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## Research paper

# Effect of the COVID-19 lockdown on physical activity and sedentary behaviors in French children and adolescents: New results from the ONAPS national survey



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## ABSTRACT

**Introduction:** In France March 14, 2020 a national lockdown was imposed in France for 55 days to prevent the spread of COVID-19 and all schools were closed. This study aimed to investigate the effects of home confinement as a result of lockdown on the activity (physical activity and sedentary behaviors), and their determinants, on French children (6-10 years) and adolescents (11-17 years).

**Methods:** The National Observatory for Physical Activity and Sedentary behaviors launched an online survey from April 1<sup>st</sup>, to May 6<sup>th</sup>, 2020 using popular social networks and websites. It compared the level of physical activity (PA), sitting and screen time before and during the lockdown and identified the impact of the initial PA (active vs. inactive), sedentary (high vs. low) profiles of the participants and their housing conditions.

**Results:** 6,491 children were included in this study. Initially active children and adolescents decreased their PA more than those initially inactive ( $p > 0.001$ ), while those who met the sitting time recommendations increased more their sitting time during lockdown ( $p < 0.001$ ). The same applied to screen time ( $p < 0.001$ ). Living in an urban environment was associated with a decrease in PA ( $p < 0.001$ ), an increase in sitting time ( $p < 0.001$ ) and children's screen time ( $p = 0.002$ ) during lockdown.

**Conclusion:** This study showed the deleterious effects of confinement caused by lockdown on physical activity and sedentary behaviors. Housing conditions were associated with lifestyle behaviors over this period of lockdown. Future public health policies should consider these results.

## 1. Introduction

Since early 2020, the SARS-CoV-2 virus has rapidly spread all over the world, leading governments to take national measures to protect the

population's health. The World Health Organization (WHO) officially declared the global COVID-19 pandemic on March 11, 2020. Since the first confirmed case, more than 63 million COVID-19 infections have

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been identified and more than 2,000,000 people have died over the globe (as of February 1, 2020) [1]. In addition to the high rate of COVID-19-related deaths, some collateral damage to physical and mental health during the imposed lockdown have been identified, such as increased anxiety, depression, or stress [2,3].

In France, stage 3 was reached on March 14, 2020 (corresponding to the free circulation of the COVID-19 virus on national territory), and a national lockdown was imposed 3 days later for a total of 55 days, in attempts to prevent the spread of the COVID-19 virus. All primary and secondary schools were completely closed and all the teaching activities were conducted virtually. As a direct consequence, physical activity (PA) and sedentary behaviors (SB) have been negatively affected, which has been associated with impaired well-being, mental, physical, and metabolic health [4–8].

In several countries, surveys have been conducted to evaluate the exact impacts of this lockdown on movement behaviors, collectively observing a drastic decrease of the physical activity level (PAL) altogether with an increased time spent sedentary [4–6,8,9]. In France, the National Observatory for Physical Activity and Sedentary Behaviors (ONAPS), conducted a major survey that revealed that both initially active and inactive individuals (did or did not meet the PA recommendations) were negatively impacted by this lockdown [9].

Although the majority of studies have been conducted among adults, some results are available among children and adolescents. A Canadian study conducted among 1,472 parents of children and youth aged 5–17 years showed that only 4.8% (2.8% girls, 6.5% boys) of children (5–11 years) and 0.6% (0.8% girls, 0.5% boys) of youth (12–17 years) had reached the recommendations for a healthy lifestyle (24h movement guidelines) during this lockdown [10]. According to this research group, having parents who encourage and are involved in PA [10,11], having a domestic animal that needs to be walked [10], having an environment and neighborhood favoring PA [12] have been key determinants. This survey also revealed an increase in screen time among the youngest children [10–12] and determined the parents' ability to restrict screen time as the major factor associated with this progression [11]. Similar results have been observed among 12-year-olds (n=113) [13] Spanish youth aged 3 to 16 years (n=860) [14]; adolescents from Bosnia-Herzegovina (n=688, 15–18 years old) [15], and young people in Egypt [16]. While Pombo et al. obtained similar results regarding the effect of the lockdown of Portuguese children's PA level (n=2,159; mean age of 13 years), the authors also found that the access to a large outdoor area, having at least one parent who did not have to work from home, or sharing the house with other children were strong positive predictors of PA during the lockdown [17].

Based on the data from the French national survey conducted in about 28,000 individuals from all ages (ONAPS COVID-19 Survey; [9]), the present paper assessed the effect of the COVID-19-related lockdown on the movement behaviors (PA and SB), and their determinants, on French children and adolescents. Importantly, these effects were analyzed considering the initial PA (active vs. inactive) and sedentary (high vs. low) profiles of the participants.

## 2. Methods

As previously detailed (global ONAPS COVID-19 survey; [9]), an expert committee (composed of representatives of public health, academics and scientific, governmental, medical and collectivity areas) were gathered by the ONAPS and the French Ministry of Sports, to determine at the national level, key indicators to identify, understand and evaluate the changes induced by this lockdown on the population's PA and SB.

