International Journal of Kinesiology & Sports Science
ISSN: 2202-946X
www.ijkss.aiac.org.au

The Consequences of the Restrictive Measures Due to Two Strict Covid-19 Lockdowns on Self-Reported Physical Activity in Adolescents

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ARTICLE INFO

Article history
Received: April 29, 2022
Accepted: July 01, 2022
Published: July 31, 2022
Volume: 10 Issue: 3

Conflicts of interest: None
Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

ABSTRACT

Background: Restrictions due to COVID-19 lockdowns reduced the possibilities of children and adolescents for being active, with negative consequences in adopting a healthy lifestyle. **Purpose:** To compare Greek adolescents' self-reported weekly participation in physical activity, during and before the two initial strict lockdowns, due to COVID-19. Secondary aims were to examine these differences with regard to gender, and associations between weekly physical activity participation with health status variables. **Methods:** Three hundred and sixty-three adolescents (N=363) from secondary schools, in the Greek territory (108 boys and 255 girls) filled in the Godin-Shephard Leisure-Time Physical Activity Questionnaire and the TNO-AZL Questionnaire for Children's Health-Related Quality of Life Children's Form, online. It was a cross-sectional study and data were collected during first and second strict lockdowns, from different adolescents who filled in the above online questionnaires once. **Results:** Adolescents reduced significantly weekly frequency of strenuous, moderate and total physical activity, during lockdowns ($p<.05$). Time factor had a different effect on boys and girls, only in moderate physical activity ($p<.05$). Positive correlations were found between strenuous and total physical activity with positive moods, and moderate physical activity with cognitive functioning and school performance, during lockdowns ($p<.05$). **Conclusions:** This study adds information regarding the negative impact on physical activity participation in Greek adolescents during COVID-19 strict lockdowns. The findings, also, highlighted that reduced physical activity among adolescents during lockdowns associated with poorer psychosocial status. Thus, these results could be used to inform strategies for promoting health movement behaviors, in order to reduce possible negative consequences during future pandemics.

Key words: Leisure Activities, Exercise, Healthy Lifestyle, Health Status

INTRODUCTION

The world has been living in the COVID-19 pandemic for about three years, with a gradual removal of the restrictive measures, and return to normal life, globally. While COVID-19, on March 12, 2020 was named a global pandemic by the World Health Organization (WHO, 2020b), preventive measures limiting activities in everyday life, were taken to reduce the viral spread, such as the shutdown of schools (Kovacs et al., 2021). On the 10th of March, as soon as officials verified the first cases of COVID-19 in Greece, a national lockdown was imposed and continued till June 2020. The operation of all educational institutions was suspended, team sports leagues games and practices, every sport activity in organized environment such as gyms and swimming pools was cancelled. Then, on Monday the 9th of November, a second lockdown was imposed by the Greek authorities with the same restrictive measures. However, just a few exceptions were allowed with a special permission for outdoor exercise, for taking domestic dogs outside, or spending time in nature, for travelling to and off workplace, for doing necessary shopping and for looking after close relatives in need (Androutsos et al., 2021).

These restrictions reduced the possibilities of children for being active and adopting a healthy lifestyle, globally, as schools offer opportunities for physical activity participation through physical education classes, recess, walking, or cycling to and from home, intramural and intermural sports (Capel & Blair, 2019). The above restrictions affected the child's and adolescent's ability to meet recommendations for physical activity (PA) participation with physical and psychological benefits (WHO, 2020a). Guidelines for children and adolescents (aged 5-17 years), before and during the pandemic, recommended at least 60 minutes a day of moderate to vigorous-intensity physical activity (MVPA) and no more than two hours of sedentary recreational screen

Published by Australian International Academic Centre PTY.LTD.

