

Effect of COVID-19 isolation measures on physical activity of children and their parents, and role of the family environment: a cross-sectional study

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Key words: Physical activity, COVID-19, lockdown, family determinants

Parole chiave: Attività fisica, COVID-19, lockdown, determinanti familiari

Abstract

Background. The rigorous isolation measures due to the COVID-19 pandemic seriously impacted children's lifestyles. A descriptive cross-sectional study was carried out to collect and analyze information about physical activity habits of children and their parents during the social distancing period resulting from the COVID-19 pandemic.

Methods. An online questionnaire was administered to 363 families (507 children aged 5-13) recruited by convenience sampling, asking for physical activity type and frequency before, during, and after the lockdown period (9th March - May 3rd 2020), education, outdoor spaces, and children's weight gain perception.

Results. Results show a remarkable decrease in children's physical activity during lockdown (88.9 vs 39.8% active children) associated with older age and low availability of outdoor spaces ($p < 0.001$). Parents' physical activity was related to educational level, and a slight but significant correlation between parents' education and children's physical activity was found, especially with father's university degree ($p < 0.05$). Active mothers significantly influenced children's physical activity during the lockdown, especially if not engaged in smart working. The return to an active lifestyle by children did not reach previous levels (75.9% active children) and was directly related to parent's physical activity. Finally, the risk of weight gain was lower in active children during the lockdown ($OR = 0.46$; $p < 0.001$).

Conclusions. This work highlights the importance of physical activity during a pandemic event to prevent the risk of gaining weight, and underlines the relevance of the entire family system as a source of promotion of healthy behaviors in children.

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Introduction

Following the WHO announcement of COVID-19 pandemic (March 11, 2020), strict measures of physical distancing and contact restrictions, with home confinement of people, were adopted in several countries in order to reduce infection spread. In almost all countries, governments declared a state of emergency, tightening the effort to keep people at home. School systems were shut down, non-essential government and private services were closed, and employees were moved to work from home.

Thus, lockdown heavily limited people's exercise possibilities, although some nonorganized physical activity (PA) remained allowed, such as going for a walk, cycling, and jogging in house proximity, or playing outside in private areas. Therefore, during the lockdown period, a deep change in the daily routine of both adults and children/adolescents was observed: diet, PA, screen time (time spent watching TV or on a smartphone/tablet) were all affected, leading to important modifications/impairments in healthy behaviors (1-3) and reducing opportunities for being active.

Kovacs et al. (4) reported that two months after the WHO declared COVID-19 a global pandemic, more than 80% of European students aged 6–18 years did not meet PA guidelines. Indeed, as reported in previous studies, school inattention (such as for holidays and vacations) is related to unhealthy habits in children, who will spend more time on electronic devices, reducing PA levels, and having inadequate nutrition (5). Thus, a similar behavior, occurring during pandemic home confinement of children, may have promoted a similar effect (6). This is particularly damaging for vulnerable groups, like obese children (7), since the perception of body weight increment during lockdown has been described (8).

To contrast sedentary behavior during home confinement, WHO promoted the

WHO 'Be Active' campaign, aimed at stimulating people to be "as active as possible" (9). WHO recommendations on PA are available on the WHO website as "tiles" showing a short illustrated message with an effective impact for people of various ages (9); WHO lists some tips to stay active at home and limit the sitting time (regular check of posture and stand up; walking up and down the stairs; do some stretching and dance; exercise classes online; active video games). Moreover, recommendations on the amount of PA people of all ages should do to benefit their health and well-being are given, encouraging children to be physically active for at least 1h/day and adults to do PA for 30 minutes/day (9).

Since health behavior patterns in childhood and adolescence are likely to persist in adults, promoting adequate levels of PA in children is a major public health issue.

Evidence from the literature provided substantial support for the importance of family environment on children's active lifestyle (10). Parental factors, such as socio-economic issues, educational level, job, and PA practice, are important determinants of the PA level in children (11). Mothers and fathers with a higher education degree are probably more informed about the importance of PA on health status and thus more prone to transfer this information to their children (11, 12). Besides this, it is known that children are more active when their parents regularly participate, support, and encourage sports, outdoor activities, and, in general, an active lifestyle (13-15).

In Italy, the first wave of pandemics determined a lockdown period lasting from March to May 2020. Lockdown measures included sudden interruption of school activities for children and adolescents and shutdown of organized sports and public sports facilities (16).

However, the sedentary behavior determined by the home confinement exacerbated a situation which has been

previously described. Indeed, recent data reported that more than half of Italian children and the majority of adolescents fail to meet the WHO recommendations on PA and sedentary behavior (17), which suggests at least 60 min of moderate-to vigorous-intensity PA every day.

Taking into account that the majority of Italian parents stayed at home during the lockdown, engaged in smart working, or with lost or suspended work, or otherwise housewives, they benefited from more time to spend with the family and in childcare (18). A recent report indicated that 75% of Italian children (2-11 years old) practiced PA with their parents during home confinement (1).

The purpose of this study was to provide a description and a better understanding of the behavior in PA practice in children, early adolescents, and their parents during the COVID-19 lockdown. This work also intended to analyze if determinants associated with the family environment still had a role in influencing children's PA during the pandemic situation. Moreover, the study investigated positive predictors, within parental issues and home characteristics, for PA practice in children aged 5-13.

This analysis aims to contribute with useful information to support programs of PA promotion that appear particularly desirable in this pandemic scenario, but will still be valid in the future.

Methods

Study outline

A descriptive cross-sectional study was carried out to collect and analyze information about variables influencing children and adolescent PA during the social distancing period resulting from the COVID-19 pandemic.

