise) and sport participation. A range of studies have explored the complex relationship of physical activity levels (PALs) and sport participation with smoking and drinking but with inconsistent results (Modric, Zenic, & Sekulic, 2011; Paavola, Vartiainen, & Haukkala, 2004; Zenic, Terzic, Rodek, Spasic, & Sekulic, 2015).. While some studies noted higher rates of smoking and drinking among physically inactive individuals, others evidenced higher levels of SUM in athletic and more physically active individuals (Modric et al., 2011; Paavola et al., 2004; Zenic, Terzic, et al., 2015). For example, Poortinga found that sports activities and heavy drinking were more prevalent among sports club members (Poortinga, 2007). Meanwhile, Paavola et al. found that smoking and alcohol use were positively correlated, with smoking being negatively correlated with leisure-time PALs (Paavola et al., 2004), which actually supported the findings of Conway and Cronan, who previously demonstrated that smoking was associated with lower PALs and lower physical endurance even after controlling for exercise activity (Conway & Cronan, 1992). Further, Audrain-McGovern et al. and Aaron et al. both found that higher PALs reduced the odds of the progression of smoking and the initiation of alcohol use, respectively (Aaron et al., 1995; Audrain-McGovern, Rodriguez, & Moss, 2003). Meanwhile, Rainey et al. found that athletic youth were less likely to smoke but more likely to use smokeless tobacco and engage in alcohol use (Rainey, McKeown, Sargent, & Valois, 1996).

There is a large body of evidence that the COVID-19 pandemic led to an increase in SUM and a decrease in PALs (Puen, Cobar, Dimarucot, & Camarador, 2021; Kuna, Duvnjak, & Kokic, 2023). In general, factors such as stress, job loss, reduced wages, and interruptions in addiction care were associated with an increase in SUM (Grossman, Benjamin-Neelon, & Sonnenschein, 2020; Quadri et al., 2023). Studies that specifically examined college students found that the pandemic led to an increase in SUM, especially with regard to alcohol consumption (van Hooijdonk et al., 2022). It seems that the shift toward remote learning and increased anxiety have been linked to such trends (Fruehwirth, Gorman, & Perreira, 2021). In addition, the prevalence of mental health problems, including acute stress, anxiety, and depressive symptoms, was high among college students during the pandemic, and these all increased the likelihood of SUM (Li et al., 2021). At the same time, during the pandemic period, due to the imposition of social distancing and lockdown measures, PALs and sport participation decreased, and this was confirmed globally in various sociodemographic groups, including college students (Bertrand et al., 2021; Gilic, Zenic, Separovic, Jurcev Savicevic, & Sekulic, 2021).

Considering the increase in SUM rates, the simultaneous decrease in PALs, and the lack of sport activities during the pandemic period, researchers were interested in possible associations that may have existed between PALs and SUM among college students in the early post-pandemic period. A study carried out with college-/university-level students from the territory of southeastern Europe showed that neither PALs nor sport participation were associated with prevalence of smoking among the participants, which was at least partially the consequence of the studied period (the first year after the pandemic) and

negative trends in PALs and SUM that occurred previously during the pandemic period (Drenjak, Pehar, Užičanin, Kontić, & Zenić, 2023). Meanwhile, in a study that explored associations between PALs and alcohol drinking, it was highlighted that an overall increase in PALs could be helpful in decreasing alcohol consumption among college/university students (Drenjak, Užičanin, & Zenić, 2023). However, previous studies were cross-sectional; therefore, the causality could not be interpreted. In addition, to the best of our knowledge, no study has shown associations that may exist between sport participation/PALs and concurrent SUM (simultaneous drinking and smoking) in college/university students in the early post-pandemic period.

Empirical evidence has suggested a complex interplay among PALs and sports, smoking, and drinking, thus demonstrating the clear necessity of further research on this problem, especially while considering concurrent SUM (Zenic, Rezic, Zovko, Vlahovic, & Sattler, 2020). Further, considering the increase in SUM and decrease in PALs that occurred during the pandemic, there is a clear need to explore these associations in the post-pandemic period. Finally, considering that SUM is generally correlated with (increased) stress, while college students face a range of stressors (e.g., academic pressure, interpersonal issues, and family-related stress), this population should be considered as a group of particular interest with regard to the evaluation of the factors associated with SUM in the post-pandemic period (Yikealo, Yemane, & Karvinen, 2018). Finally, research has consistently shown that the misuse of multiple substances (concurrent SUM) is associated with more severe physical and mental health outcomes than single SUM, and this is particularly concerning in young adulthood (Phillips, 2000; Marshall, 2006; Quek et al., 2013). These findings underscore the need for greater awareness of the risks associated with concurrent SUM. Therefore, the aim of this study was to evaluate the gender-specific associations between PAL, sport participation, and concurrent SUM among college students (students) from southeastern Europe in the first post-pandemic year. Initially, we hypothesized that higher PALs and sport participation would be associated with a lower likelihood of concurrent SUM, irrespective of gender.

