

EVIDENCING THE INFLUENCE OF PRE-PANDEMIC SPORTS PARTICIPATION AND SUBSTANCE MISUSE ON PHYSICAL ACTIVITY DURING THE COVID-19 LOCKDOWN: A PROSPECTIVE ANALYSIS AMONG OLDER ADOLESCENTS

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Abstract

Objectives: The physical activity level (PAL) has significantly decreased as a result of the social distancing and lockdown related to the COVID-19 pandemic, but there is a lack of knowledge on the correlates of PAL during the pandemic. The aim of this research was to examine the influence of pre-pandemic sports participation and substance use and misuse (SUM) on PAL during the COVID-19 pandemic. **Material and Methods:** The study included 661 high-school students from Bosnia and Herzegovina (aged 15–18 years, 292 females). The investigation included 2 testing waves: before the COVID-19 pandemic (baseline, January 2020) and during the COVID-19 lockdown (follow-up, April 2020). The variables included PAL as measured by the *Physical Activity Questionnaire for Adolescents*, sports factors, and SUM. **Results:** Sports factors at baseline were positively correlated with PALs at both baseline and follow-up. Smoking tobacco negatively affected PALs at both baseline and follow-up. Alcohol consumption was positively correlated with PAL at baseline but had no effect on PAL at follow-up. **Conclusions:** This study confirmed the importance of sports participation in maintaining PAL during challenging situations, such as the COVID-19 lockdown. The substance-specific influence of SUM on PAL before and during the lockdown points to evident social and cultural aspects of SUM behaviors in adolescents. Further studies evidencing the cumulative effects of PAL decline during the lockdown are warranted. *Int J Occup Med Environ Health.* 2021;34(2)

Key words:

risk factors, tobacco, health behavior, exercise, teenagers, virus diseases

Funding: this study was supported by the Croatian Science Foundation (grant No. DOK-2018-09-1940 entitled “Young Researchers Career Development,” grant manager: Prof. Damir Sekulic).

Received: September 26, 2020. Accepted: December 16, 2020.

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INTRODUCTION

At the end of 2019, the COVID-19 virus appeared and rapidly spread worldwide, which led to the declaration of a pandemic on March 11, 2020 [1]. Countries around the globe enacted different measures and methods for stopping or slowing down the spread of the COVID-19 disease; however, numerous countries imposed measures of self-isolation, home-confinement, and limited social interactions for several weeks or even months. The most important measure undertaken (besides emphasizing hygiene) was enforced social distancing, which included closing daycares, schools, universities, fitness centers, and sports and recreation clubs, and limiting social gatherings [1]. As a result of the implied moving restrictions, it was expected that physical activity levels (PALs) would decline. Indeed, studies have confirmed such expectations worldwide [2,3]. This negative trend was particularly evident in adolescents because the lockdown induced by COVID-19 negatively influenced their life habits to the greatest extent [4]. Therefore, in parallel with investigating changes in PALs, factors that have influenced PALs in adolescents during the COVID-19 pandemic have been examined.

Specifically, recent studies have reported the influence of gender, age, the fitness status, living environment and family factors on changes in PALs among adolescents during the COVID-19 pandemic [3–5]. For example, a better fitness status was associated with higher PALs among Croatian adolescents before and during the pandemic [4]. The authors of that study explained such findings by theorizing that adolescents with a better fitness status have greater knowledge and awareness about staying physically active and exercising (i.e., they possess a better “physical literacy”), which allowed them to be active even during the lockdown [4]. Additionally, a more evident PAL decrease was found among boys than among girls, probably because of the type of activities that boys partake under regular circumstances (i.e., team sports such as football, basketball, handball), and the fact

that sports and recreational facilities were closed during the lockdown [4].

Furthermore, a PAL decline was more evident among adolescents from urban living environments than among their rural peers [3]. This finding was explained by the higher pre-pandemic PALs among urban adolescents and their more frequent participation in organized sports before the pandemic [3]. Finally, a very recent study evidenced paternal education as being positively correlated, and family conflicts as being negatively correlated, with PALs in adolescents both before and during the pandemic [5]. This highlighted the importance of the parent-child relationship and parental support for maintaining PALs among adolescents in challenging situations, such as the COVID-19 pandemic [5].

In regular circumstances, numerous factors influence the maintenance of PALs in youth (i.e., gender, the socio-economic status, the living environment, and life habits) [6,7]. However, during childhood and adolescence, sports involvement is known to be one of the most influential factors [8]. Indeed, practicing sports is considered one of the main sources of PALs in youth; that is, participating in organized sports activities determines a large share of the total PAL [8]. As evidence of this, it has been recorded that the youth who participate in sports activities have higher total PALs than their peers who are not involved in sports [9]. However, there is an evident lack of research that has examined the influence of sports-related factors (sports involvement, achieved sports result, type of sports) on PAL during the COVID-19 pandemic. This is a particularly intriguing issue because, during the COVID-19 lockdown, regular sports activities were quite limited because of the closing of sports facilities.