The study involved children aged 5-13 (n. 507) and their parents (n. 726) corresponding

to 363 family units. Data collection was conducted by recruiting students of primary and middle schools (lower secondary) and their parents. Due to the particular period in which the study was conducted, along with the need to act quickly within a limited timeframe, the enrolment strategy followed the convenience sampling method: participants were selected among the researchers' personal contacts (teachers and students) of the primary and middle schools involved.

All participants were fully informed about the study requirements and were asked to accept the data sharing and privacy policy before participating in the study. Signed informed consent forms were obtained from all parents by each participant school.

In consideration of possible variability due to social and cultural issues, all geographical areas of Italy were represented and defined as "North", "Central", "South and Islands".

A questionnaire was conceived by our research group after a revision of the scientific literature (1-2, 4, 8). The questionnaire was *ad hoc* created on Google Forms and disseminated on social media (WhatsApp) among children of selected schools. Participants completed the questionnaire directly connected to the Google platform. The survey was active for 111 days between 12th Oct 2020 and 30th Jan 2021.

The online administration complied with social distancing provisions and personal data protection regulations (Legislative Decree 196/2003). The anonymous nature of the web survey does not allow to trace in any way sensitive personal data. Therefore, the present web survey study does not require approval by the Ethics Committee.

The survey comprised five sections: (1) *general personal data* (age, sex, region and town of residence; school year number; parents were also asked for education level and occupational activity during lockdown); (2) *household characteristics* (presence of

private or shared with other people outdoor space/garden for PA); (3) *PA frequency and session duration* and *PA type*, taking into consideration three measurement points: before, during (from 9th March to May 3rd 2020) and after the end of the lockdown (between October 2020 and January 2021, covering the time during which the survey was active); (4) *parental perception of weight gain in children*; (5) *children feelings about PA*. The full version of the questionnaire is provided as Appendix 1.

Once completed, each questionnaire was transmitted to the Google platform, and the final database was downloaded as a Microsoft Excel sheet.

Statistical analysis

The results from the questionnaires were analyzed for statistical evaluation. The chi-square test was used to find differences in the PA habits before and during the 2020 lockdown in children divided by gender and age. Spearman's rho coefficients were calculated to find correlations between children's PA habits and home environment (outdoor spaces availability) and parents' education and PA habits. "Days per week" PA was considered in this analysis.

Ordinal regression analyses were conducted using "children's PA (days per week)" and "decrease of children's PA (days per week)" as dependent variables. Covariates were "age", "children's PA before lockdown (days per week)", "mothers' PA during lockdown (days per week)", and "fathers' PA during lockdown (days per week)". Factors were "mothers' education (middle school, high school, and university degree)", "fathers' education (middle school, high school, and university degree)", "mothers in smart working", "fathers in smart working", and "outdoor spaces (no outdoor spaces, shared garden, and private garden)",

The binary logistic regression analysis, with backward stepwise elimination, was performed using "weight gain (yes/no)"

as the dependent variable. Predictors were "no outdoor spaces", "children's PA before lockdown (yes/no)", "children's PA during lockdown (yes/no)", "mothers' PA during lockdown (yes/no)", "mothers in smart working", "fathers' PA during lockdown (yes/no)", "fathers in smart working". The categorical variables were converted into numbers and considered as ordinal variables; in details, "no outdoor spaces", none=1, shared garden=0, private garden=0; "PA habits", no=0, yes=1; "smart working", no=0, yes=1. Odds ratios (OR), corresponding 95% confidence intervals (CI), and p values were estimated.

The collinearity diagnostic did not reveal particular issues in inserting both parents' variables in the regression analyses. All statistical analyses were performed using the statistical package SPSS (version 17; SPSS Inc., Chicago, IL, USA). Results were considered significant at $p < 0.05$.

Results

Physical activity in children

The questionnaire was closed on January, 30th 2021; 1,224 responses were obtained and analyzed. National coverage was as follows: 9.5% of respondents were living in Northern Italy, 31% in Central Italy, and 59.5% in Southern Italy and the Islands. Participants' personal characteristics are reported in Table 1.

Children engaged in this survey were mostly active (88.9%). The most popular activities were outdoor play, dancing, and volleyball for girls and outdoor play, soccer, and swimming for boys.

As expected, during the lockdown, a remarkable decrease in PA was noticed, with a drop to 39.8% (Table 2). Moreover, after the end of the confinement, the return to PA was difficult and showed reduced percentages of attendance (75.9%), with respect to pre-lockdown data, with a

Table 1 - Study group.

		Total sample	Northern Italy	Central Italy	Southern Italy and islands
Children	N.	507	48	159	300
	Age (years, M ± SD)	8.9 ± 2.3	9.7 ± 2.1	8.7 ± 2.1	8.8 ± 2.5
	Age groups (years):				
	5-7 (1 st -2 nd level of primary school)	172 (33.9 %)	10 (20.8 %)	58 (36.5 %)	104 (34.7 %)
	8-10 (3 rd -5 th level of primary school)	212 (41.8 %)	20 (41.7 %)	70 (44.0 %)	122 (40.7 %)
	11-14 (middle school)	123 (24.3 %)	18 (37.5 %)	31 (19.5 %)	74 (24.7 %)
Gender (% Female)		52.1 %	50.0 %	52.2 %	52.3 %
Mothers	N.	363	35	124	204
	Age (years, M ± SD)	39.8 ± 5.5	39.4 ± 3.2	40.9 ± 5.5	39.2 ± 5.7
	Education level:				
	Middle school	81 (22.3 %)	0 (0.0 %)	23 (18.5 %)	58 (28.4 %)
	High school	197 (54.3 %)	25 (71.4 %)	68 (54.8 %)	104 (51.0 %)
University	85 (23.4 %)	10 (28.6 %)	33 (26.6 %)	42 (20.6 %)	
Fathers	N.	363	35	124	204
	Age (years, M ± SD)	43.6 ± 6.1	45.9 ± 5.0	43.5 ± 5.5	43.4 ± 6.5
	Education level:				
	Middle school	135 (37.2 %)	2 (5.7 %)	52 (41.5 %)	81 (39.7 %)
	High school	190 (52.3 %)	22 (62.9 %)	61 (49.2 %)	107 (52.4 %)
University	38 (10.5 %)	11 (31.4 %)	11 (8.9 %)	16 (7.8 %)	