Methods

Participants and study design

The participants in this cross-sectional investigation were college/university students from Bosnia and Herzegovina (B&H) and Croatia. At the time of testing, all participants were aged from 18 to 21 years, and the total sample comprised 412 participants (52% females). The participants were selected from three convenient universities at which the investigators were engaged as teachers. A multi-stage sampling procedure was performed to select the subjects. In the first stage, the faculties (i.e., organizational units of the universities) were divided into two groups (small and large) on the basis of the number of full-time students in each faculty. Second, 50% of the faculties in each group were randomly selected. One academic year was then included by relative proportion in the sampling. It must be noted that the authors did not specify necessary requirements regarding the study program, meaning that each study program was (theoretically/statistically) proportionally represented. Prior to the study, approval was obtained from the Ethical Board of the Faculty of Kinesiology, University of Split, Croatia (EBO: 2181-205-05-02-05-14-005, 11 May 2017)

The participants were analyzed one to two months after the COVID-19 pandemic ended in Croatia and in Bosnia and Herzegovina. One month prior to testing, all participants were contacted by college authorities and asked for their participation in the study. Initially, we contacted 600 potential participants, who were randomly selected from the pool of the observed universities. Throughout the initial contact, the participants were informed about the purpose and objectives of the study, and they were informed about the study's importance. They were informed that if they agreed to participate, no

personal information would be asked of them, and their responses would not be personally connected to them. An online survey was conducted on an internet-based platform. All participants who agreed to participate received a link to the survey by email. On the basis of the data obtained we calculated the intraclass correlation (ICC) between universities, which showed a proper within-university (within-cluster) variance (ICC=0.11).

Variables

Variables were collected with previously used and validated questionnaires: (i) the Alcohol Use Disorder Identification Test (AUDIT), (ii) the Questionnaire of Substance Use (QSU), and (iii) the International Physical Activity Questionnaire (IPAQ). All three questionnaires have already been extensively presented in the previous literature (Tahiraj et al., 2016; Zenic, Ostojic, et al., 2015; N. Zenic et al., 2020), so the tools used will be only briefly presented in the following.

The QSU collects data on sport factors, sociodemographic factors, and the misuse of substances. In this study, we specifically observed gender (responses included male, female, and other), age (in years), and country of origin (B&H and Croatia). The sport factors included in this study were assessed via four questions that examined different facets of involvement in sports, namely, (i) involvement in team sports, (ii) involvement in individual sports (both responses were on a scale that included “never been involved”, “quit”, and “currently involved”), (iii) the highest competitive achievement in sports (responses included “never competed/did not participate in sports”, “local competitions”, “national-competitions”, and “international-level competitions”), (iv) time of involvement in sports (including “never involved”, “<1 year”, “2–5 years”, and “>5 years”), and (v) the number of training sessions per week (“never participated, 1–2, 3–5, 6–7, >7 per week”). Although the QSU is used to examine the consumption of a variety of substances, in this study, we observed only smoking (please see the following for the evaluation of alcohol consumption). The participants were questioned about smoking on a five-point scale, which included the following responses: never smoked, quit, smoked but not daily, smoked daily). The responses were later dichotomized, and the participants were considered as nonsmokers (first two responses) or smokers.

The AUDIT questionnaire measures the consumption of alcohol and contains 10 items. Each item is scored on a scale ranging from 0 to 4, and the AUDIT score is later expressed as a summarized score of all items that ranges from a minimum of 0 to a maximum of 40. Later, the scores were dichotomized into harmful drinking (scores of 11 and higher) and non-harmful drinking (scores lower than 11).

If participants reported smoking (see the previous explanation) and HD (scores of 11 or higher on the AUDIT scale), they were categorized into the group with concurrent SUM.

The short version of the International Physical Activity Questionnaire (IPAQ) was used to assess PALs. The short version of the IPAQ applied here has been used in many studies around the world, and its validity and reliability in the local languages (i.e., Croatian, Bosnian, and Herzegovinian) were confirmed (Maric et al., 2020; Sekulic et al., 2021; Zenic et al., 2021). Shortly, the IPAQ assesses physical activity undertaken during leisure time, yard activities, work-related activities, and transport. The IPAQ contains questions about walking, moderate-intensity activities, vigorous-intensity activities, and sitting (sedentary time) to assess the frequency and duration of each activity. In this study, we observed PALs as the energy expenditure in METs.

Statistics

Kolmogorov–Smirnov tests were conducted to define the normality of the distributions for all variables, and the descriptive statistics included means and standard deviations (for normally distributed variables), as well as counts and percentages (for ordinal and nominal variables).

Differences between genders were established with a t-test (for the AUDIT score) and Chi-square test (for smoking and concurrent SUM).

The associations of sport factors and PALs (predictors) with concurrent SUM were established by calculating logistic regressions (see the following), but in the first stage, participants who were positively classified with concurrent SUM and those who did not report concurrent SUM were compared in terms of predictors by using a Chi-square test (for nominal predictors) and Mann–Whitney test (for ordinal predictors).

Logistic regressions were calculated for binarized concurrent SUM (Yes or No). Each predictor was independently correlated with concurrent SUM, and the odds ratio (OR) with a 95% confidence intervals (95%CI) was calculated. The logistic regressions were stratified by gender due to evidenced differences between genders in concurrent SUM (please see previous analyses, and later text for more details). The significance level of $p < 0.05$ was applied, and Statistica ver. 13.5 (Tibco Inc., Palo Alto, CA, USA) was used for all calculations.

Results

Males and females significantly differed in AUDIT score with higher scores in males (4.75 ± 2.04 and 2.77 ± 1.90 for males and females, respectively; $t\text{-test}=3.72$, $p<0.001$).

The prevalence of HD was higher in males than in females (20% and 5% for males, and females, respectively; Chi square=11.86, $p<0.001$). Smoking prevalence was similar in males and females (30% male and 27% female smokers; Chi square=0.04, $p=0.83$).

Concurrent SUM was higher among males, than among females (12% and 4.3% concurrent SUM among males and females, respectively; Chi square=4.22, $p<0.05$).

Table 1 presents descriptive statistics for sport factors, and differences between groups based on concurrent SUM. As presented, Mann Whitney coefficients indicated significant differences between groups in “Experience in sport” (Mann Whitney $Z=2.11$, $p<0.05$), “Competitive achievement” (Mann Whitney $Z=2.77$, $p<0.05$), and “Number of training/competitions sessions per week” (Mann Whitney $Z=2.11$, $p<0.05$). When observing more specifically, it is evident that experience in sport was higher in those participants who reported concurrent SUM. Also, those college students who reported concurrent SUM achieved better results in sport, and had more training sessions per week.