The consumption of psychoactive substances (cigarettes, alcohol, drugs; or substance use and misuse – SUM) is another factor that can influence PAL. However, there is no conclusive evidence about the relationship between SUM and PAL in adolescents, even in “normal” circum-

stances. For example, smoking cigarettes has been recorded as a predictor of decreased PALs among U.S. adolescents [10]. On the other hand, a recent study involving adolescents from Bosnia and Herzegovina has concluded that cigarette smoking is not a predictor of PAL, but the authors noted a lower PAL among adolescents who consumed illicit drugs [11]. The association of frequent alcohol consumption among adolescents with higher PALs was recorded among African adolescents, and this is actually supportive of other studies that reported high alcohol consumption in sports communities [12]. Therefore, given the previously recorded impact of SUM on PALs in regular and normal circumstances, it is important to evaluate the potential association between SUM and PALs during the COVID-19 pandemic, especially knowing that emerging situations (i.e., crises, weather disasters, and health emergencies), are known to be associated with the increased prevalence of SUM [13].

From the previous brief literature overview, it is clear that negative trends in PAL during the COVID-19 pandemic deserve particular attention. Namely, while a PAL decrease as a result of the lockdown seems to be unavoidable, it is important to examine the factors related to such trends. Previous studies have evidenced certain protective factors, as well as some risk factors for changes in PALs during the COVID-19 pandemic [3,4]. The aim of this research was to extend the knowledge about the problem and to prospectively examine the influence during the COVID-19 pandemic among adolescents from Bosnia and Herzegovina of:

- pre-pandemic sports participation
- pre-pandemic SUM on PALs.

MATERIAL AND METHODS

Participants

This research included 661 high-school students aged 15–18 years (292 females) from 4 counties in Bosnia and Herzegovina (Tuzla, Zenica-Doboj, Herzegovina-Neretva, and

West Herzegovina Canton). All of the participants were in good health, and they regularly participated in physical education classes ≥ 2 times a week, and possibly in organized sports outside of the school curriculum in the period before the COVID-19 pandemic. The participants were informed about the aims and study protocols, and gave their informed consent before the beginning of the study (a parent/legal guardian signed the consent for the participants aged < 18 years). This study is part of a larger study (“Physical activity, substance misuse, and factors of influence in adolescence”) that was approved by the Ethical Board of the University of Split, Faculty of Kinesiology, Split, Croatia (EBO: 2181-205-05-02-05-14-005).

This study involved 2 testing waves:

- before the social distancing measures due to the COVID-19 pandemic were implemented (baseline),
- while the measures were being enforced (follow-up).

During the first testing wave, the participants were assessed for sports factors, SUM, and PALs before the pandemic. The second testing point was during the imposition of movement restriction measures and included only the testing of PALs (Figure 1).

Variables

Apart from age at baseline and gender (male, female), this study included sports factors, SUM, and PALs.

The *Physical Activity Questionnaire for Adolescents* (PAQ-A) was used for the assessment of PALs at baseline and follow-up. The PAQ-A is a questionnaire that involves questions about the past 7 days of activity; it is self-administered and used for assessing PALs among 14- to 19-year-old adolescents [14]. The PAQ-A results were observed at baseline and during the pandemic. Although being continuous in nature (1–5), for the needs of this research, the PAL was observed as binomial. The binomial variable is represented with 2 categories: a low/insufficient PAL for results < 2.73 and normal/sufficient PAL for results > 2.73 , as already suggested [15].

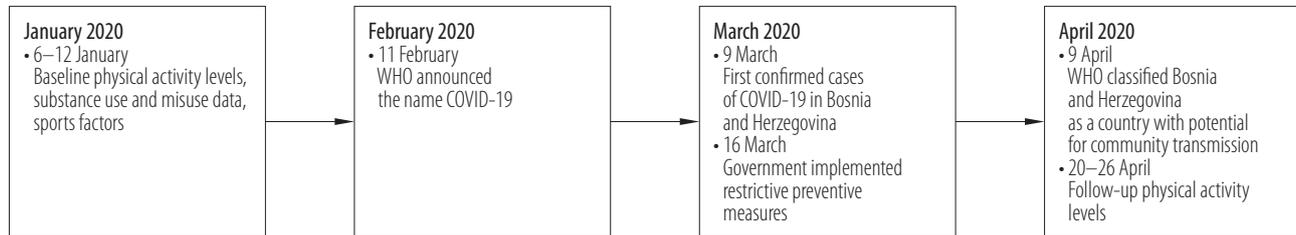


Figure 1. Timeline of the research and most important dates with regard to the COVID-19 pandemic in Bosnia and Herzegovina

The sports status was assessed using questions regarding the following:

- participation in individual sports;
- participation in team sports (with the following answers: “never involved,” “quit,” “currently involved”);
- best competitive result (with the following answers: “never participated/competed,” “local competitions,” “national competitions,” “international competitions”);
- years of sports involvement (with the following answers: “never involved,” “<1 year,” “2–5 years,” “>5 years”).