M, mean

SD, standard deviation e-mail addresses

Table 2 - Physical activity of children and parents before, during, and after the lockdown period.

	N.	Before lockdown			During lockdown			After lockdown		
		Yes	No	<i>p-value</i> ^b	Yes	No	<i>p-value</i> ^b	Yes	No	<i>p-value</i> ^b
Children ^a	507	451 (88.9)	56 (11.0)		202 (39.8)	305 (60.2)		385 (75.9)	122 (24.1)	
Gender ^a										
Girls	264	231 (87.5)	33 (12.5)		100 (37.9)	164 (62.1)		187 (70.8)	77 (29.2)	
Boys	243	220 (90.5)	23 (9.5)	0.276	102 (42.0)	141 (58.0)	0.347	198 (81.5)	45 (18.5)	0.005
Age ^a										
5-7	172	143 (83.1)	29 (19.9)		68 (39.5)	104 (60.5)		129 (75.0)	43 (25.0)	
8-10	212	196 (92.5)	16 (7.5)		86 (40.6)	126 (59.4)		164 (73.4)	48 (22.6)	
11-13	123	112 (91.1)	11 (8.9)	0.000	48 (39.0)	75 (61.0)	0.000	92 (74.8)	31 (25.2)	0.000
Parents ^a										
Mothers	363	150 (41.3)	213 (58.7)		111 (30.6)	252 (69.4)		129 (35.5)	234 (64.5)	
Fathers	363	154 (42.4)	209 (57.6)	0.763	71 (19.6)	292 (80.4)	0.001	129 (35.5)	234 (64.5)	1.000

^a n (%).^b chi-squared test.

slight but significant difference between girls (70.8%) and boys (81.5%) (Table 2). PA frequency and duration were also significantly affected by home confinement ($p < 0.001$) (Supplementary Table S1).

PA habits were influenced by children's age; results showed that younger children were less active before lockdown ($p < 0.001$). However, as revealed by the regression analyses, the greatest PA reduction during the lockdown was revealed in older children ($p < 0.05$). In fact, the analyses identified older age as a negative predictor of PA practice and as a positive predictor of PA decrease (Table 3).

Regarding the use of online resources for PA lessons, results indicated that, among participants of this study, only a small fraction of children (18%) and parents (6% of fathers and 16% of mothers) exploited web technology to stay active and maintain PA levels.

Children's weight gain during lockdown

During the lockdown period, almost half of parents perceived a weight gain in their children. Regional differences were not noticed, except for participants from Sicily, who reported a perceived weight gain in 83% of children, significantly higher than other regions ($p < 0.001$).

The weight increment was estimated to be mostly around 1-2 Kg (54%) and less frequently of 3-4 kg (32%) or more (14%) and was correlated with younger age, involving mainly children of primary school (67.8%). When parents were asked to ascribe a possible cause for weight gain, they recognized the combination of PA decrease plus higher calorie intake as the main factor (71%), while the same issues, separately taken, were less frequently considered as implicated (13% increased calorie intake alone; 16% decrease of PA alone).

Our results highlighted a higher ponderal

Table 3 - Ordinal regression analysis. Children PA during the lockdown and Decrease of children PA during the lockdown were used as dependent variables.

	Children PA during the lockdown ^a		Decrease of children PA during the lockdown ^a	
	Estimates	<i>p</i> -value	Estimates	<i>p</i> -value
Age	- 0.085	0.035	0.083	0.017
PA before lockdown (children) ^a	0.235	0.000	0.920	0.000
PA during lockdown (mother) ^a	0.214	0.000	- 0.210	0.000
PA during lockdown (father) ^a	-	n.s.	-	n.s.
Education (mother)				
University degree ^b	-	n.s.	-	n.s.
High school ^b	-	n.s.	-	n.s.
Education (father)				
University degree ^b	0.927	0.011	- 1.107	0.001
High school ^b	-	n.s.	-	n.s.
At home, no smart working (mother)	0.787	0.003	- 0.772	0.001
At home, no smart working (father)	-	n.s.	- 0.568	0.034
Outdoor spaces				
shared garden ^c	-	n.s.	-	n.s.
private garden ^c	1.118	0.000	- 0.950	0.000

^a days per week;

^b estimate coefficients vs. middle school degree.

^c estimate coefficients vs. no outdoor spaces.

Supplementary Table S1 - PA frequency before and during the lockdown.