http://dx.doi.org/10.7575/aiac.ijkss.v.10n.3p.47

time per day. This should include activities that strengthen muscle and bone, at least 3 days per week. Moreover, participation for more than 60 minutes in physical activity daily will provide additional health benefits (WHO, 2020a). However, lockdowns and being away from school routine (Racine et al., 2020) restricted the above mentioned activities with a negative impact in adolescents' mental health (Ng et al., 2020). Available data using parents' and children's reports from countries all over the world and a large online survey across ten European countries, showed a decline in PA participation, a remarkable increase in screen time and a transition to distance learning, in children aged 6–18 years, during both COVID-19 Strict lockdowns (Yelizarova et al., 2022; Alghadir et al., 2021; Chambonniere et al. 2021; Kovacs et al., 2021; Stverakova et al., 2021; Wunsch et al., 2021; Moore et al., 2020; Schmidt et al. 2020; Seculic et al. 2020). According to Dunton et al. (2020), parents reported a decrease in their children's PA and an increase in their sedentary behavior. However, a small percentage of these children continued to engage in team sports, or physical activities through distance services, in their house (Dunton et al., 2020). Similar results for lowered levels of PA during the pandemic were reported in adult clinical populations with diabetes mellitus (Ferreira et al., 2021). Greek research studies in adolescents using parents' and children's reports, showed inadequate levels of PA during the first pandemic outbreak (Androutsos et al. 2021; Morres et al., 2021). Greek authorities published instructions in accordance with EuroWHO (2020) to urge the Greek public to stay physically active, during self-quarantine. Regarding distance learning, recommended levels of MVPA could be achieved by both independent exercise and online physical education (EuroWHO, 2020; WHO, 2020a).

Most studies on PA in children and adolescents during lockdowns were conducted using questionnaires (Stverakova et al., 2021; Schmidt et al., 2020). Pre-pandemic, the use of questionnaires also were common practice when studying PA habits, because of their correlations with other research methods (Terwee et al., 2010). The Godin Leisure-Time Exercise Questionnaire has been widely used to gather information about self-reported physical activity participation and showed high validity and reliability among adults (Biddle et al., 2011; Gionet & Godin, 1989; Godin & Shephard, 1985) and adolescents (Zelener & Schneider, 2016).

Recently, literature has revealed evident gender differences regarding health habits during adolescence (Inchley et al., 2020). Girls reported better eating behaviors than boys, whereas boys reported increased PA participation, (Biddle et al., 2011) and sedentary behaviors compared to girls (Ng et al., 2018). Regarding changes in health habits during lockdown, PA participation among girls increased in Germany and Canada (Moore et al., 2020; Schmidt et al., 2020), whereas, a study in Croatia reported significant decreases among boys (Sekulic et al., 2020). On the contrary, in a study in Ukraine, adolescent boys reported higher PA participation, compared to girls (Yelizarova et al., 2022) and moreover, in a Czech study, during the spring 2020 lockdown, boys reported higher levels of participation in MVPA than girls, compared to the levels of participation in the pre-lockdown period (Ng et al., 2021).

There is a well established association between PA, and physical and mental health among children and adolescents. Literature has indicated that children and adolescents who engaged in increased levels of PA had better physical and mental health and psychosocial well-being, than those engaged in an inactive lifestyle (Wu et al., 2017). During lockdown it was shown that PA engagement was associated with well-being in adolescents and was a positive and stronger predictor of enhanced mental health and well-being outcomes (Morres et al., 2021; Wright et al., 2021). On the contrary, another study regarding PA participation in adolescent boys during lockdown, showed that health related quality of life (HRQoL) before COVID-19 outbreak, was not associated with PA participation during lockdown (Wunsch et al., 2021). In addition, Sadeghi and Jehu (2022), in their commentary, suggested that exergaming, as an easily accessible form of exercise during physical distancing, can improve physical function, psychological health, and cognition, reduce pain, and decrease the risk for chronic disease, in adult office workers.

It is therefore unclear, how COVID-19 related closures, cancellations, and restrictions have impacted PA participation among adolescents, in Greece. It is, also, important to be assessed, if this situation was associated with a negative impact on their health status. This evidence could inform decision-makers for taking effective measures to alleviate probable negative consequences, in the gradual transition from the COVID-19 era. In the present study, it was anticipated that restrictive measures due to COVID-19 pandemic reduced self-reported PA participation, in adolescents, with a negative impact in their physical and mental health. It was, firstly, hypothesized that adolescents reduced participation in weekly PA, during both initial strict lockdowns, regardless of their gender. A second hypothesis was that, adolescents would be differentiated, before and during lockdowns, in PA variables, with regard to their gender. A third hypothesis was that boys and girls would be differentiated in PA variables, regardless of lockdowns. Finally, a fourth hypothesis was that weekly PA participation of adolescents during lockdowns would be correlated with their health status variables.