Substance use and misuse were assessed using questions about cigarette smoking, alcohol consumption, and drug consumption. Cigarette smoking was detected using questions about the respondents’ smoking habits, with the following possible answers: “never smoked,” “quit smoking,” “smoke from time to time,” “smoke <10 cigarettes daily,” and “smoke ≥ 10 cigarettes daily.” Alcohol consumption was detected using the Alcohol Use Disorders Identification Test (AUDIT). The participants were divided into 2 groups: harmful drinkers and non-harmful drinkers, according to a reference score of 11 pts in the AUDIT [16]. For the evaluation of drug consumption, the participants were asked about the consumption of several different drugs (hashish, marijuana, heroin, cocaine, sedatives, ecstasy, amphetamines) with 7 potential answers ranging from “never used,” “tried once,” or “tried more than once,” to “consumed >40 times.” The participants were divided into consumers (ever tried) and non-consumers based on these answers [17].

All variables were previously determined to be valid and reliable among a similar sample of the participants [15,17].

Statistics

Descriptive statistics included the calculation of frequencies and percentages for all variables. Differences between PALs at baseline and follow-up were determined using the χ^2 test. Furthermore, differences between the groups of adolescents according to the achieved PAL (an insufficient vs. sufficient PAL) at baseline and follow-up were determined by the Mann-Whitney Z test (MWZ; for ordinal variables), or the χ^2 test (for nominal variables). The associations between sports factors and SUM, with dichotomized PALs at baseline and follow-up were determined by logistic regression. Specifically, a sufficient PAL was coded as “1” and an insufficient PAL as “0.” The numeration of independent variables in logistic regression is presented in the tables. The odds ratio (OR), with the corresponding 95% confidence interval (95% CI) were reported. The Hosmer-Lemeshow test was used to evaluate the model fit, and a statistically significant test indicates that the model does not adequately fit the data. The statistical package Statistica ver. 13.5 was used for all calculations. For all the analyses, a p-value of 0.05 was applied.

RESULTS

Differences between PALs at baseline (before the COVID-19 lockdown), and follow-up (during the lockdown) are presented in Figure 2. Overall, 48% of adoles-

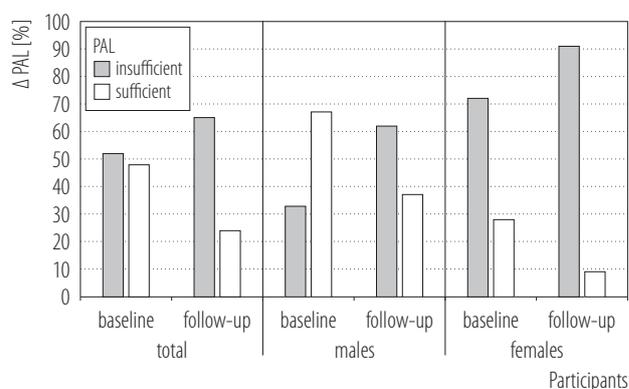
cents achieved a sufficient PAL at baseline, while only 24% of them achieved a sufficient PAL at follow-up. The percentage of boys who had a sufficient PAL decreased from 67% at baseline to 37% at follow-up. Similarly, 28% of girls had a sufficient PAL at baseline, while only 9% achieved a sufficient PAL at follow-up. All differences were significant as indicated by the χ^2 test (Figure 2).

Table 1 presents descriptive statistics of the studied variables and differences between the groups of adolescents according to their PALs at baseline (before the COVID-19 imposed rules of social distancing). Significant differences between the groups were evidenced in individual sports participation (MWZ: 7.83, $p < 0.001$), team sports participation (MWZ: 8.59, $p < 0.001$), experience in sports (MWZ: 8.03, $p < 0.001$), and sports achievement (MWZ: 5.75, $p < 0.001$). In all cases, a sufficient PAL was found in adolescents with higher scores on sports factors. Furthermore, harmful alcohol drinking was higher ($\chi^2 = 4.54$, $p = 0.03$), while smoking was lower in the adolescents who achieved a sufficient PAL at baseline.

Individual sports participation, team sports participation, experience in sports, and sports achievement observed at baseline were higher in those adolescents who achieved a sufficient PAL at follow-up (MWZ: 6.65, 7.95, 7.48, and 6.78, respectively, all $p < 0.01$). Meanwhile, smoking prevalence was higher in the adolescents with an insufficient PAL during the COVID-19 lockdown (MWZ: 1.56, $p = 0.04$).

The logistic regression calculated for dichotomized PAL criteria are presented in Figure 3. While preliminary calculations indicated a strong association between male gender and PALs at both baseline and follow-up (OR = 4.11 and 3.98, 95% CI: 2.32–7.11 and 2.11–8.23 for baseline and follow-up, respectively), logistic regressions were calculated as a crude model (model 0), and a model controlled for gender as a covariate (model 1).

When non-controlled for gender, PAL at baseline was correlated to individual sports participation, team sports



For all groups $\chi^2 = 20.56$, $p < 0.001$.

Figure 2. Changes in the physical activity levels (PALs) from baseline (before the pandemic) to follow-up (during the pandemic), and differences between measurements for the adolescents involved in the study

participation, experience in sports, sports achievement, smoking, and harmful drinking (Figure 3a).

Correlates of PALs at follow-up (during the lockdown) are presented in Figure 3b. Individual sports participation, team sports participation, experience in sports, and sports achievement were positively correlated with a sufficient PAL. Meanwhile, smoking was lower in those adolescents who had a sufficient PAL at follow-up.