	Children			Mothers			Fathers		
	Before	During	<i>p-value</i> ^b	Before	During	<i>p-value</i> ^b	Before	During	<i>p-value</i> ^b
PA, days per week ^a									
0	56 (11.0)	305 (59.4)	0.000	213 (58.7)	252 (69.4)	0.041	209 (57.6)	292 (80.4)	0.000
1	11 (2.2)	17 (3.4)		8 (2.2)	3 (0.8)		16 (4.4)	0 (0.0)	
2	176 (34.7)	61 (12.0)		50 (13.8)	37 (10.2)		46 (12.7)	20 (5.5)	
3	141 (27.8)	44 (8.7)		47 (12.9)	43 (11.8)		53 (14.6)	24 (6.6)	
4	65 (12.8)	25 (4.9)		27 (7.4)	14 (3.9)		24 (6.6)	11 (3.0)	
5	26 (5.1)	22 (4.3)		10 (2.8)	8 (2.2)		7 (1.9)	6 (1.7)	
6	12 (2.4)	12 (2.4)		7 (1.9)	3 (0.8)		3 (0.8)	0 (1.0)	
7	20 (3.9)	21 (4.1)		1 (0.0)	3 (0.8)		5 (1.4)	10 (2.8)	
PA, hours per day ^a									
0	56 (11.0)	303 (59.8)	0.000	213 (58.7)	252 (69.4)	0.000	209 (57.6)	292 (80.4)	0.000
1	194 (38.3)	130 (25.6)		90 (24.8)	97 (26.7)		72 (19.8)	51 (14.0)	
2	218 (43.0)	63 (12.4)		60 (16.5)	13 (3.6)		69 (19.0)	16 (4.4)	
3	32 (6.3)	6 (1.2)		0 (0.0)	1 (0.3)		9 (2.8)	3 (0.8)	
4	7 (1.4)	5 (1.0)		0 (0.0)	0 (0.0)		4 (1.1)	1 (0.3)	

^a *n* (%).^b chi-squared test.

Supplementary Table S2 - Spearman's correlation coefficients between children's PA and outdoor spaces and parents' PA and education. Children and parents' PA habits are considered as "days per week".

		Outdoor spaces	Education (Father)	PA before lockdown (Father)	PA during lockdown (Father)	Education (Mother)	PA before lockdown (Mother)	PA during lockdown (Mother)
Children PA before lockdown	Correlation Coefficient	0.133 **	0.125**	0.137**	n.s.	0.133**	0.207**	n.s.
	p-value	0.003	0.005	0.002		0.003	0.000	
Children PA during lockdown	Correlation Coefficient	0.306**	0.126**	n.s.	0.160**	0.093*	0.093*	0.225**
	p-value	0.000	0.005		0.001	0.036	0.035	0.000

growth in children who were active in the pre-lockdown period but shifted to a sedentary lifestyle during home confinement and lower ponderal growth in children who remained active during the lockdown. Logistic regression analysis of these data thus revealed that children's PA before and during the lockdown are significant predictors of weight gain. Particularly, kids physically active before (but not during) the lockdown period had a 2.4 times greater risk

of gaining weight; on the other hand, doing PA during the lockdown reduced the risk of gaining weight by half (Table 4). Moreover, the average weight gain during lockdown was 0.6 kg for physically active children and 1.2 kg for those with a sedentary lifestyle (Figure 1).

Parental influence on children PA

Some parental features possibly influencing PA in children have been

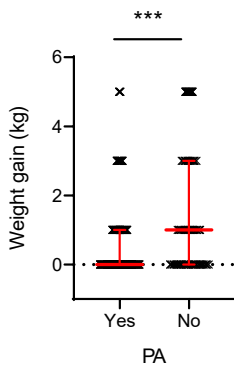


Figure 1 - Children's weight gain (kg) according to physical activity habits during the lockdown period. Data are presented as single values with median and interquartile range (red lines). *** p<0.001 (Mann Whitney test).

investigated in this study. Data were separately collected between mothers and fathers and statistically analyzed to find significant correlations with children's behavior. Parents were first asked about their practice of PA and sports (type, frequency, and session duration) before, during, and after the lockdown. Very similar values were found for active mothers (41.3%) and fathers (42.4%) before lockdown (p=0.763). Activities more frequent before lockdown were gym, jogging, and walking for mothers, and jogging, gym, and soccer for fathers.

As above reported for children, a considerable decrease of PA during lockdown was found in parents, from 41.9 to 25.1% of active people, on average, especially in fathers with respect to mothers (p<0.001) (Table 2), with an increase in dancing (mothers) and a decrease in soccer (fathers). Also, in parents, the return to PA occurred to a lesser extent with respect to pre-lockdown (35.5% for both mothers and fathers), without any difference between mothers and fathers (p=1.000).

However, mothers remained more active than fathers (30.6 vs 19.6%) during the lockdown period (Table 2 and Figure 2A). Moreover, a lower decrease in frequency and duration of mothers' PA in each of the time points analyzed was found in comparison to those of fathers. For example, mothers practicing PA 3 days/week decreased from 47 to 43, while fathers who were practicing PA 3 days/week decreased from 53 to 24 (Supplementary Table S1). A possible explanation for mothers' constant activity may reside in their employment status during the lockdown. Indeed, 66% of mothers were unemployed or suspended work during home confinement (vs 37% of fathers); 21% worked at home/teleworking (vs 15% of fathers); only 13% continued working outside home (vs 48% of fathers) (Figure 2A).

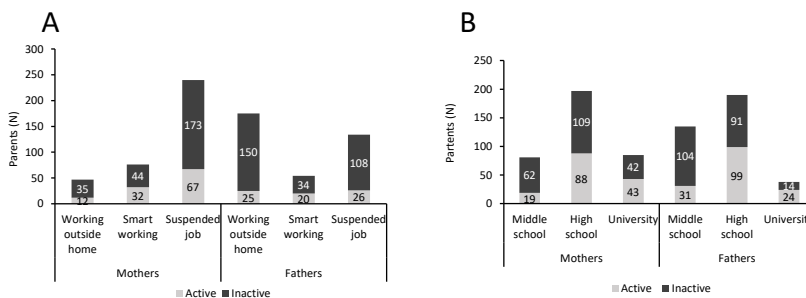


Figure 2 - Parents' physical activity habits according to the employment status during the lockdown (A) and educational levels (B). Data are presented as number of parents in each group.