As a result, the main purpose of the study was to compare self-reported weekly PA, in adolescents during and before the two initial strict lockdowns, due to COVID-19. Secondary aims were to examine these differences with regard to gender, and the relation between weekly PA participation with their health status variables.

METHOD

Participants and Study Design

Approval to conduct this study was obtained by the Departmental Research Ethics Committee. Adolescents' parents were informed about the research requirements and procedures and signed informed consents. Zs' participation was voluntary, and their names and any identifying information were not collected. It was a cross-sectional study and data were collected from different adolescents who filled in online questionnaires once, some of them from April to

June 2020 and others from November 2020 to January 2021, during the period of implementation of strict restrictive measures, when lessons at schools were online and all sport activities were postponed. In Greece, there are approximately 312604 secondary school students spread over 13 regions in Greek territory (Hellenic Statistical Authority, 2019). Statistical calculators based on a reference technique for sample size were used (Qualtrics Experience Management, 2021), and in a population of 312604, a sample of 384 participants was considered representative at the 95% confidence level, with a standard margin of error of 5%. It was planned to randomly recruit 384 students, but three hundred and sixty-three adolescents accepted to participate in the study (N=363: mean age 14.66 ± 1.67), 108 boys (*Mean* age: 14.48 ± 1.49 years, *Mean* body weight: 63.37 ± 13.91 Kg, *Mean* body height: 171.42 ± 10.45 cm) and 255 girls (*Mean* age: 14.74 ± 1.73, *Mean* body weight: 57.06 ± 9.49, *Mean* body height: 165.44 ± 7.17). The majority of both boys and girls (about 95%) attended public schools; about 65% of them lived in cities and the rest, in rural areas (about 35%). About half of both boys and girls (about 45%) inhabited in block of flats and the rest in a house. Moreover, most of boys and girls (about 86%) reported that participated in structured PA and sports, before COVID-19 outbreak, and a reduced percentage (69%) reported that continued to participate in some kind of PA during lockdowns. Data from both lockdowns analyzed together due to non-significant differences ($p>0.05$) for all depended variables examined in the present study. The variables were weekly frequency of strenuous, moderate and mild PA, total PA, total PA for health and each one of the seven scales of the health status questionnaire. Independent variables were gender and time pre and during lockdowns.

Instruments and Procedures

The Godin-Shephard Leisure-Time Physical Activity Questionnaire was used to assess self-reported PA by reporting how many times the listed activities were done for more than 15 minutes in a week (7 days), during free time. The validity and reliability of the questionnaire is high (Godin & Shephard, 1985) and it was, also, reported in its Greek version (Theodorakis & Hassandra, 2005). According to Godin and Shephard (1985) the questionnaire's score can be computed in two steps. Firstly, weekly frequency of strenuous, moderate, and mild activities are multiplied by nine, five, and three, respectively; these three latter values correspond to MET value categories of the activities listed (high scores indicate better physical activity levels). Secondly, the total weekly leisure activity score is computed in arbitrary units by summing the products of the separate components, according to the following formula: Weekly leisure-time activity score = (9 x Strenuous) + (5 x Moderate) + (3 x Mild). However, in this study the calculation of arbitrary units was also, performed according to Godin's (2011) suggestions to use the reported frequency of strenuous and moderate activities (excluding mild intensity) to compute a health contribution score. In reference to this calculation, the following rule was adopted: 24 units or more: Active *(substantial health benefits),* 14 to 23 units: Moderately Active (*some health benefits)*, less than 14 units: Insufficiently Active (*less substantial or low health benefits*), (Godin, 2011). In the present, both total scores were calculated.