DISCUSSION

The main findings of this study were as follows:

- pre-pandemic sports factors were correlated with PALs at both baseline and follow-up;
- smoking cigarettes had a negative effect on PALs at both baseline and follow-up;
- alcohol consumption had a positive effect on PAL at baseline, but it had no effect on PAL during the lockdown;
- drug consumption did not have an effect on PAL.

Sports factors and PAL

These results showed that all sports factors were associated with PALs at baseline and follow-up. It is clear that adolescents involved in organized sports activities are gen-

Table 1. Descriptive statistics and differences between adolescents with sufficient and insufficient physical activity levels (PALs) in the periods before (January 2020) and during the COVID-19 lockdown (April 2020), in Bosnia and Herzegovina

Variable	Participants												
	PAL before the pandemic						PAL during the pandemic						
	insufficient			sufficient			insufficient			sufficient			
	n	%	p	n	%	MWZ/ χ^2	n	%	p	n	%	MWZ/ χ^2	
Individual sports						7.83			0.001			6.65	0.001
yes, still participating (1)	27	8.8		109	34.4		68	14.8		68	41.5		
yes, but quit (2)	101	32.9		103	32.5		155	33.7		49	29.9		
no, never (3)	179	58.3		105	33.1		237	51.5		47	28.7		
Team sports						8.59			0.001			7.95	0.001
yes, still participating (1)	24	7.8		117	36.9		69	15.0		72	43.9		
yes, but quit (2)	132	43.0		121	38.2		189	41.1		64	39.0		
no, never (3)	151	49.2		79	24.9		202	43.9		28	17.1		
Experience in sports						8.03			0.001			7.48	0.001
never involved (1)	117	38.1		49	15.5		148	32.2		18	11.0		
<1 year (2)	74	24.1		63	19.9		107	23.3		30	18.3		
2–5 years (3)	78	25.4		94	29.7		130	28.3		42	25.6		
>5 years (4)	38	12.4		111	35.0		75	16.3		74	45.1		
Sports achievement						5.75			0.001			6.78	0.001
never participated/competed (1)	200	65.2		132	41.6		280	60.8		48	29.1		
local competitions (2)	95	30.9		160	50.5		157	34.1		98	59.8		
national competitions (3)	13	4.2		23	7.3		20	4.3		16	9.8		
international competitions (4)	1	0.3		4	1.3		3	0.7		2	1.2		
Smoking						1.76			0.03			1.56	0.04
never smoked (1)	202	65.8		208	65.6		303	65.9		107	65.2		
quit (2)	15	4.9		15	4.7		19	4.1		11	6.7		
1–2 cigarettes but not daily (3)	53	17.3		66	20.8		88	19.1		31	18.9		
<10 cigarettes daily (4)	14	4.6		18	5.7		20	4.3		12	7.3		

>10 cigarettes daily (5)	23	7.5	10	3.2	30	6.5	3	1.8	0.49
Alcohol drinking ^a				4.65	0.03				0.47
non-harmful drinking (1)	282	91.9	273	86.1	412	89.6	143	87.2	
harmful drinking (2)	25	8.1	44	13.9	48	10.4	21	12.8	
Illicit drugs ^a				0.02	0.88				1.79
no (1)	296	96.4	306	96.5	447	97.2	155	94.5	
yes (ever tried) (2)	11	3.6	11	3.5	13	2.8	9	5.5	0.18

MWZ – Mann-Whitney Z test.

The numbers in parentheses represent the numerical values for each response in individual variables (later used in logistic regression calculation).

^a Variables where differences between the groups were evaluated using the χ^2 test.