In this survey, parents' education level was, in most cases, a high school diploma (53% fathers, 54% mothers, 53.5% on average). Only 10% of fathers declared a university degree, against 24% of mothers (17%, average), while 37% of fathers and 22% of mothers got a middle school diploma (29.5%, average). We found that the highest percentage of active people was recorded among parents with a university degree, with the same trends but some differences between mothers and fathers (Figure 2B).

In our study, before the lockdown, a higher percentage of active children was found in families with both active parents, with respect to families with sedentary parents (97.3% vs 79.9%), with similar trends also during and after the lockdown period. Indeed, the return to an active lifestyle by children was directly related to parents' habits (Figure 3).

Quantitative correlations between children's PA habits and parents' education and PA aptitude have been calculated.

Spearman's coefficients revealed a slight but significant correlation between parents' education and children's PA (Supplementary Table S2). The regression analysis identified fathers' university degrees only associated

with children's PA during the lockdown (Table 3). On the other hand, the PA of the mothers and not that of the fathers during the lockdown was identified as a positive predictor of children's PA by the regression analysis ($p < 0.001$) (Table 3), revealing a more significant influence of mothers in comparison to fathers in this issue. The highest mothers' influence also emerged, taking into account the occupational status. Mothers in smart working during the lockdown were found as a negative predictor of children's PA and a positive predictor of PA decrease during the lockdown (Table 3), suggesting that having more free time allowed mothers to dedicate time to their children's activities.

Private outdoor areas and PA practice

Among participant families, 47% had a private outdoor area/garden, 20% had an outdoor area/garden shared with other people (*i.e.*, condo), and the remaining 33% did not have any outdoor space. The possibility to enjoy private outdoor areas was found to be very important for PA continuity since a very high proportion (73%) of children living in a house with a private outdoor area/garden remained active, and a minor percentage was recorded among children with common areas (46%) or without spaces (49%).

Moreover, among children who remained active during the lockdown, 50% practiced PA/played sports in their own outdoor space/garden, 43% inside home, and 7% elsewhere (in the condo and outside home). Spearman's coefficient calculation confirms the correlation between the availability of outdoor spaces and children's PA before and during the lockdown (Supplementary Table S2). Moreover, the regression analyses identified the availability of private outdoor spaces as a positive predictor of children's PA during the lockdown and a negative predictor of PA decrease with respect to the period prior to the lockdown (Table 3).

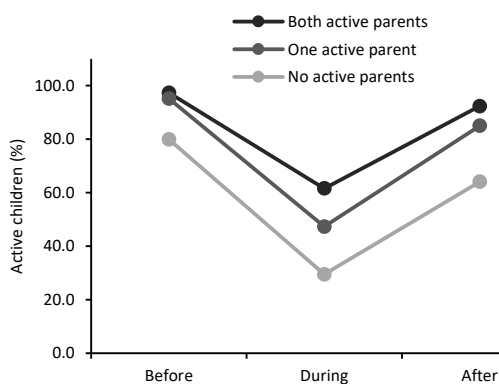


Figure 3. Active children (%) according to the parents' physical activity before, during, and after the lockdown.

Discussion

People lifestyle was seriously impacted by the rigorous isolation measures due to the COVID-19 pandemic implemented in March and April 2020. In this study, we provide a description and an analysis of PA practice of Italian children and their parents in that period to define the determinants associated with an active lifestyle during home confinement.

During the Italian lockdown, a remarkable decrease in PA was noticed, with a drop in the percentage of active children from 88.9% to 39.8%. Moreover, after the end of the confinement, the return to PA was difficult and showed reduced percentages of attendance with respect to pre-lockdown data. A similar trend was also described by Kovacs et al. (4) for European children, for whom the prevalence of insufficient activity increased compared to the pre-COVID-19 level estimated by the HBSC data (17). Moreover, in line with the same authors, except for outdoor play, some activities (*e.g.* volleyball, soccer, and swimming) have been replaced, for both boys and girls, by fitness or other moderate-intensity activities.

The percentage of active children during lockdown calculated in our survey (39.8%) was lower with respect to other data collected in Italy (48%) (1), also with lower PA frequency and duration, probably because of the wide proportion of participants from Southern Italy and islands. Indeed, unequal geographical distribution of sport and PA practice is known to occur in both Italian children and adults, with a North to South-and-islands gradient (18).

Anyway, regardless of the confinement period, participants in our study did not meet the World Health Organization international guidelines for children (17), recommending at least 60 min of moderate-to vigorous-intensity PA every day, suggesting the need for specific interventions (19).

The prolonged isolation determined

a strong increase in the use of electronic devices and internet connections (20), with an extension of the average recreational screen time (2). Around 70% of European children exceed the recommended 2h/day of screen time on weekdays (4).

In this period, a significant improvement in the offer of online resources for PA practice has been observed, but, among the participants in this study, only a small fraction of children and parents exploited web technology to stay active and maintain PA levels. However, the implementation of online PE lessons during distance learning could be highly beneficial, since the delivery of online physical education (PE) in EU schools during remote learning in the pandemic period was associated with higher PA levels and is a predictor of meeting the WHO 60 min/day recommendations (4). Additionally, interventions using activity trackers and smartphone apps had demonstrated their ability to increase PA in children and adults (14).