Also, for the purpose of the study the TNO-AZL Questionnaire for Children's Health-Related Quality of Life (HRQoL)-children form (TACQOL-CF), (Vogels et al., 1998), a multidimensional instrument with 7 scales and 56 items was used. It covers seven eight-item domains: problems/limitations concerning, general physical functioning/complaints (BODY), motor functioning/performance (MOTOR), independent daily functioning (AUTO), cognitive functioning and school performance (COGNIT), social contacts with parents and peers (SOCIAL), positive moods (EMOPOS) and negative moods (EMONEG), during lockdowns due to COVID-19 pandemic. In each item, the prevalence of problems in health status was measured. When a health status problem was reported, the adolescent completed his/her emotional reaction to this problem referred to a period of 'the last few weeks'. An example of an item for BODY was "Have you had headaches?" with responses in a scale from 'never', 'occasionally' to 'often'. When the response was 'occasionally' or 'often', another statement should be answered 'at that time, I felt…', in a scale from 'fine', 'not so good', 'quite bad' to 'bad'. Items were scored taking a value from 4 to 0. A total scale score had a range of 0 to 32, which was resulted by adding item scores within a scale. Higher scale scores indicated better HRQoL. Different responses were given in positive or negative mood scales (EMOPOS and EMONEG). A typical mood item was 'In the past few weeks …I felt happy', with responses in a scale from 'never', 'occasionally' to 'often'. Mood item were scored taking a value from 0 to 2. Total mood scale score ranged from 0 to 16. No total score of health status was calculated, only single scale's scores. In the present study, the questions in each scale were summed and the higher total scores of scales indicated better functional status. Internal consistency (Cronbach a) in scales' scores for the Greek version ranged from 0.65 to 0.84. Test retest reliability was within acceptable values for all scales (ICC>.74).

The above mentioned questionnaires were filled in online, using Google forms. The online form was consisted of three parts. In the first part, there was information related to the purpose and importance of the study, instructions for filling in the form, informed consent for the parents and the agreement for participation for the adolescent. In the second part, firstly there was the Godin-Shephard Leisure-Time Physical Activity Questionnaire, which assessed self-reported weekly frequency of participation in PA during the current lockdown, secondly, the same questionnaire which measured weekly self-reported frequency of PA, before the outbreak of COVID-19 and thirdly, the seven subscales of the TACQOL, referred to the current period of lockdown. Finally, in the third part, there was available contact information about the researchers of the study.

Statistical Analyses

Descriptive statistics were performed for better representation of the averages through data tables. An independent

samples t-test was conducted for demographics (age, body weight and body height), between genders. A 2X2 (gender*-time) analysis of variance (ANOVA) with repeated measures on the last factor was used for each one of the self-reported weekly frequency of strenuous, moderate and mild PA and total PA scores, during and before lockdowns. Also, main effects of gender and time were examined. To assess the strength of the results, partial-eta-squared (η^2=.01 small, η^2=.06 medium and η^2=.14 large), (Field, 2010) and Cohen's d values were calculated (Sawilowsky, 2009; Cohen, 1988). Pearson's correlations were estimated among PA variables and the scales of TACQOL. Statistical significance was set at p<.05 level.

RESULTS

Repeated Measures ANOVAs by Dender on Weekly PA, During and before the Lockdowns

Five repeated measures analysis of variance (ANOVA) were conducted using gender as independent variable on self-reported weekly frequency of strenuous, moderate, mild PA, total PA and total PA for health calculation, during and before lockdowns, in adolescents. According to Girden (1992), regarding Mauchly's test of sphericity, the Greenhouse-Geisser estimate was found to be closer to 1.00, so the variances of differences were very homogenous and hence the data were closer to be spherical. Estimates of sphericity were found to be greater than 0.75 and as a result the Huynh-Feldt correction was used (Girden, 1992).

The first repeated measure ANOVA examined main effects for self reported weekly frequency of strenuous PA during and before lockdowns (time*2 and gender*2). There was not a significant interaction effect between time and gender [$F_{(1,361)}$=.750, p =.387, η^2 =.002]. However, there were significant main effects for time [$F_{(1,361)}$ = 69.51, p =.000, η^2 =.161] and gender [$F_{(1,361)}$ = 6.79, p =.010, η^2 =.118].

The second repeated measure ANOVA examined main effects for self-reported weekly frequency of moderate PA during and before lockdowns (time*2 and gender*2). There was a significant interaction effect between time and gender [$F_{(1,361)}$ = 6.97, p =.009, η^2 =.019]. According to this interaction effect, two separate independent samples t-tests were applied to analyze effects of gender, in self-reported weekly frequency of moderate PA and showed no statistical significant differences during [$t_{(1,361)}$ = -.79, p =.430] and before [$t_{(1,361)}$ = 1.22, p =.223] lockdown. Moreover, two paired samples t-tests checked differences in time (during and before lockdown) in self-reported weekly frequency of moderate PA, separately in boys and girls. The results showed statistical significant differences in boys [$t_{(1,107)}$ = -3.749, p =.000] and no differences in girls [$t_{(1,254)}$ = -1.617, p =.107]. There was also a significant main effect for time [$F_{(1,361)}$ = 18.64, p =.000, η^2 =.049], but not for gender [$F_{(1,361)}$ =.071, p =.790, η^2=.000].