Table 1. Descriptive statistics (*F* – counts, % - percentages) for sport-factors in total sample, and separately in groups based on prevalence of concurrent substance misuse (Concurrent SUM), with differences between groups calculated by Mann Whitney test (* denotes significant differences between groups at $p < 0.05$)

	Total		Concurrent SUM		Mann	
	F	%	No	Yes	Whitney	test
Individual sport participation						1.86
Yes. still participating	16	4.0	15	3.8	1	4.0
Yes. but quit	203	51.0	181	47.0	22	67.9
No. never	179	45.0	170	44.0	9	28.1
Missing	0	0.0	0	0.0	0	0.0
Team sport participation						0.10
Yes. still participating	48	12.0	48	12.3	3	10.0
Yes. but quit	206	51.8	180	46.7	23	71.3
No. never	144	36.2	138	35.8	6	18.8
Missing	0	0.0	0	0.0	0	0.0
Experience in sport						2.11*
Never participated	97	24.4	95	24.6	2	6.3
< 1 year	94	23.6	85	22.0	9	28.1
2-5 years	111	27.9	100	25.9	11	34.4
> 5 years	96	24.1	86	22.3	10	31.3
Missing	0	0.0	0	0.0	0	0.0
Competitive achievement						2.77*
Never participated/Never competed	201	50.5	192	52.5	9	28.1
Local rank	165	41.5	146	39.9	19	59.4
National rank	25	6.3	22	6.0	3	9.4
International rank	4	1.0	3	0.8	1	3.1
Missing	3	0.8	3	0.8	0	0.0
Number of training/competitions per week						2.11*
Never participated	96	24.4	94	26.0	2	6.3
1-2 per week	115	28.9	106	29.0	9	28.1
3-5 per week	146	36.7	131	35.8	15	46.9
6-7 per week	34	8.5	30	8.2	4	12.5
> 7 per week	6	1.5	4	1.1	2	6.3
Missing	0	0.0	0	0.0	0	0.0

Differences between groups based on concurrent SUM in PAL are presented in Figure 1. As evidenced, no significant differences were found when t-test was calculated for total sample, and in gender-stratified analyses.

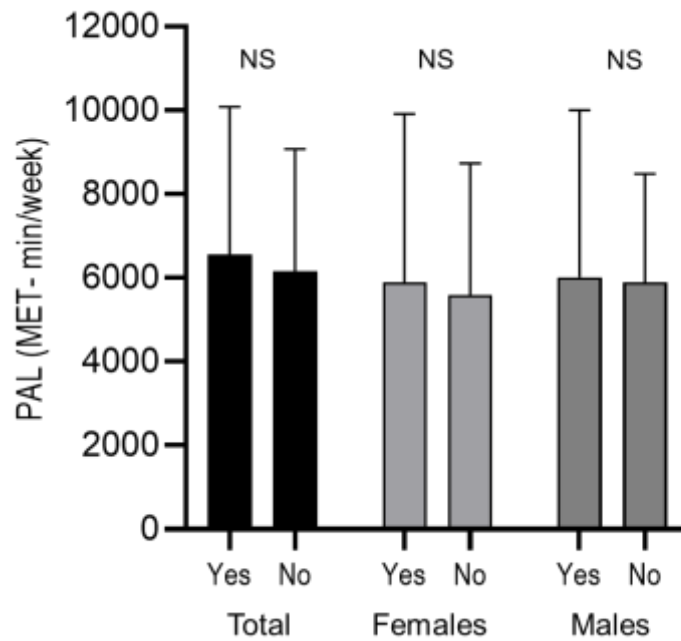


Figure 1. Physical activity levels obtained by IPAQ, and differences between groups based on concurrent substance misuse obtained by t-test for independent samples in total sample and gender-stratified (NS – non-significant differences between groups)

Results of the logistic regression calculated for criterion concurrent SUM in male college students are presented in Figure 2. In general, no significant association between sport factors, and PAL with concurrent SUM in males was found.

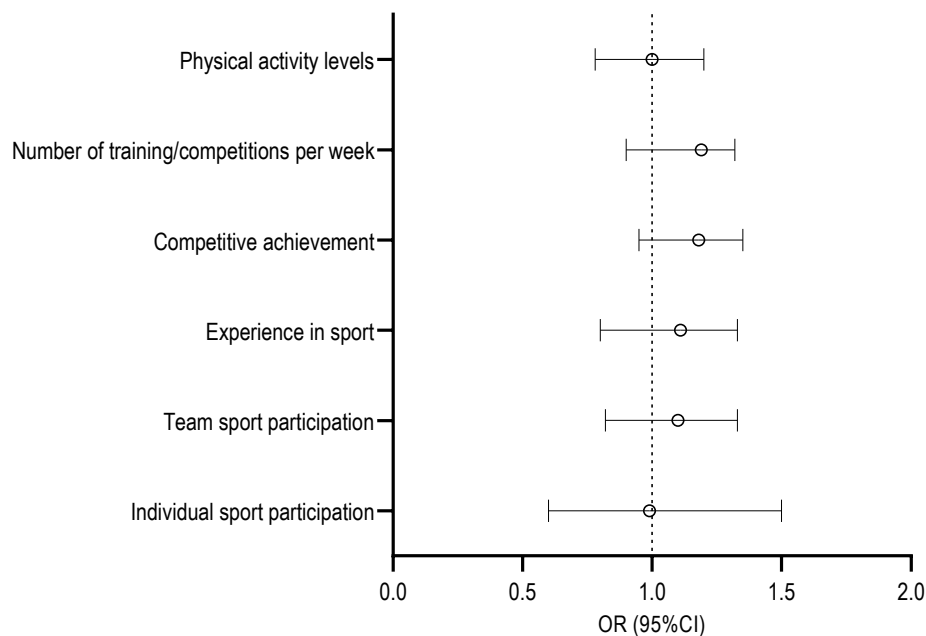


Figure 2. Logistic regression results; correlations between sport factors and physical activity levels, and concurrent SUM in males (OR – Odds Ratio, 95%CI – 95% Confidence Interval)