Changes in eating habits during COVID-19 emergency, especially in 6-11 aged children (1) and with lower adherence to the Mediterranean diet (8), should raise particular concern, especially if considering the consistent association between Mediterranean diet adherence and healthy behavior and normal weight status in Italian adolescents (21). During the lockdown period, almost half of parents recruited in this study perceived a weight gain in their children, with a significantly ($p < 0.001$) higher prevalence in Sicily, in line with the National surveillance system (Okkio alla salute, Italian Ministry of Health), reporting an increase of bad eating habits and higher overweight and obesity levels in southern Italian regions (22). Interestingly, we found a higher ponderal growth in children who were active in the pre-lockdown period but shifted to a sedentary lifestyle during home confinement and lower ponderal growth in children who remained active during the lockdown, highlighting the

importance of an active lifestyle to maintain a healthy weight.

Data about PA practiced by Italian adults (18–69 years old) in March–December 2020 (including during and after lockdown) reported that 49% complied with WHO recommended PA levels, 24% were partially active, while 27% were completely inactive (23). Sedentary people were mainly women and people with low education levels. Interestingly, a significant increase in leisure time PA has been observed with respect to the previous year, in agreement with that reported in Belgium (24) and in Germany (2) for children and adolescents. Personal motivation for the maintenance of healthy habits and reduced working time can be reasons behind the increase of PA during the lockdown period. A similar trend, however, did not appear among participants in our survey, probably reflecting the very strict measures imposed in Italy during the period of home confinement, when the pandemic evolution was more serious.

In accordance with previous reports (25), adults' PA correlated with educational level: the highest percentage of active people was recorded among parents with a university degree, with the same trends but some differences between mothers and fathers.

Parents also have an essential role in shaping children's movement behavior. Adults' PA habits and education level are indeed important determinants of PA in children (10, 12), and about 75% of the children practiced PA with their parents during the lockdown (1).

Our results highlight the importance of parents' lifestyle for children's health. In fact, a higher percentage of active children has been found in families with both active parents, with respect to families with sedentary parents, especially mothers, at each of the time points analyzed. Indeed, children are most active when both mothers and fathers support and model active behaviors through encouragement, praise,

and co-participation in outdoor play, sports, and active recreation (14).

Since recreational time spent outdoors is associated with higher PA levels (26), another aim of this survey was to clarify whether children living in houses with private gardens or outdoor areas, like terraces or balconies, were more prone to or facilitated to practice PA during the lockdown. In accordance with previous data (1, 4), a strong correlation was found in this survey between an active lifestyle and outdoor space availability, especially in private garden. Therefore, the promotion of outdoor activities by parents could be very important to increase active behavior in children. Considering the limited adhesion of the participants in our study towards online PA activities, it can be hypothesized that the presence of outdoor space may affect PA practice in children more than time spent with electronic devices.

The main strength of this research consists in providing new information about PA of adults and children during the pandemic lockdown and in the 6-months following period, with data collected from a wide number of individuals (no. 1,233) with national coverage.

Nevertheless, the first limitation of the study relies on the difficulty of obtaining a robust generalization to the whole Italy (geographic bias) of data collected by means of convenience sampling through spontaneous web-based adhesion. Another weakness is mainly related to self- and parent-reported information about time spent in PA and PA intensity, since self-reported data are heavily prone to recall bias and social desirability (27).

Conclusions

This study highlights that a strong reduction of PA, intended as frequency, duration, and intensity, occurred among

participants in this survey, both adults and children, during the home confinement due to COVID-19 restrictions, with only a partial return to the activity after the end of the isolation period.

During that time, a moderate weight gain, significantly associated with a sedentary lifestyle, has been reported in children, especially if previously engaged in sports. These data raise concerns about the negative consequences of insufficient PA during the pandemic restrictions and claim the need for adequate promotion initiatives to recover recommended PA levels.

However, some family aspects may limit health negative effects related to the restrictive measures. First of all, parental attitude to exercise, higher educational level, and occupational status (especially mothers' that suspended their job) are associated with lesser inactive behavior in children. Also, the presence of outdoor spaces, especially if private, encouraged PA practice and has been found more effective than online PA tools in promoting and increasing movement in children. Therefore, web-based PA should be better promoted and publicized, especially among people who do not enjoy private outdoor spaces.

Results of this study support the need to implement effective measures of PA promotion in children during social distancing, especially in the regions where PA practice is usually under the international guidelines, such as southern Italy areas, and suggest the importance of parents' contribution for a successful program.

Funding sources. No funding was received for conducting this study.

Potential conflicts of interest. The authors report no conflicts of interest/competing interests.

Riassunto

Effetto delle misure di isolamento da COVID-19 sull'attività fisica dei bambini e dei loro genitori e ruolo dell'ambiente familiare: uno studio trasversale

Introduzione. Le rigorose misure di isolamento dovute alla pandemia da COVID-19 hanno avuto un grave impatto sullo stile di vita dei bambini. In questo lavoro viene riportato uno studio trasversale descrittivo finalizzato alla raccolta e analisi di informazioni sulle abitudini relative all'attività fisica dei bambini e dei loro genitori durante il periodo di distanziamento sociale dovuto alla pandemia di COVID-19.

Metodi. Lo studio è stato condotto su 363 famiglie (per un totale di 507 bambini di età compresa tra 5 e 13 anni), reclutate mediante campionamento di convenienza, alle quali è stato somministrato un questionario online chiedendo il tipo e la frequenza di attività fisica prima, durante e dopo il periodo di lockdown (9 marzo – 3 maggio 2020), l'istruzione, gli spazi esterni e la percezione dell'aumento di peso dei bambini.