The third repeated measure ANOVA was estimated to examine main effects for self reported weekly frequency of mild PA, during and before lockdown (time*2 and gender*2). There was not a significant interaction effect between time and gender [$F_{(1,361)}$ =.556, p =.456, η^2 =.002]. There were not significant main effects for time [$F_{(1,361)}$ =.329, p =.566, η^2 =.001] and gender [$F_{(1,361)}$ =.0105, p =.746, η^2=.000].

The fourth repeated measure ANOVA examined main effects for total PA during and before lockdown (time*2 and gender*2). There was not a significant interaction effect between time and gender [$F_{(1,361)}$ = 3.28, p =.071, η^2 =.009]. There was a significant main effect for time [$F_{(1,361)}$ = 64.14, p =.000, η^2 =.151], but not for gender [$F_{(1,361)}$ = 3.16, p =.076, η^2 =.009].

The last repeated measure ANOVA examined main effects for total PA for health, during and before lockdown (time*2 and gender*2). There was no significant interaction effect between time and gender [$F_{(1,361)}$ = 2.96, p =.086, η^2 =.008]. However, there were significant main effects for time [$F_{(1,361)}$ = 68.65, p =.000, η^2 =.160] and gender [$F_{(1,361)}$ = 3.94, p =.048, η^2 =.011].

Adolescents showed overall decreased mean scores in self reported weekly frequency of participation in strenuous and moderate PA, in total weekly PA, and in total weekly PA for health values, during lockdown compared to time before lockdowns. Additionally, boys outperformed girls in overall weekly frequency of strenuous PA and in total PA for health scores. However, the time factor had a different effect between boys and girls, only in weekly frequency of moderate PA, with a statistical significant reduction during lockdowns in boys. Means and standard deviations for all the above variables before and during lockdowns and repeated measures ANOVAs are presented in Table 1.

Cohen's d effect sizes (ES) for each one of the PA variables, gender group comparisons, during and before lockdowns are presented in Table 2. A *d* value of.01 denotes a very small ES, a.20 denotes a small ES, a value of.50 a medium ES, a value of.80 a large ES, a value of 1.20 a very large and a value of 2.0 a high ES (Cohen, 1988; Sawilowsky, 2009). All PA variables corresponded to a small up to a very small ES (values ranging from 0.28 to 0.004), during and before lockdowns (Table 2).

Pearson's Correlations between PA Variables and TACQOL Subscales

The five variables for self reported weekly frequency of strenuous, moderate, mild PA, total PA and total PA for health, during lockdown, were positively correlated. Additionally, positive correlations were found between the five scales BODY, MOTOR, AUTO, COGNIT and SOCIAL scales and negative correlations were found between EMOPOS and EMONEG (Table 3).

Moreover, regarding associations between PA and TACQOL scales, positive correlations were found between self reported weekly frequency of participation in strenuous PA, total PA and total PA for health, during lockdown, with EMOPOS. In addition, self reported weekly frequency of participation in moderate PA were positively correlated with COGNIT. In terms of gender, being a girl was linked to lower scores for self reported weekly frequency of strenuous PA and BODY.

Table 1. Means, standard deviations, and repeated measures ANOVAs (time*gender) in adolescents.