Correlations between sport factors and physical activity levels, and concurrent SUM (criterion) in female students calculated by logistic regression are presented in Figure 3. In brief, the only significant association was found between “Competitive achievement” and criterion (OR=1.25, 95%CI:1.05-1.45), with higher likelihood for concurrent SUM in females who achieved higher competitive success in sport.

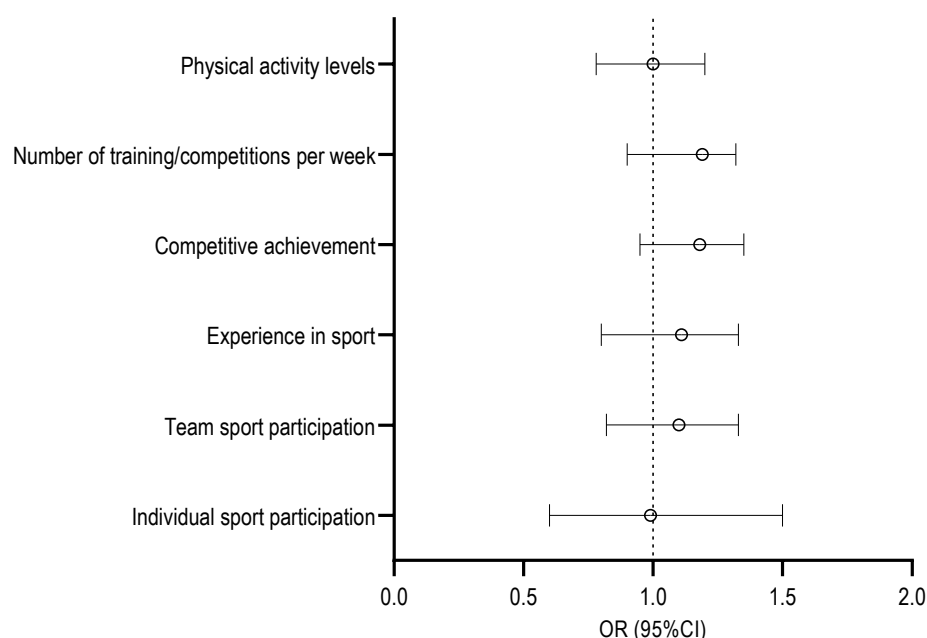


Figure 2. *Logistic regression results; correlations between sport factors and physical activity levels, and concurrent SUM in males (OR – Odds Ratio, 95%CI – 95% Confidence Interval)*

Discussion

Considering the study’s aims, the two most important findings will be discussed in the following. First, when observing the total sample of college students and when observing males, sport participation and PALs were not significantly associated with concurrent SUM. However, in females, competitive achievement in sports was associated with concurrent SUM, with a higher likelihood of concurrent SUM in female students who achieved better success in sports. Therefore, our initial hypothesis was rejected.

The problem of the association of sports/PALs with SUM is frequently studied, mostly because of the overall perception that sports and, consequently, higher PALs are related to a healthy lifestyle and, therefore, could be protective against SUM (as an unhealthy habit) (Gilic et al., 2021; Zenic et al., 2021). However, the findings of empirical studies, including those in which authors specifically observed college-/university-level students, are generally controversial. Some studies have highlighted the potentially protective effects of sport participation and higher PALs on SUM (Zenic et al., 2021; Zenic, Ostojic, et al., 2015). Meanwhile, some authors found that extrinsically motivated athletes were at higher risk for SUM, and this was particularly evident among students engaged in team sports (Rockafellow & Saules, 2006; Ford, 2007). This was actually a confirmation of earlier findings of Leichter et al. (1998) and a later study by Green et al. (2014), who also found a link between participation in sports and alcohol use (Leichter, Meilman, Presley, & Cashin, 1998; Green, Nelson, & Hartmann, 2014). When examining this relationship more specifically, some authors studied the links between sport participation and the consumption of different substances. For example, some studies confirmed that participation in

sports is linked to higher alcohol consumption, but it is also associated with lower levels of smoking and illegal drug use (Veliz, Boyd, & McCabe, 2015; Williams et al., 2020).

Even studies in which the authors specifically observed PALs (not necessarily in connection with sport participation) showed different findings. In general, while some authors highlighted that a positive association in which PALs were protective against SUM, others highlighted a higher risk of SUM in more physically active participants (Collingwood, Reynolds, Kohl, Smith, & Sloan, 1991; Zschucke, Heinz, & Ströhle, 2012)). Therefore, our findings on the non-significant correlation between sports/PALs and concurrent SUM are not surprising. Namely, while we observed concurrent SUM, there is a certain possibility that sport participation and PALs were differentially associated with facets of concurrent SUM (e.g., smoking and harmful alcohol consumption), as suggested in previous studies (Zenit et al., 2021; Zenit et al., 2023). Altogether, this could logically result in a non-significant association between predictors and concurrent SUM as a criterion in college students.