Risultati. I risultati mostrano una notevole diminuzione di attività fisica dei bambini durante il lockdown (88.9 vs 39.8% bambini attivi), particolarmente associato alla maggiore età dei bambini e alla scarsa disponibilità di spazi esterni ($p < 0.001$). L'attività fisica dei genitori era direttamente correlata al livello di istruzione ed è stata trovata una leggera ma significativa correlazione tra l'istruzione dei genitori e l'attività fisica dei bambini, specialmente con la laurea del padre ($p < 0.05$). Le madri attive hanno influenzato significativamente l'attività fisica dei bambini durante il lockdown, soprattutto se non impegnate nello smart working. Il ritorno ad uno stile di vita attivo da parte dei bambini non ha raggiunto i livelli precedenti (75.9% bambini attivi) ed è stato direttamente correlato all'attività fisica dei genitori. Infine, il rischio di aumento di peso era minore nei bambini attivi durante il lockdown (OR = 0.46; $p < 0.001$).

Conclusioni. Questo lavoro mette in evidenza l'importanza dell'attività fisica durante un evento pandemico per prevenire il rischio di aumento di peso, e sottolinea l'importanza dell'intero sistema familiare come fonte di promozione di comportamenti sani nei bambini.

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APPENDIX 1

QUESTIONNAIRE

Physical Activity During Covid19:

- 0) This questionnaire will be used to assess the lifestyle (sport/physical activity, nutrition & well-being) of elementary and middle school children and their parents. Data collection will be carried out in compliance with the privacy guarantee regulations (Legislative Decree 196/2003). The data will be reported in an aggregate form without identification references. This will guarantee anonymity, and data will not be communicated or disseminated in any way except in the manner mentioned above.
- I Agree
 - I do not Agree
- 1) What region are you from?
 - Calabria
 - Campania
 - Lombardia
 - Marche
 - Sicilia
 - Other
 - 2) What is your city of residence?
 - 3) Your home has an:
 - Outdoor area / private garden
 - Outdoor area / common garden (example: condominium)
 - No outdoor area / no garden
 - 4) Number of children attending elementary school and/or middle school:
 - 1
 - 2
 - 3
 - Other

Questions to be answered by parents:

- 5) Age of your child:
- 6) Gender:
- female
 - male
- 7) Grade:
- Primary school, 1st Grade
 - Primary school, 2nd Grade
 - Primary school, 3rd Grade
 - Primary school, 4rd Grade
 - Primary school, 5th Grade
 - Middle school, 1st Grade
 - Middle school, 2nd Grade
 - Middle school, 3th Grade

Before the lockdown (until March 9, 2020)

- 8) Did your child engage in physical activity (including outdoor play) or play sports?
- Yes
 - No
- 9) What physical activity or sport did your child practice?
- No physical activity or sports
 - Soccer
 - Basketball
 - Dancing
 - Swimming
 - Gymnastics
 - Volleyball
 - Martial Arts
 - Outdoor play
 - Attended the Gym
 - Running / Jogging
 - Tennis
 - Skating
 - Rugby
 - Other
- 10)How many days per week?
- 0 day
 - 1 day
 - 2 days
 - 3 days
 - 4 days
 - 5 days
 - 6 days
 - 7 days
- 11)How many hours per day?
- 0 hours
 - from 30 minutes to 1 hour
 - 2 hours
 - 3 hours
 - 4 hours
 - 5 hours
 - 6 hours
 - 7 hours

During the lockdown (from March 9 to May 3, 2020)

- 12 • Did your child engage in physical activity (including outdoor play) or play sports?
- Yes
 - No
- 13)What physical activity or sport did your child practice?
- No physical activity or sports
 - Soccer
 - Basketball
 - Dancing
 - Swimming
 - Gymnastics
 - Volleyball
 - Martial Arts
 - Outdoor play
 - Attended the Gym
 - Running / Jogging
 - Tennis
 - Skating
 - Rugby
 - Other
- 14)Did your child do physical activity or play sports following online sessions (whether after school lessons or online meetings with friends or family)?
- Yes
 - No
- 15)Where was your child physically active or playing sports?
- Inside the home
 - In the garden
 - Somewhere else
 - No activity was done
- 16)How many days per week?
- 0 day
 - 1 day
 - 2 days
 - 3 days
 - 4 days
 - 5 days
 - 6 days
 - 7 days
- 17)How many hours per day?
- 0 hours
 - from 30 minutes to 1 hour
 - 2 hours
 - 3 hours
 - 4 hours
 - 5 hours
 - 6 hours
 - 7 hours
- 18)Has your child experienced weight gain?
- Yes
 - No

- 19) How much weight has your child gained?
- From 1 to 2 kg
 - From 3 to 4 kg
 - More than 4 kg

- 20) If yes, do you think the weight gain is associated with:
- Decreased physical activity
 - Increased calorie intake
 - Both

After the lockdown (from May 3, 2020)

- 21) Has your child returned or continued to do physical activity (including outdoor play) or play sports after the lockdown?

- Yes
- No

- 22) What physical activity or sport did your child practice?

- No physical activity or sports
- Soccer
- Basketball
- Dancing
- Swimming
- Gymnastics
- Volleyball
- Martial Arts
- Outdoor play
- Attended the Gym
- Running / Jogging
- Tennis
- Skating
- Rugby
- Other

- 23) How many days per week?

- 0 day
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

- 24) How many hours per day?

- 0 hours
- from 30 minutes to 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- 6 hours
- 7 hours

Questions to be answered by the child:

- 25) Do you enjoy the physical activity (including outdoor play) or playing sports?