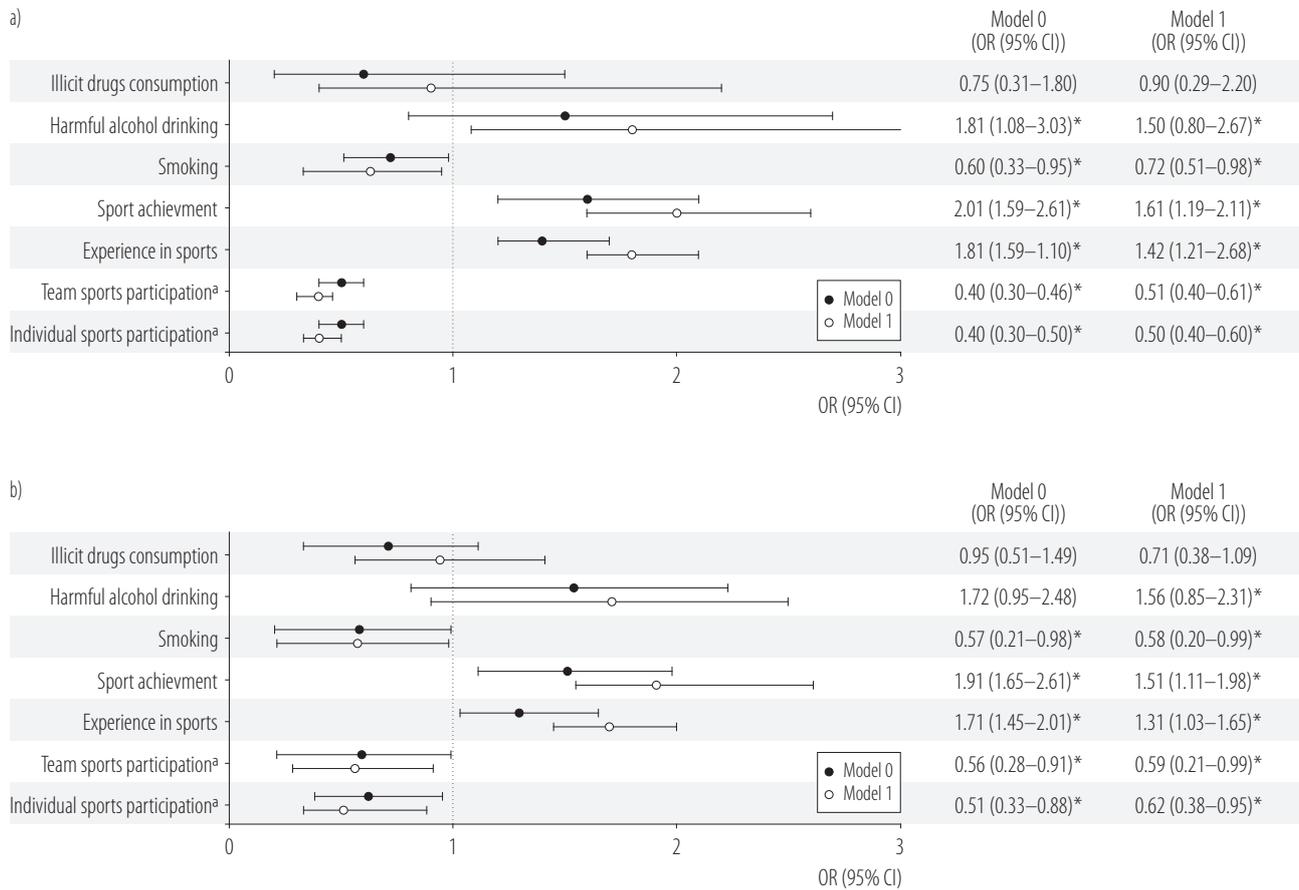
erally more active, which explains the association of sports with PAL at baseline (i.e., before the lockdown). Therefore, these results support the findings of previous studies that evidenced similar associations in adolescents worldwide [8]. From the perspective of this research, it is important to mention a recent study that has evidenced a positive influence of the fitness status on PALs both before and during the pandemic in Croatia [4]. The authors of that study explained their results highlighting the issue of physical literacy and its influence on PAL [4].

Physical literacy is defined as “the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life” [18]. It is clear that sports participation promotes physical literacy, and it is described as having the following 4 main interacting domains:

- physical fitness,
- fundamental motor skill proficiency,
- physical activity behaviors,
- psycho-social factors, including feelings, knowledge, and attitudes [19].

The association between sports participation and physical literacy is frequently confirmed, with higher physical literacy among children actively involved in sports [20]. Altogether, these findings logically explain the positive influence of pre-pandemic sports participation and PAL at baseline.

Moreover, it has been proven that a frequent and long-lasting involvement in organized sports influences the development of motor skills, abilities, attitudes and motivation, which are important for future physical activity [21]. According to Telama [21], one of the theories of tracking physical activity, referred to as the ability and readiness hypothesis, states that previous experiences and participation in sports and physical activities make it easier to continue with physical activity or start it again after a potential break, even if the types of practiced activity differ. This explanation is plausible here for the established re-



Model 0 – a crude model non-controlled for covariates; model 1 – a logistic regression model controlled for gender as a covariate.

* $p < 0.05$.

^a Variables with opposite metrics (numerical values for each predictor are presented in Table 1).

Figure 3. Correlates of the physical activity levels (PALs) a) before the pandemic and b) during the COVID-19 lockdown, in the adolescents involved in the study – logistic regression results for dichotomized PAL criterion (insufficient PAL – sufficient PAL)

relationship between pre-pandemic sports factors and PAL during the pandemic.

Additionally, adolescents who participate in sports likely have a greater need for activity than their peers, even during the pandemic and periods of restricted movement, because they have developed the habit of an increased PAL, have felt positive physiological changes during physical activity and are aware of the positive effect of that activity on their health. As physical literacy is observed to affect the capacity for maintaining an active and healthy lifestyle [18], the positive influence of sports participa-

tion on PAL during the lockdown becomes even clearer. Therefore, it can be anticipated that the adolescents who have a sports background are more capable of creating and choosing appropriate activities even during home confinement and situations with limited access to sports facilities and equipment.

For the purposes of this research, it is important to explain another possible influence of sports participation on PALs before and during the COVID-19 lockdown. Namely, as far as the authors are aware, even though all sports facilities were closed, sports clubs and coaches were creating

different ways to keep their members active to decrease the detrimental effects of reduced physical activity and sports involvement on physical capacity and abilities. Numerous sports clubs organized online training sessions through web-based communication platforms such as Skype, Zoom, and Google Meet, and developed adjusted training programs, which is also confirmed among U.S. adolescents [22]. Although the frequency and intensity of the training sessions were definitely not the same as before the pandemic, such strategies certainly helped to maintain PALs during the pandemic among those adolescents who were members of sports clubs in the pre-pandemic period.