### 2.1. Elaboration of the survey

Different questionnaires following the same basic structure were developed for children between the age of 6 and 10 years and for adoles-

cents (11–17 years old). The questionnaires and their methodology were adapted and inspired from the IPAQ[18] and ONAPS-Q (in progress) questionnaires in adults and YRBSS (Youth Risk Behavior Surveillance System) investigation in children and adolescents[19]. Briefly, the internal structure of the questionnaires were developed using the same type of questions and structure with possible answers (for instance: time being active over a period of 7 days; screen time per day; etc.). Geographical, socio-demographic, and health status information were first requested before properly addressing the participants' behaviors in terms of PA levels, sitting time and screen time. The participants were also asked to indicate whether they increased or decreased their time devoted to PA and SB compared with their lockdown habits. Concerning PA, participants are considered as initially inactive if they did not engage in at least 5 hours and 30 minutes per week of moderate to vigorous PA (5 hours and 30 minutes being the highest range proposed in by questionnaire). Concerning SB we used the recommendations thresholds like not exceed 2h/day of screen time [11]. More precisely, the participants were asked to declare their (or their children's) PA and sedentary habits at the time of the lockdown (when they completed the questionnaires) and retrospectively, what they were doing before the lockdown. Parents of children below 10 years of age were asked to fill out the questionnaires while older children and adolescents completed the questionnaire themselves. The final version of these questionnaires resulted from a back-and forth consultation between the members of the expert committee, until a consensus was reached.

### 2.2. Launch and relaunch of the questionnaires

The survey was made available online at the ONAPS website (<http://www.onaps.fr/>) on April 1<sup>st</sup>, 2020 (after 15 days of lockdown). Social media platforms were used to promote the survey regularly until May 6<sup>th</sup>, 2020, the date at which the survey was closed. Social media (Facebook, LinkedIn for example) and other networks were used for its promotion. Several types of online media were used to disseminate the survey, targeting different kinds of professional, associations, demographic and geographical networks and areas. In the context of the COVID-19 lockdown, particular efforts were deployed to reach a large and representative sample. On a regular basis (April 6<sup>th</sup>, 16<sup>th</sup>, 24<sup>th</sup>, 28<sup>th</sup>, May 6<sup>th</sup> (the last day of the lockdown)), the operational office of the ONAPS relaunched the survey in order to optimize the success of the questionnaires. The survey was closed 36 days after it officially started (on May 6<sup>th</sup>), one week before the end of the lockdown.

### 2.3. Ethical consideration

This work received ethical agreement from the appropriate authorities (Committee for the Protection of Persons Sud est VI. reference 2020 / CE 27).

### 2.4. Data management

The survey was administered online using the LimeSurvey software version 2.67.3. Data were collected anonymously and none of the provided answers allowed any potential for participant identification. Of the 22,895 properly completed questionnaires, 1,588 concerned children ages 6 to 10 years old and 4,903 were completed by adolescents (11–17 years old). Three indicators (physical activity levels, sitting time and screen time) have been transformed into quantitative data by taking the central value of each class (example: less than 30 minutes per week were encoded as 15 minutes of PA per week). Originally we had chosen to propose qualitative values in order to avoid inconsistent values and data entry errors. Data were then gathered into an Excel sheet before being analyzed by the biostatistician team (CL, BP).

**Table 1**

Proportion of children and adolescents who increased, decreased or did not change their PA level during the confinement depending on gender and initial level of PA.

	Children Decreased	Similar	Increased	p	Adolescents Decreased	Similar	Increased	p
<b>Sex</b>				0.10				<b>&lt;0.001</b>
Girls	293 (39.9%)	151 (20.6%)	290 (39.5%)		1791 (59.7%)	560 (18.6%)	651 (21.7%)	
Boys	374 (43.8%)	187 (21.9%)	293 (34.3%)		1085 (57.1%)	508 (26.7%)	308 (16.2%)	
<b>Physical activity level</b>								
Initially inactive (<5h30/week)	486 (40.8%)	122 (10.2%)	583 (49.0%)		1560 (53.7%)	388 (13.3%)	959 (33.0%)	
Initially active (>5h30/week)	181 (45.6%)	216 (54.4%)	0 (0.0%)		1316 (65.9%)	680 (34.1%)	0 (0.0%)	

Data are presented as number of subjects (row percentages). Boldfaced values: P < 0.05

**Table 2**

Changes in PA level during the lockdown confinement depending on the housing situation of the children and adolescents.