However, there is a certain possibility that the period in which the study was conducted influenced our findings. Our study specifically focused on the first post-pandemic year. In the previous pandemic period, PALs and sport participation decreased as a consequence of the imposition of social distancing and lockdown measures (Gilić et al., 2021). On the other hand, there is evidence that SUM increased during the same period (Grossman et al., 2020; Quadri et al., 2023). As a result, it is possible that such changes even influenced the relationships between the variables. Namely, the quantitative changes in study variables could almost certainly result in qualitative changes (changes in the associations between the observed indicators).

Gender-stratified approaches to studying eventual relationships between sports/PALs and SUM are not common. While a great deal of studies have explored this problem among adolescents and young adults (Modrić et al., 2011; Zenit, Ostojic, et al., 2015) researchers have rarely decided to evaluate these relationships specifically for each gender. However, more recent studies highlighted the necessity of such a method, especially in countries in which genders significantly differ in terms of their sport participation (Zenit et al., 2023; Zenit et al., 2021). In addition, a gender-stratified analysis appeared to be more convenient, since empirical evidence has underlined a sport-specific influence on SUM (i.e., with a higher risk of SUM in some typically male sports, such as rugby or football). Our results showed significant associations between sport participation and concurrent SUM in female students, but no association was shown for males, which clearly confirmed the appropriateness of separate analyses for males and females. As presented previously, among females, greater competitive success in sports was associated with a higher likelihood of concurrent SUM. From our perspective, the mechanisms of this association are both contextual and sociocultural. Therefore, in the following, we will provide an overview of both mechanisms.

The sociocultural context of sport participation in southeastern Europe (the territory of former Yugoslavia) is somewhat specific. There are no clear sociocultural barriers to female participation in sports at any level. Research on female sports in Croatia has identified several factors that influence women's engagement in sports; these are evidently general and not gender-specific, and they include the type of sport, educational level, marital status, and place of living (Sindik, Mikic, Dodigovic, & Čorak, 2016). Although we could not find any studies that directly investigated similar problems in B&H, considering the similarity of the cultural backgrounds of these two countries, we are convinced that evidence from Croatia is easily transferable to B&H. However, as long-term professionals in sports, the authors of this study are of the opinion that there is still a need for comprehensive implementation of a regulatory framework with a gendered perspective in the field of sports. Therefore, despite the proclaimed "equality" in the availability of sports for both men and women, we are still witnessing huge

differences in sport participation between genders, with men being evidently more involved in sports than women, which was confirmed in this research

The literature from around the world has offered a variety of reasons for women being less involved in sports than men (e.g., women generally have less interest in sports, have lower competitiveness, and take fewer risks than men) (Deaner, Balish, & Lombardo, 2016). Meanwhile, in our region, another reason deserves attention. Namely, there is no doubt that in Croatia and in Bosnia and Herzegovina, typical female sports (i.e., aesthetic sports such as dance and gymnastics) are less represented than typical male sports (i.e., martial arts and team sports). Because of the characteristics of martial arts, girls rarely participate in them, which is mostly due to their sociocultural backgrounds (e.g., family constraints, stereotyping), as well as hygienic reasons (the menstrual cycle is a significant obstacle to female participation in sports in which physical contact is inevitable); therefore women are more oriented toward team sports. This was confirmed in our study, where the majority of the studied females who were involved in sports participated in team sports. This low female participation in sports probably generated a specific environment for (concurrent) SUM among females.

In brief, research has frequently—although not exclusively—presented an increased risk of SUM among athletes who play team sports. For example, attraction to one's team was found to predict alcohol and marijuana use among intercollegiate athletes (Grossbard, Hummer, LaBrie, Pederson, & Neighbors, 2009). Further, participation in team sports was associated with increased binge drinking and smokeless tobacco use among Canadian adolescent girls, while female soccer athletes were identified as being at the greatest risk of substance use (Boyes, O'Sullivan, Linden, McIsaac, & Pickett, 2017; Ford, 2007). To explain these trends, several of the most important reasons should be highlighted.

First (i), sports are a social activity, with team sports being particularly social. After sessions of playing team sports (e.g., training, competitions), gatherings are very common, and in such circumstances, substances (mostly alcohol and cigarettes) are frequently consumed (Drenjak, Užičanin, et al., 2023). Second (ii), athletes often travel for competition or training. In the period of adolescence, (female) athletes are less likely to be under the proper control of responsible adults (e.g., coaches, officials, physicians). Therefore, studies have confirmed that there is an earlier initiation of SUM for athletes than for their non-athletic peers (Zenit et al., 2020). Third (iii), athletes are competitive in nature. Because of that, they have a tendency to compete in SUM (especially in alcohol consumption) (Sekulic, Bjelanovic, Pehar, Pelivan, & Zenit, 2014). Fourth (iv), athletes have a certain tendency toward risk-taking, which unfortunately increases the risk of SUM (Cherpitel, 1993). The problem is even more aggravated among more successful (female) athletes simply because (i) post-sport gatherings in which success is celebrated are more common, (ii) they travel more often and further, (iii) they are more competitive than their less successful and non-athletic peers, and (iv) they almost certainly have a greater tendency toward risk-taking.

One could argue that the previous explanations are plausible for males as well; therefore, similar associations between sport factors and concurrent SUM should appear not only among females, but also among males. However, (concurrent) SUM is more frequent among males than among females. Consequently, the previously specified risks of higher SUM are not as influential on males as they are on females. Taken together, these reasons likely explain the fact that correlations between sport factors and concurrent SUM were solely found among females.

Regardless of the previous explanations of the established relationships, it seems that the COVID-19 pandemic did not significantly influence the associations between the study variables. Most probably, because the studied participants were young adults/college students, relative stability was found in all observed variables, since the trends in concurrent SUM, PALs, and sport participation did not change

considerably over the course of the study. However, this points to another important problem, which goes beyond the aims of this study and should be investigated in more detail in the future.