Substance use and misuse and PAL

Studies have rarely investigated the effect of SUM on PAL in adolescents and, to the best of the authors' knowledge, no study has explored this problem specifically for the pandemic period. Thus, it is difficult to compare the results obtained in this study with results of other studies. However, when explaining the obtained results, the overall situation in the country where the participants live should be taken into account. In Bosnia and Herzegovina, smoking is a socially acceptable behavior, and the country has one of the highest prevalence rates of adolescent smoking in Europe: 37% of adolescents smoke cigarettes, and 20% are daily and regular smokers [23]. Similarly, >20% of adolescent boys from Bosnia and Herzegovina are classified as harmful drinkers [23]. However, the prevalence of drug usage is low, and with a prevalence of <7% ("have ever tried" drug consumers), the drug consumption rate among adolescents in Bosnia and Herzegovina is among the lowest in Europe [23].

This research noted that cigarette smoking negatively impacted on PALs in both testing waves. In other words, the youth who reported smoking cigarettes had lower PALs both before and during the pandemic. This could be interpreted in several ways.

First, it is well known that cigarette smoking has some negative effects on physical performance and functional capacities. More precisely, athletes and active populations are well aware of the fact that smoking leads to immediate and chronic detrimental effects on the lung and heart functions that decrease/reduce cardiovascular fitness and physical capacity [24]. Second, smoking cigarettes is not proclaimed or accepted in the social groups of people who practice sports and similar activities, and it does not fit in the social norms of that population [25]. Third, cigarettes are more associated with at-risk youth who care less about their health. More precisely, the youth who are characterized as deviant or risk-taking are generally less physically active, and are more involved in activities and behaviors that are not good for their health, including smoking cigarettes [26]. The latter can be explained by the opposite phenomenon, i.e., the youth who regularly participate in physical activity have better health-related behaviors, including healthy eating and lower rates of cigarette smoking [27]. Therefore, together with the previously discussed positive association of sports factors with PAL, the negative correlation between smoking and PALs before and during the pandemic becomes clear.

The finding that alcohol consumption is associated with an increased PAL at baseline is in accordance with the findings of previous studies. Namely, several studies have shown that adolescents who drink alcohol reach higher PALs than their peers who do not [28]. Specifically, drinking alcohol is a social activity, and is frequently associated with the social and team nature of the physical activity [28]. Additionally, sports celebrations, mass-media alcohol promotions related to sports events, and the influence of active peers (athletes are considered role models) are factors that impact on the positive association of alcohol with PAL [25].

The most significant factor associated with alcohol is considered to be post-exercise drinking or, more precisely, gatherings after sports or other physical activities that

include alcohol [25]. Since adolescents during baseline testing had regular life routines, and restrictive measures had not been imposed, they were able to participate in all regular social activities including sports and socializing (bars, night clubs) with their peers. On the other hand, an association between drinking and PAL during the pandemic was not found. This is almost certainly related to the fact that the overall PAL decreased as a result of the pandemic. This decrease was certainly mostly influenced by a PAL decrease in a group of competitive athletes who often consume alcohol. Regarding the previously mentioned social aspect of alcohol consumption after sports, the finding that alcohol did not affect PAL at follow-up is logical.

The finding that illicit drug use did not affect PALs either at baseline or at follow-up may be observed as surprising. Specifically, a review study by Kwan et al. [29] recorded a low prevalence of illicit drug use among athletes in the majority of observed studies, with the exception of marijuana which showed equivocal findings. Most likely, the main reason for the negative association of illicit drug use with physical activity and sports participation is that active adolescents are aware of the immediate detrimental physical and psychological effects of illicit drug use on exercise and sports performance [30]. Specifically, illicit drug consumption is associated with time disorientation, confusion, cardiac and respiratory arrest, and decreased concentration, coordination, and reaction time [30]. Additionally, drug use is not an approved behavior or norm among active adolescents and athletes; therefore, it is not socially accepted [26].

However, although one could expect that illicit drug consumption would be negatively correlated with PALs in this study, the lack of association could be explained by the low prevalence of adolescents who use illicit drugs (<4%). Consequently, simply because of mathematical issues (i.e., the small number of subjects in the “positive” group), the OR could not reach statistical significance (95% CI).

Limitations and strengths

This study involved adolescents from only 1 country included in a regular scholastic system. Also, follow-up testing was specific, and the availability of personal IT resources (i.e., computer, smartphone) limited the possibility that all children who were tested at baseline would participate in follow-up testing. Therefore, the results are generalizable to similar samples. In addition, the study did not evidence some potentially important correlates of PAL (i.e., educational and scholastic factors), which almost certainly limited the possibility of a more elaborated discussion. The most important limitation comes from the fact that the participants may have leant towards socially acceptable answers. However, the strict anonymity of the testing procedures and the authors’ previous experience probably limited this bias. This study is one of the first which evaluated pre-pandemic sports participation and substance misuse, with PALs during the COVID-19 pandemic. Moreover, the study was conducted in a country where substance misuse in adolescents is already evidenced as an important public-health problem. Finally, the use of the measuring instruments which had been previously validated in similar samples of the participants was an important strength of the investigation. Therefore, the authors believe that, while not being the final word on the topic, the investigation will provide new information regarding the problem and will initiate further research.