Physical activity (PA) variables	During lockdown			Before lockdown			Total gender		Time (df=1)			Gender (df=1)			time*gender (df=1)		
	Male (N=108)	*Female (N=205)*	*Total time*	*Male (N=108)*	*Female (N=205)*	*Total time*	*Male*	*Female*	*F*	*p*	η^2	*F*	*p*	η^2	*F*	*p*	η^2
	M±SD	*M±SD*	*M±SD*	*M±SD*	*M±SD*	*M±SD*	*M±SD*	*M±SD*									
Strenuous PA	1.78 ±1.83	1.36 ±1.71	*1.49±1.76*	2.67 ±1.98	2.08 ±2.02	*2.26 ±2.03*	*2.25±1.77*	*1.72±1.86*	69.51	.000*	.161	6.79	.010*	.018	.750	.387	.002
Moderate PA	1.87 ±1.84	2.04 ±1.92	*1.99 ±1.90*	2.47±2.04	2.18±2.01	*2.27±2.02*	1.95±*1.87*	2.11±*1.96*	18.64	.000*	.049	.071	.790	.000	6.97	.009*	.019
Low PA	2.43 ±2.29	2.42 ±2.23	*2.42±2.25*	2.55±2.33	2.40±2.29	*2.45±2.30*	*2.49±2.31*	*2.41±2.26*	.329	.566	.001	.105	.746	.000	.556	.456	.001
Total PA	31.74 ±26.13	29.76 ±24.79	*30.65±25.19*	44.11±30.02	36.94±27.53	*39.0 ±28.45*	*37.92±28.07*	*33.35±26.16*	64.14	.000*	.151	3.16	.076	.009	3.28	.071	.009
Total PA for health	25.43 ±22.57	22.49 ±21.46	*23.37±21.81*	36.44±25.57	29.71±24.23	*31.72± 24.79*	30.93±*24.07*	*26.10±22.84*	68.65	.000*	.160	3.94	.048*	.011	2.96	.086	.008

Statistically significant findings (, $p < 0.05$). An asterisk (*) denotes a statistical significance*

Table 2. Cohen's d effect sizes (ES) for each one of the physical activity variables for gender group comparisons during and before lockdowns.

Physical Activity	*Cohen's d*	
	Gender	
	During lockdown	Before lockdown
Strenuous PA	.23	.28
Moderate PA	.09	.14
Low PA	.004	.06
Total	.12	.25
Total health	.13	.27

DISCUSSION

The main purpose of the study was to compare self-reported weekly frequency of strenuous, moderate, mild PA and total weekly PA, in adolescents during and before the two initial strict lockdowns, due to COVID-19. Secondary aims were to examine these differences with regard to gender, gender differences in the above PA variables, during and before lockdowns, and the relation between weekly PA participation with their health status variables.

According to the first hypothesis, the results showed that adolescents reported reduced frequency in weekly strenuous, moderate PA and total weekly PA, during lockdowns, compared to PA frequency before lockdowns, regardless of gender. Moreover, in reference to the calculation of Godin (2011) adolescents could be characterized as moderately active, with some benefits for their health during lockdowns, whereas their PA level before lockdowns could be characterized as active, with substantial benefits for their health. These results are in line with results from studies conducted in countries all over the world, which showed a decline in PA and a considerable increase in screen time, in adolescents, during lockdowns. Literature supported that PA participation, during lockdowns, was mostly through distance services and took place indoors or outdoors, near their house (Dunton et al., 2020). Also, this reduction of PA related to changes in body weight, eating and health habits, in adolescents. Moreover, the results of the present study are in line with studies which used parents' reports about their children's PA level, showing a decreased in PA level and an increase in sedentary behavior (Yelizarova et al., 2022; Alghadir et al., 2021; Chambonniere et al. 2021; Kovacs et al., 2021; Stverakova et al., 2021; Wunsch et al., 2021; Dunton et al., 2020; Moore et al., 2020; Schmidt et al., 2020; Seculic et al., 2020). Two Greek research studies have found similar results with the present study, showing insufficient levels of PA only during the first lockdown, in adolescents (Androutsos et al. 2021; Morres et al., 2021). On the contrary, only one study in Germany showed a substantial increase in habitual PA, which led to an overall increase in PA among children and adolescents, but found a decline in sport activity (Schmidt et al., 2020).

According to the second hypothesis the results showed that, adolescents differentiated before and during lockdowns only, in self reported weekly frequency of moderate PA, with

Table 3. Means, standard deviations, and pearson's correlations between study variables

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
1. High PA_lockdown	1.49	1.75	—												
2. Moderate PA_lockdown	1.99	1.99	.446**	—											
3. Low PA_lockdown	2.42	2.25	.221**	.516**	—										
4. Total PA_Health_ lockdown	23.37	21.81	.921**	.760**	.386**	—									
5. Total PA_lockdown	30.65	25.19	.856**	.796**	.602**	.969**	—								
6. BODY	23.31	6.19	.061	.091	.089	.096	.084	—							
7. MOTOR	27.27	5.15	.025	.096	.081	.060	.074	.622**	—						
8. AUTO	28.45	4.67	-.081	.017	-.010	-.051	-.047	.479**	.714**	—					
9. COGNIT	25.74	5.58	-.049	.105*	.054	.010	.024	.555**	.619**	.535**	—				
10. SOCIAL	25.09	4.28	-.087	-.019	-.065	-.071	-.079	.433**	.493**	.524**	.535**	—			
11. EMOPOS	8.65	1.88	.148**	.071	.082	.139**	.142**	.072	.006	-.052	-.015	-.020	—		
12. EMONEG	6.39	2.05	-.045	-.026	-.012	-.044	-.041	.025	.062	-.030	.060	.025	-.599**	—	
13. GENDER	—	—	-.110*	.042	-.002	-.062	-.054	-.183**	-.085	.016	-.067	.016	.039	-.040	—