- Yes
- No

- 26) Is it important for you to engage in physical activity (including outdoor play) or playing sports?

- Yes
- No

- 27) Did you miss being active (engaging outdoor play) or playing sports during the quarantine?

- Yes
- No

- 28) Have you been happy to return to physical activity (including outdoor play) or playing sports after quarantine?

- Yes
- No

Questions to be answered by the father:

- 29) Age:

- 30) Years of Schooling:

- Middle School Diploma.
- High School Diploma
- University Degree

Before the lockdown (until March 9, 2020)

- 31) Did you do any physical activity or play sports?

- Yes
- No

- 32) What physical activity or sport did you practice?

- No physical activity or sports
- Soccer
- Basketball
- Dancing
- Swimming
- Gymnastics
- Volleyball
- Martial Arts
- Outdoor play
- Attended the Gym
- Running / Jogging
- Tennis
- Skating
- Rugby
- Other

- 33) How many days per week?

- 0 day
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

- 34) How many hours per day?

- 0 hours
- from 30 minutes to 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours

- 6 hours
- 7 hours

During the lockdown (from March 9 to May 3, 2020)

- 35) Employment status during the lockdown:
- Continued to work outside the home
 - Worked from home / teleworking
 - Unemployed
- 36) Did you engage in any physical activity or play sports during the lockdown??
- Yes
 - No
- 37) What physical activity or sport did you practice?
- No physical activity or sports
 - Soccer
 - Basketball
 - Dancing
 - Swimming
 - Gymnastics
 - Volleyball
 - Martial Arts
 - Outdoor play
 - Attended the Gym
 - Running / Jogging
 - Tennis
 - Skating
 - Rugby
 - Other
- 38) Did you engage in physical activity or play sports following online session?
- Yes
 - No
- 39) Where did you engage in physical activity or play sports?
- Inside the home
 - In the garden
 - Somewhere else
 - No physical activity was done
- 40) How many days per week?
- 0 day
 - 1 day
 - 2 days
 - 3 days
 - 4 days
 - 5 days
 - 6 days
 - 7 days
- 41) How many hours per day?
- 0 hours
 - from 30 minutes to 1 hour
 - 2 hours
 - 3 hours
 - 4 hours
 - 5 hours
 - 6 hours
 - 7 hours

After the lockdown (from May 3, 2020)

- 42) After the lockdown, did you start being physically active? Or, did you continue being physically active or play sports?
- Yes
 - No
- 43) What physical activity or sport did you practice?
- No physical activity or sports
 - Soccer
 - Basketball
 - Dancing
 - Swimming
 - Gymnastics
 - Volleyball
 - Martial Arts
 - Outdoor play
 - Attended the Gym
 - Running / Jogging
 - Tennis
 - Skating
 - Rugby
 - Other
- 44) How many days per week?
- 0 day
 - 1 day
 - 2 days
 - 3 days
 - 4 days
 - 5 days
 - 6 days
 - 7 days
- 45) How many hours per day?
- 0 hours
 - from 30 minutes to 1 hour
 - 2 hours
 - 3 hours
 - 4 hours
 - 5 hours
 - 6 hours
 - 7 hours

Questions to be answered by the mother:

- 46) Age:
- 47) Years of Schooling:
- Middle School Diploma
 - High School Diploma
 - University Degree

Before the lockdown (until March 9, 2020)

- 48) Did you engage any physical activity or play sports?
- Yes
 - No
- 49) What physical activity or sport did you practice?
- No physical activity or sports
 - Soccer
 - Basketball

- Dancing
- Swimming
- Gymnastics
- Volleyball
- Martial Arts
- Outdoor play
- Attended the Gym
- Running / Jogging
- Tennis
- Skating
- Rugby
- Other

50)How many days per week?

- 0 day
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

51)How many hours per day?

- 0 hours
- from 30 minutes to 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- 6 hours
- 7 hours

During the lockdown (from March 9 to May 3, 2020)

52)Employment status during the lockdown:

- Continued to work outside the home
- Worked from home / teleworking
- Unemployed

53)Did you engage in any physical activity or play sports during the lockdown??

- Yes
- No

54)What physical activity or sport did you practice?

- No physical activity or sports
- Soccer
- Basketball
- Dancing
- Swimming
- Gymnastics
- Volleyball
- Martial Arts
- Outdoor play
- Attended the Gym
- Running / Jogging
- Tennis
- Skating
- Rugby

- Other

55)Did you engage in physical activity or play sports following online session?

- Yes
- No

56)Where did you engage in physical activity or play sports?

- Inside the home
- In the garden
- Somewhere else
- No activity was done

57)How many days per week?

- 0 day
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

58)How many hours per day?

- 0 hours
- from 30 minutes to 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- 6 hours
- 7 hours

After the lockdown (from May 3, 2020)

59)After the lockdown, did you start being physically active? Or, did you continue being physically active or play sports?

- Yes
- No

60)What physical activity or sport did you practice?

- No physical activity or sports
- Soccer
- Basketball
- Dancing
- Swimming
- Gymnastics
- Volleyball
- Martial Arts
- Outdoor play
- Attended the Gym
- Running / Jogging
- Tennis
- Skating
- Rugby
- Other

61)How many days per week?

- 0 day
- 1 day
- 2 days

- 3 days
 - 4 days
 - 5 days
 - 6 days
 - 7 days
- 62) How many hours per day?
- 0 hours
 - from 30 minutes to 1 hour
 - 2 hours
 - 3 hours
 - 4 hours
 - 5 hours
 - 6 hours
 - 7 hours