Limitations and strengths

All variables observed in this study were collected with questionnaires, which was certainly the most considerable limitation. Therefore, it is possible that the participants did not respond honestly to some of the questions, especially those related to SUM. However, since we did not evaluate the consumption of illegal substances, we believe that the results are plausible. In addition, apart from the basic sociodemographic data, physical activity levels, and sport factors, other variables that were potentially related to concurrent SUM were not observed. Therefore, in some cases, we lack some important information that could hopefully help us create a more profound interpretation of the results.

On the other hand, this is one of the first studies to examine the associations between studied variables among college students after the pandemic period. Considering that this population is burdened with a great deal of stress and that SUM is known to be associated with stress, this is an important strength of this study. In addition, this is one of the rare studies in which PALs and sport participation were studied separately, and the sport factors included various indices related to sports. This allowed us to discuss the correlations more specifically, especially when considering the gender-stratified analysis.

In future investigation it would be therefore important to prospectively observe the problem in order to precisely evaluate causality between study variables. Also, investigations in other age-groups are warranted.

Conclusion

The results showed the specific associations between sport participation and concurrent SUM among female students; those who achieved greater success in sports had a higher risk of concurrent SUM. Most probably, the specific sociocultural context of female sport participation influenced these relationships. Therefore, public health authorities should develop effective strategies for the prevention of SUM, especially among female athletes.

Sport factors were not shown to be related to concurrent SUM among male students. Therefore, there is no proof that sport participation is a factor with any influence on SUM among young adult males. It is important to note that practically all of the participants in the study were urban residents (full-time college students residing in urban centers); therefore, specific limitations related to sport participation in association with urban/rural differences in sport availability did not influence our results to a great extent.

Despite the previous conclusions and explanations, there is a certain possibility that the results were influenced by the specific period in which the study was performed (first post-pandemic year). Consequently, negative changes that occurred in the study variables during the pandemic could have influenced the relationships between variables in the post-pandemic period. Therefore, further studies are needed in order to explore the problem more accurately.

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3 CONCLUSIONS

3.1 Synthesis of the findings

Synthesis of Research Efforts and the Post-Pandemic Framework

This dissertation presents a comprehensive analysis of students' health habits at a specific societal juncture - the period immediately following the global COVID-19 pandemic. Through three successive scientific papers, the research encompassed key determinants of youth lifestyle: PAL, participation in organized sports, and the consumption of the most prevalent PAS - tobacco and alcohol. The fundamental intent of this work was to determine whether behavioral patterns altered during the mobility restriction period persisted as permanent characteristics in the post-pandemic reality. The results point to a profound intertwining of kinesiological and public health parameters, emphasizing that the return to the "status quo ante" was not a linear process, but rather a period in which the protective and risk factors of student health in Southeastern Europe were redefined.

Dynamics of Physical Activity: From Necessity to Prevention

The first key insight of this dissertation concerns the role of the level of physical activity. Research analysis consistently confirms that a high level of physical activity is the strongest and most stable protective factor against smoking and excessive alcohol consumption. Among students who maintained or increased their activity levels after the pandemic, a significantly lower prevalence of risky behavioral patterns was recorded. This finding suggests that physical activity functions as a mechanism of psychological stabilization; it not only enhances physical fitness but also serves as a constructive tool for stress management. In the post-pandemic period, this stress was highly pronounced due to academic pressures and the challenges of social reintegration, which aligns with findings indicating significantly compromised student mental health owing to the cumulative effects of the pandemic (Chen & Lucock, 2022). The dissertation concludes that PAL represents the foundation of health capital, directly linked to more responsible decision-making regarding one's own body and the avoidance of harmful substances.

The Paradox of Sports Engagement and Social Cohesion

A specific scientific contribution of this work lies in the clear differentiation between general physical activity and participation in organized sports. While the results indicate that PAL plays a universally protective role in preserving psychological health, sports participation yielded ambiguous results - a phenomenon recognized in the literature as the "sports paradox" (Lisha & Sussman, 2010). This phenomenon is particularly visible within the context of psychoactive substance use, where sports, on the one hand, reduce the propensity for smoking, but on the other hand, may increase the risk of certain risky behaviors, as previously documented among the youth population in the Southeastern European region (Sekulić et al., 2012).

Smoking Prevention: The results clearly demonstrate that sports participation is a powerful factor in combating cigarette smoking. Due to the imperatives of physical fitness and pulmonary capacity, athletes resort to tobacco less frequently. In this context, sports function as a direct barrier to risky behavior.

Alcohol Risk: Conversely, the papers published within the framework of this dissertation confirm a concerning association between sports participation and harmful alcohol consumption. The return to sports clubs after the pandemic also brought about a return to specific socializing "rituals." Within sports circles, alcohol is often perceived as a means to celebrate victory or alleviate defeat, which frequently leads to dangerous occasional heavy drinking (binge drinking) among the student population.

In conclusion, the research suggests that while sports clubs promote physical health, they can simultaneously serve as environments where alcohol consumption is normalized. This necessitates a redefinition of the roles of coaches and physical education professors, who must become active carriers of preventive strategies within the sports system. The profession thus becomes the bearer of preventive messages.

Gender Differences: Distinct Pathways of Risk

The results of this dissertation confirm that the investigated associations must be observed through the prism of gender stratification, given that sports and physical activity factors do not exert an identical influence on modifying behaviors in male and female university students (Marić et al., 2021). It is precisely this systematic analysis by sex that revealed that male and female populations respond to crisis situations and sports environments in fundamentally different ways.