*$p < .05$; **$p < .01$. $N = 363$. *Gender has been coded as 1 (boy) and 2 (girl)*

regard to their gender. Specifically, boys outperformed girls in moderate weekly PA participation before lockdowns. In contrast, girls increased moderate weekly PA participation during lockdowns, outperforming boys. However, in total weekly PA, there were no significant gender differences, because both boys and girls had reduced total weekly PA and were moderately active during lockdowns. It is worth mentioning that, the majority (about 90%) of both boys and girls who participated in the present study, reported that participated in organized sport activities before COVID-19 outbreak. A significant percentage of them (69%), reported that continued to exercise at home, during lockdowns following online instructions of their sport professionals. These results can be compared with findings from a study contacted in Canada, in which PA participation among girls increased, but in general, girls were less physically active, used social media more and slept more than boys (Moore et al., 2020). Similar results were found in a study in Germany, in which habitual PA was increased both in boys and girls, although sport activity participation showed a decline (Schmidt et al., 2020). Furthermore, significant decreases in PA reported among boys, in a study in Croatia (Sekulic et al., 2020). On the contrary, two studies found that PA and perceived MVPA to be higher in adolescent boys, compared to girls during both strict lockdowns (Yelizarova et al., 2022; Ng et al., 2021).

According to the third hypothesis the results showed that boys outperformed girls in self reported weekly frequency of strenuous PA and weekly PA participation, regardless of restrictive measures. In reference to the calculation of Godin (2011) both boys and girls could be characterized as active, with substantial benefits for their health, however, boys outperformed girls in weekly strenuous PA participation. Gender differences during adolescence in health behaviors are well documented (Inchley et al., 2020). Boys reported higher levels of PA participation compared to girls and this can be explained by physical and psychosocial reasons (Biddle et al., 2011).

According to the fourth hypothesis, self reported weekly frequency of strenuous PA and total weekly PA participation were strongly and positively correlated with positive moods, during lockdowns. In addition, self reported weekly frequency of moderate PA, during lockdowns, was positively correlated with cognitive functioning and school performance. Also, gender was negatively correlated with self reported weekly frequency of strenuous PA and general physical functioning and complaints during lockdowns, in adolescents. Results of the present study are in line with studies conducted during lockdowns, which revealed that PA participation per week was associated with well-being in adolescents and it was a positive and stronger predictor of enhanced mental health and well-being outcomes (Morres et al., 2021; Wright et al., 2021). Similarly, Chang et al. (2020) and Zhang et al. (2020) found reduced participation in MVPA, in adolescents during lockdowns, with a negative impact in their mood states. However, another study showed that HRQoL before COVID-19 was not associated with PA participation during lockdowns, in adolescents (Wunsch et al., 2021). There is a well established positive association

between participation and intensity of PA and HRQoL including psychological moods, among adolescents (Marker et al., 2018). Adolescents who engaged in high levels of PA had improved physical and mental health status and psychosocial benefits, than those who were physically inactive (Wu et al., 2017). Restrictive measures reduced PA and this seemed to have affected negatively psychological moods, in the present study. In conclusion policy makers should take into consideration that PA participation is a key factor in similar restrictive situations and can help in avoiding negative consequences in adolescents' psychosocial status. As a result lockdowns limited PA participation among adolescents leading in a lowered physical and mental health and psychosocial well-being, that it may have long term negative consequences (Loades et al., 2020).

In summary, the results of the present study showed that adolescents reduced total self reported weekly frequency of MVPA, being moderately active with some benefits for their health during lockdowns, compared to their PA level before lockdowns, which was enough to produce health benefits. These results showed that, adolescents' MVPA level, during lockdowns, was not in accordance with World Health Organization guidelines that recommend at least 60 minutes of participation a day in MVPA (WHO, 2020a). However, Khan (2020) proposed an alteration of global rules for physical exercise, with a certain protocol of moderate exercise for health benefits in older adults, during isolation circumstances and this could be addressed to adolescent population.