CONCLUSIONS

The COVID-19 pandemic, which is a global crisis of an unprecedented scale, has resulted in many restrictions on daily living including social distancing, isolation, and home confinement. Emerging data point out at a considerable decrease in global PALs during the period of social isolation implemented worldwide to reduce disease transmission.

This study adds a significant body of evidence on the pandemic impact on PAL and SUM among adolescents. It has been shown that pre-pandemic sports factors are significantly associated with PALs at baseline and follow-up

during the pandemic. While smoking cigarettes has a negative effect on PAL in general, alcohol initially had a positive effect which was not observed at follow-up. An interesting finding is that illicit drug use has no association with PAL at all. The authors assume that a low prevalence of adolescents who use illicit drugs may be a proper explanation.

It is clear that this pandemic will not stop easily. Therefore, urgent actions are needed to normalize and restore physical activity among this population. The academic and medical society needs to encourage a national strategy to minimize the negative health effects induced by the pandemic, related to reduced physical activity and increased sedentary behaviors. Healthy lifestyle behaviors, including the absence of substance misuse, should be promoted on a large community scale. Moreover, health-promotion strategies directed at routine physical activities, as well as sports participation, may be helpful in recuperating adolescents from the stress and anxiety they experienced while in lockdown during the COVID-19 crisis. It would be of public health benefit not only during this outbreak and crisis recovery period, but also as a recommended prevention of health-related impacts during any future pandemics.

ACKNOWLEDGMENTS

The authors are particularly grateful to their colleagues from the University of Mostar, Bosnia and Herzegovina, for their help and support in the investigation.

REFERENCES

1. Bedford J, Enria D, Giesecke J, Heymann DL, Ihekweazu C, Kobinger G, et al. COVID-19: towards controlling of a pandemic. *Lancet*. 2020;395(10229):1015–8, [https://doi.org/10.1016/s0140-6736\(20\)30673-5](https://doi.org/10.1016/s0140-6736(20)30673-5).
2. Moore SA, Faulkner G, Rhodes RE, Brussoni M, Chulak-Bozzer T, Ferguson LJ, et al. Impact of the COVID-19 virus outbreak on movement and play behaviours of Canadian children and youth: a national survey. *Int J Behav Nutr Phys Act*. 2020;17(1):85, <https://doi.org/10.1186/s12966-020-00987-8>.
3. Zenic N, Tairar R, Gilic B, Blazevic M, Maric D, Pojskic H, et al. Levels and Changes of Physical Activity in Adolescents during the COVID-19 Pandemic: Contextualizing Urban vs. Rural Living Environment. *Appl Sci*. 2020;10(11):3997, <https://doi.org/10.3390/app10113997>.
4. Sekulic D, Blazevic M, Gilic B, Kvesic I, Zenic N. Prospective Analysis of Levels and Correlates of Physical Activity During COVID-19 Pandemic and Imposed Rules of Social Distancing; Gender Specific Study Among Adolescents from Southern Croatia. *Sustainability*. 2020;12(10):4072, <https://doi.org/10.3390/su12104072>.
5. Gilic B, Ostojic L, Corluka M, Volaric T, Sekulic D. Contextualizing Parental/Familial Influence on Physical Activity in Adolescents before and during COVID-19 Pandemic: A Prospective Analysis. *Children*. 2020;7(9):125, <https://doi.org/10.3390/children7090125>.
6. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc*. 2000;32(5):963–75, <https://doi.org/10.1097/00005768-200005000-00014>.
7. Kleszczewska D, Mazur J, Siedlecka J. Family, school and neighborhood factors moderating the relationship between physical activity and some aspects of mental health in adolescents. *Int J Occup Med Environ Health*. 2019;32(4):423–39, <https://doi.org/10.13075/ijomeh.1896.01389>.
8. Wickel EE, Eisenmann JC. Contribution of youth sport to total daily physical activity among 6- to 12-yr-old boys. *Med Sci Sports Exerc*. 2007;39(9):1493–500, <https://doi.org/10.1249/mss.0b013e318093f56a>.
9. Machado-Rodrigues AM, Coelho e Silva MJ, Mota J, Santos RM, Cumming SP, Malina RM. Physical activity and energy expenditure in adolescent male sport participants and nonparticipants aged 13 to 16 years. *J Phys Act Health*. 2012;9(5):626–33, <https://doi.org/10.1123/jpah.9.5.626>.
10. Kimm SY, Glynn NW, Kriska AM, Barton BA, Kronsberg SS, Daniels SR, et al. Decline in physical activity in black girls and white girls during adolescence. *N Engl J Med*. 2002; 347(10):709–15, <https://doi.org/10.1056/NEJMoa003277>.