Among the male population (students), sports participation is more strongly associated with externalizing risky behaviors, which is consistent with global insights into the specific risk profile of athletes (Lisha & Sussman, 2010). Men more frequently utilize alcohol as a means of asserting social status within a group. For them, the return to sports after the pandemic was faster, but it was also accompanied by a swifter return to the "tradition" of social drinking that is deeply embedded in sports culture.

Female students, on the other hand, demonstrated a higher level of health risk awareness, with physical activity among them being more frequently linked to intrinsic motivation and concern for personal well-being. Nevertheless, the research observed a concerning phenomenon of "risk convergence." Namely, the results indicate that female students who are heavily engaged in competitive sports begin to exhibit drinking patterns similar to those of their male peers, confirming the thesis that high levels of competitive pressure can override the primarily protective role of sports (Veliz et al., 2015). This represents a novel trend in the Southeastern European region that demands special attention in the design of future preventive strategies.

Psychosocial Pressures and PAS as a Coping Mechanism

The dissertation explored in depth the reasons why university students, despite being aware of the harmful effects, continued with consumption or even increased their use of PAS following the pandemic. It was established that during the post-pandemic period, cigarettes and alcohol served as "social glue" and a means of reducing tension. Such behavior stems directly from the psychological need to manage negative emotions and facilitate social interaction, which Merrill and Read (2010) identified as key motives for turning to alcohol.

The academic environment, which became more demanding due to the catch-up coursework and changes in teaching formats, generated intense pressure that many students attempted to mitigate through substance use. This development confirms earlier warnings regarding the student mental health

crisis caused by the pandemic, which demands urgent and systemic interventions to prevent the long-term adoption of detrimental habits (Grubic et al., 2020).

Furthermore, the results indicate that under the uncertain conditions of the post-pandemic period, self-regulation and psychological resilience proved to be crucial factors determining how students would behave (Abakumova et al., 2022). It is precisely within this segment that a critical lack of institutional support at universities becomes apparent; instead of systemically strengthening this resilience, students were left to rely on their own capacities. Those who were not involved in the sports system or failed to maintain their PAL - thereby losing an important mechanism of psychological stabilization - were significantly more vulnerable to developing harmful habits as a form of "escape" from a stressful environment.

Socio-Cultural Specificities of Southeastern Europe

The obtained results must be interpreted within the specific socio-cultural context of the region (Croatia, Bosnia and Herzegovina, and the broader environment), which is characterized by a pronounced permissiveness toward alcohol and tobacco consumption (Sekulic et al., 2012). The dissertation confirms that regional patterns - such as the social rituals of drinking coffee accompanied by smoking, or the normalization of alcohol consumption within sports circles - are often more dominant than general public health guidelines, thereby posing a significant barrier to the implementation of preventive programs (Marić et al., 2021).

The pandemic temporarily pushed these patterns into the private sphere, primarily through drinking in isolation or home environments; however, the period following the lifting of restrictions was marked by their return to the public space. Research confirms that over time, there was a significant increase in drinking outside the home, which proved to be the riskiest context for the development of negative consequences among the student population (Hultgren et al., 2022). This return to public spaces was often accompanied by heightened intensity due to a strong need for socialization, further underscoring the necessity for targeted preventive measures.

These findings indicate that preventive programs from Western countries cannot simply be adopted directly; rather, they must be tailored to the specific mentality and customs of students in this region. The need to take the local context into account is also supported by earlier research in Bosnia and Herzegovina, which confirms that socio-cultural factors significantly modify the impact of sports on risky behaviors among youth (Zenic et al., 2015). This reinforces the conclusion of this dissertation regarding the necessity of developing authentic preventive strategies that align with the actual social rituals and lifestyles of university students in the Southeastern European region.

Ethical and Pedagogical Obligations in Kinesiology

The conclusion of this work emphasizes the profound responsibility of the kinesiological profession within the academic environment. This dissertation demonstrates that merely encouraging movement is insufficient if it is not accompanied by systematic education regarding risks. Kinesiology in higher education must evolve from a simple process of physical exercise into a process of health education. The implementation of a Health-Based Physical Education pedagogical model implies that the primary objective of instruction becomes the internalizing of active living values, thereby helping students identify and practice those activities that enhance their long-term well-being (Haerens et al., 2011). In doing so, kinesiology assumes an active role in the prevention of risky behaviors, educating students on how to make conscious decisions aimed at health preservation.

A key point: Sports teams must transform into safe, substance-free environments—environments that promote the implementation of Protective Behavioral Strategies (PBS). Research confirms that the consistent, day-to-day use of these strategies significantly reduces the risk of negative consequences associated with alcohol consumption among university students (Pearson et al., 2013).

Scientific Validation: Timing of Intervention

The results provide robust evidence that prevention programs are most effective when implemented during the first two years of study, while lifestyle patterns are still being formed. Meta-analytic data confirm that timely behavioral interventions incorporating goal-setting and the identification of high-risk situations significantly reduce alcohol-related problems (Scott-Sheldon et al., 2014). This approach ensures that kinesiology fulfills its foundational mission: the cultivation of a healthy and responsible individual.

Ultimately, these findings confirm that the student population in Southeastern Europe has maintained a high level of risky behaviors in the post-pandemic period, with sports manifesting as a "double-edged sword" in this specific context. Systemic investment in physical literacy, a gender-tailored approach, and the strengthening of psychological resilience through movement represent the only reliable pathways toward reducing harmful substance consumption. This dissertation, therefore, serves not merely as an analysis of the current state of affairs, but as a scientific call for systemic transformation—spanning from regular physical education classes to university sports and recreation. These forms of physical activity must cease to be treated as mere extracurricular components of university life and must instead become foundational tools of public health prevention in higher education.