Despite the fact that girls in the present study, indicated an increase in self reported weekly frequency in moderate PA participation compared to boys, total weekly PA level was significant lower for all adolescents and this reduction was associated with poor positive moods. Lockdowns and being away from school routine (Racine et al., 2020) were found to restrict participation in PA with a negative impact in adolescents' mental health (Ng et al., 2020) and other possible negative long-term health effects, both physical and psychosocial (Loades et al., 2020).

Overall, studies on the impact of lockdowns on PA indicated different results which are not comparable in many cases, due to different methodologies e.g. different questionnaires, or devices used, countries' different policy measures in promoting PA in adolescents e.g. distance physical education classes, recommendations for achieving levels of MVPA by independent exercise, differentiated restrictions imposed by governments and also, the number of COVID-19 infections among countries that directly affected public behavior. For the case of Greece, authorities published instructions to urge people stay physically active, during self-quarantine (EuroWHO, 2020; WHO, 2020a). Regarding, restrictive measures, those were very strict in first and second lockdowns, with school closures and distance learning and only just a few exceptions were allowed with special permission (Androutsos et al., 2021). As a result, this restriction policy, limited opportunities in adolescents for participation in PA and this coupled with sedentary behavior due to distance learning and using streaming services for every day communication, restricted PA participation further. In addition, it is questioned if the current technical possibilities had been adequate to maintain sufficient levels of PA at home, although there were virtual options for students' participation. However, exergaming could be an effective and easy option of exercise in adolescents with many health benefits during the pandemic, as it was supported for adult office workers population (Sadeghi & Jehu, 2022). As a result, policies should focus on providing not only sophisticated virtual options, but also, safe natural space for non-organized outdoor activities, in similar restrictive situations. Moreover, attention should be given in other factors that were found to reduce PA participation, during lockdowns, such as the reduction in outdoor play, living in a detached house, owning a dog and parental encouragement for PA participation (Moore et al., 2020).

Given that the impact of COVID-19 lockdowns on adolescents' PA participation is documented in various countries with methodological differentiations and different policies of coping with the COVID-19 spread, the strength of this study was that adds data from a sensitive age group that avoids PA, in normal situations. Moreover, assessment was conducted by self-reported questionnaires and not parent forms, all over the Greek territory and during the first and the second strict lockdowns. In addition, associations between PA participation and health status were also examined, adding more information about the possible detrimental effects of lockdowns in adolescents' wellbeing. The present study was limited by the fact that PA level was measured by self-reported questionnaires and not by PA devices. Results cannot possibly be generalized in other countries. Future studies should assess the long-term consequences of COVID-19 lockdowns regarding PA participation and health behaviors in adolescents. In this way, targeted strategies for promoting lifelong participation in PA can be implemented. Also, future research should focus on adolescents' gender differences in their health status variables, during similar situations.

CONCLUSION

This study gives additional information about the negative impact of COVID-19 strict lockdowns on weekly PA participation, in Greek adolescents. These findings highlighted that reduced PA participation among adolescents during lockdowns may have led in a poorer mental health and psychosocial well-being. Practical implications of the study may promote physical activity engagement during lockdowns and during transitional periods, in adolescents. Moreover, the results could be used to inform strategies for promoting health movement behaviors, in order to reduce possible negative consequences during future pandemics. In addition, different gender movement and health behaviors associations with PA participation were indicated.

ACKNOWLEDGEMENTS

The authors appreciate the willingness and collaboration of parents and adolescents and research assistants who were involved in the study.

Author Contributions

Conceptualization, E.K., M.K & I.P.; methodology, E.K., M.K., & S.M.; investigation E.K., M.K. and I.P., data curation, E.K. and M.K.; writing—original draft preparation, E.K., M.K., I.P., S.M. & F.G.; writing—review and editing E.K., M.K. I.P., S.M. & F.G.; visualization, E.K. All authors have read and agreed to the published version of the manuscript.

Disclosure Statement

There are no relevant financial or non-financial competing interests to report.

IRB Consent

The research study was approved by the Departmental Research Ethics Committee.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, [E.S. Katartzi], upon reasonable request.

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