11. Miljanovic Damjanovic V, Obradovic Salcin L, Zenic N, Foretic N, Liposek S. Identifying Predictors of Changes in Physical Activity Level in Adolescence: A Prospective Analysis in Bosnia and Herzegovina. *Int J Environ Res Public Health*. 2019;16(14), <https://doi.org/10.3390/ijerph16142573>.
12. Peltzer K. Leisure Time Physical Activity and Sedentary Behavior and Substance Use Among In-School Adolescents in Eight African Countries. *Int J Behav Med*. 2010;17(4):271–8, <https://doi.org/10.1007/s12529-009-9073-1>.
13. Rodriguez LM, Litt DM, Stewart SH. Drinking to cope with the pandemic: The unique associations of COVID-19-related perceived threat and psychological distress to drinking behaviors in American men and women. *Addict Behav*. 2020; 110:106532, <https://doi.org/10.1016/j.addbeh.2020.106532>.
14. Janz KF, Lutuchy EM, Wenthe P, Levy SM. Measuring activity in children and adolescents using self-report: PAQ-C and PAQ-A. *Med Sci Sports Exerc*. 2008;40(4):767–72, <https://doi.org/10.1249/MSS.0b013e3181620ed1>.
15. Sekulic D, Rodek J, Sattler T. Factors associated with physical activity levels in late adolescence: a prospective study. *Med Pr*. 2020;71(6):637–47, <https://doi.org/10.13075/mp.5893.01012>.
16. Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption–II. *Addiction*. 1993;88(6):791–804, <https://doi.org/10.1111/j.1360-0443.1993.tb02093.x>.
17. Zenic N, Terzic A, Rodek J, Spasic M, Sekulic D. Gender-Specific Analyses of the Prevalence and Factors Associated with Substance Use and Misuse among Bosniak Adolescents. *Int J Environ Res Public Health*. 2015;12(6):6626–40, <https://doi.org/10.3390/ijerph120606626>.
18. Whitehead M. Definition of physical literacy and clarification of related issues. *ICSSPE Bulletin*. 2013;65(1.2).
19. Lloyd M, Colley RC, Tremblay MS. Advancing the debate on ‘fitness testing’ for children: perhaps we’re riding the wrong animal. *Pediatr Exerc Sci*. 2010;22(2):176–82, <https://doi.org/10.1123/pes.22.2.176>.
20. Dudley D, Cairney J, Wainwright N, Kriellaars D, Mitchell D. Critical Considerations for Physical Literacy Policy in Public Health, Recreation, Sport, and Education Agencies. *Quest*. 2017;69(4):436–52, <https://doi.org/10.1080/00336297.2016.1268967>.
21. Telama R. Tracking of physical activity from childhood to adulthood: a review. *Obes Facts*. 2009;2(3):187–95, <https://doi.org/10.1159/000222244>.
22. Dunton GF, Do B, Wang SD. Early effects of the COVID-19 pandemic on physical activity and sedentary behavior in children living in the U.S. *BMC Public Health*. 2020;20(1):1351, <https://doi.org/10.1186/s12889-020-09429-3>.
23. Bjelica D, Idrizovic K, Popovic S, Sisc N, Sekulic D, Ostojic L, et al. An Examination of the Ethnicity-Specific Prevalence of and Factors Associated with Substance Use and Misuse: Cross-Sectional Analysis of Croatian and Bosniak Adolescents in Bosnia and Herzegovina. *Int J Environ Res Public Health*. 2016;13(10), <https://doi.org/10.3390/ijerph13100968>.
24. Papathanasiou G, Georgakopoulos D, Georgoudis G, Spyropoulos P, Perrea D, Evangelou A. Effects of chronic smoking on exercise tolerance and on heart rate-systolic blood pressure product in young healthy adults. *Eur J Cardiovasc Prev Rehabil*. 2007;14(5):646–52, <https://doi.org/10.1097/HJR.0b013e3280ecfe2c>.
25. Lisha NE, Sussman S. Relationship of high school and college sports participation with alcohol, tobacco, and illicit drug use: a review. *Addict Behav*. 2010;35(5):399–407.
26. Sussman S, Pokhrel P, Ashmore RD, Brown BB. Adolescent peer group identification and characteristics: a review of the literature. *Addict Behav*. 2007;32(8):1602–27, <https://doi.org/10.1016/j.addbeh.2006.11.018>.
27. Dinger MK, Vesely SK. Relationships between Physical Activity and other Health-Related Behaviors in a Representative Sample of U.S. College Students. *Am J Health Educ*. 2001;32(2):83–8, <https://doi.org/10.1080/19325037.2001.10609404>.
28. Piazza-Gardner AK, Barry AE. Examining physical activity levels and alcohol consumption: are people who drink more

- active? *Am J Health Promot.* 2012;26(3):e95–104, <https://doi.org/10.4278/ajhp.100929-LIT-328>.
29. Kwan M, Bobko S, Faulkner G, Donnelly P, Cairney J. Sport participation and alcohol and illicit drug use in adolescents and young adults: a systematic review of longitudinal studies. *Addict Behav.* 2014;39(3):497–506, <https://doi.org/10.1016/j.addbeh.2013.11.006>.
30. Thomas JO, Dunn M, Swift W, Burns L. Elite athletes' perceptions of the effects of illicit drug use on athletic performance. *Clin J Sport Med.* 2010;20(3):189–92, <https://doi.org/10.1097/JSM.0b013e3181df5f87>.