3.2 Strengths and limitations

The primary strength of this dissertation, grounded in three published scientific papers, lies in its multicenter approach and timely analysis of the post-pandemic period in Southeastern Europe. The research encompasses representative samples of university students from different countries in the region, thereby ensuring a high level of applicability of the findings to this specific geographical and cultural area. A distinct scientific contribution is manifested in the analysis of data by sex; a separate approach for male and female students enabled the identification of specific risk pathways that would have remained hidden in pooled models. Furthermore, the clear distinction between general physical activity and organized sports participation provides a nuanced insight into the "sports paradox," whereby the work transcends a mere description of the status quo and offers a profound understanding of the social dynamics within sports teams. The use of standardized and validated measurement instruments ensured data reliability and enabled a direct comparison of results across different dimensions of psychoactive substance use (alcohol, cigarettes, and simultaneous use).

On the other hand, the work has certain limitations that should be acknowledged when interpreting the results. First, a cross-sectional design was applied, which precludes causal inference. Although significant associations were established between sports participation and PAS consumption, it cannot be claimed with certainty that sports directly cause specific behaviors. Second, data collection relied on participant self-reports, which introduces the possibility of response bias due to social desirability, particularly regarding sensitive questions about substance consumption. Third, although the sample encompassed multiple centers, it primarily focuses on students of social sciences, humanities, and

kinesiology, which may limit the generalizability of the results to students of technical or medical faculties. Finally, the research did not comprehensively capture novel forms of tobacco consumption (such as e-cigarettes and heated tobacco devices) that gained popularity precisely in the post-pandemic period. Despite these limitations, the work provides critically important insight into the public health status of university students following a global crisis, laying a solid foundation for future preventive strategies and systemic research.

3.3 Overview of the study hypotheses

With regard to main study hypotheses, following conclusions can be made.

H1: Lower physical activity would be associated with higher tendency toward cigarette smoking.

- Results showed that neither physical activity levels nor sport participation were associated with prevalence of smoking in the studied university students. Therefore, this hypothesis was not confirmed.

H2: Higher alcohol consumption will be associated with (i) sport participation, and (ii) higher PAL in college/university level students.

- Physical activity level was significantly correlated to alcohol drinking among male students, but no association between sport and physical activity, and alcohol drinking was found in females. Therefore, this hypothesis was partially confirmed.

H3: Higher PALs and sport participation would be associated with a lower likelihood of concurrent SUM, irrespective of gender.

- When observing the total sample of college students and when observing males, sport participation and physical activity levels were not significantly associated with concurrent SUM. However, in females, competitive achievement in sports was associated with concurrent SUM, with a higher likelihood of concurrent SUM in female students who achieved better success in sports. Therefore, this study hypothesis was partially confirmed

3.4 Directions for future research

The results obtained within the framework of this dissertation open numerous avenues for future research that could further elucidate the complex relationship between physical activity and risky behaviors in a post-pandemic world. Primarily, future studies should move away from a cross-sectional approach and implement a longitudinal design. Tracking the same cohort of students from their first year of study until their entry into the labor market would enable a more precise understanding of causal relationships and answer whether PAS consumption patterns become permanent features of adult lifestyles. Such an approach would provide deeper insight into the persistence of the "sports paradox" and changes in gender differences over time.

Furthermore, it is essential to expand the scope of variables defining substance consumption. Given the rapid transformation of the market, future research must encompass novel forms of tobacco and nicotine consumption, such as e-cigarettes, heated tobacco products, and nicotine pouches. Although systematic reviews point to reduced levels of certain toxicants, these products still deliver high levels of nicotine

(up to 83%), thereby maintaining addiction and exposing users to health risks (Simonavicius et al., 2019).

Of particular concern is the fact that within sports circles, these products are often perceived as a "less harmful" substitute for conventional cigarettes, primarily due to the absence of negative effects on the respiratory system (Marclay et al., 2011). This perception, coupled with the belief in the potential ergogenic effect of nicotine on athletic performance and focus, leads to an exceptionally high prevalence of consumption in certain sports disciplines (Mündel, 2017). Future research must therefore more precisely examine the boundary between nicotine abuse as a performance-enhancing aid and the development of severe forms of addiction among student and athletic populations.

Special attention should also be dedicated to the use of illicit drugs, primarily cannabis as a means of relaxation (Jordan et al., 2019) and stimulants utilized to enhance academic performance (Arria et al., 2008). Investigating the simultaneous consumption of alcohol and energy drinks (Arria et al., 2011), as well as the use of dietary supplements in sports (Backhouse et al., 2013; Ntoumanis et al., 2014), is crucial for understanding modern patterns of polysubstance use.

Future scientific interest should also pivot toward qualitative research methods, such as in-depth interviews or focus groups with coaches and athletes. This would allow for an understanding of subjective motives for alcohol consumption within sports teams and the identification of specific elements of sports culture that either encourage or inhibit risky behaviors. Finally, there is a clear need to evaluate the effectiveness of evidence-based prevention programs. Future research should test digital platforms and mobile applications that promote physical literacy and mental health, tailoring them to the specific mentality of students in Southeastern Europe. By linking objective measures of physical fitness with advanced psychological instruments, science can provide an even more precise response to the challenges of preserving the health of young generations in the digital and post-crisis era.

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5 BIOGRAPHY

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For nearly three decades, she has been active in the higher education and sports systems. She has participated in more than thirty national and European projects and has actively contributed to the work of numerous sports organisations as well as various professional associations. She has received numerous awards and recognitions for her contributions to kinesiology and parasport.

Currently, she works as a Senior Lecturer at the University of Rijeka, Faculty of Health Studies. Her spheres of interest in research are: physical activity of students, parasport, para swimming, and kinesitherapy.