	Children Decreased	Similar	Increased	p	Adolescents Decreased	Similar	Increased	p
<b>Housing area</b>				<b>&lt;0.001</b>				<b>&lt;0.001</b>
Rural	248 (35.2%)	159 (22.5%)	298 (42.3%)		1566 (55.6%)	637 (22.6%)	612 (21.8%)	
Suburban	156 (46.7%)	62 (18.6%)	116 (34.7%)		655 (62.0%)	219 (20.8%)	182 (17.2%)	
Urban	263 (47.9%)	117 (21.3%)	169 (30.8%)		655 (63.5%)	212 (20.5%)	165 (16.0%)	
<b>Housing conditions</b>				<b>&lt;0.001</b>				0.13
No outdoor access	52 (64.2%)	14 (17.3%)	15 (18.5%)		111 (63.8%)	36 (20.7%)	27 (15.5%)	
Balcony	100 (62.1%)	23 (14.3%)	38 (23.6%)		243 (64.8%)	70 (18.7%)	62 (16.5%)	
Shared outdoor access	50 (43.1%)	26 (22.4%)	40 (34.5%)		204 (58.6%)	80 (23.0%)	64 (18.4%)	
Individual outdoor access	465 (37.8%)	275 (22.3%)	490 (39.9%)		2318 (57.9%)	882 (22.0%)	806 (20.1%)	

## 2.5. Statistical considerations

Statistical analysis was performed separately for children and adolescents using Stata software (version 15; StataCorp, College Station, Texas, USA). All tests were two-sided, with a Type I error set at 0.05. All variables were categorical and presented as number of subjects and percentages. The factors associated with the evolution before/during lockdown (increase, similarity, decrease) of the three indicators (PA level, sitting time, and screen time) were studied by chi-squared tests.

## 3. Results

### 3.1. Description of sample

Data were collected from 6,491 children and adolescents (57.6% female). One-quarter (24.5%) of the sample was between the ages of 6 to 10 years (46.2% female), while 75.5% of responses were from young people between the ages of 11 to 17 years (61.2% female).

A total of 5.1% of the children and 3.6% of the adolescents did not have access to an outdoor area during the lockdown, while 10.1% of children and 7.6% of adolescents had access to a balcony only, 7.3% of children and 7.1% of adolescents had access to a shared outdoor area and 77.5% of children and 81.7% of adolescents lived in accommodation with an individual backyard. Concerning the housing area, 34.6% of children and 21.1% of adolescents lived in an urban area, 44.4% of children and 57.4% of adolescents lived in rural areas, and 21.0% of children and 21.5% of adolescents lived in a suburban area.

### 3.2. Physical activity

A total of 42.0% of children and 58.7% of adolescents reported decreased PA during the lockdown, compared to 21.3% of children and 21.8% of adolescents maintained a similar volume of PA, and 36.7% of children and 19.6% of adolescents declared an increase their PA. The proportion of participants who increased, decreased or did not change their PAL during the lockdown was significantly associated with gender in adolescents (p<0.001) but not in children (p=0.10). The Table 1 presents the proportions of children and adolescents who de-

clared increased, decreased or unchanged overall level of PA depending on gender and initial level of PA.

As depicted in Table 1, being physically active before lockdown was associated with the change in PA level during lockdown in both age groups (p<0.001). A total of 45.6% of children and 65.9% of adolescents who were initially active admitted a decrease of their level of PA during lockdown. Forty-eight percent of children and 53.7% of adolescents who were initially inactive declared a decrease of their PA during lockdown. A total of 49.0% and 33.0% of initially inactive children and adolescents respectively, increased their PA level during lockdown. Of note, the fact that our questionnaire could not identify PAL above 5h30min per week, explains the absence of initially active children and adolescents who increased their PAL.

The geographic location (rural, suburban, urban) of the accommodation was significantly associated with the children and adolescent's PA during the lockdown (p<0.001), while the housing condition (access to an outdoor area or not) was associated with PA changes in children only (p<0.001 in younger children and p=0.13 in adolescents). As presented in Table 2, PA decreased among 35.2% of children who lived in rural areas, decreased among 46.7% of children who lived in suburban areas, and decreased among 47.9% of children who lived in urban areas. Access to an outdoor area moderated the change in PA levels of children, such that 64.2% reported a decrease in PA when they did not access to an outdoor area, compared to a decrease in PA among only 37.8% who had individual outdoor area access (p<0.001).

According to our results, the initial level of sitting time in children was associated with their PAL changes during lockdown while their initial screen time did not affect their PAL during lockdown (p=0.04 and p=0.95 respectively). In adolescents, pre- lockdown screen time (p<0.001) and sitting time (p=0.01) was associated with their PAL changes. A total of 32.8% of children who did not exceed the 6h/day of sitting increased their PAL and 37.6% among those whose daily sitting time was higher than 6h/day.

### 3.3. Sitting time

Based on our results, as presented in the Table 3, not exceeding sitting time recommendations (<6h/day) before the lockdown was associated with the sitting time during lockdown for both children and

**Table 3**

Changes in sitting time during the lockdown confinement presented by gender, initial PAL, sitting time, screen time, and housing situation of children and adolescents.

	Children Decreased	Similar	Increased	p	Adolescents Decreased	Similar	Increased	p
<b>Sex</b>				0.54				<0.001
Girls	215 (29.3%)	242 (33.0%)	276 (37.7%)		428 (14.3%)	1847 (61.6%)	721 (24.1%)	
Boys	256 (30.0%)	298 (34.9%)	299 (35.1%)		357 (18.8%)	1014 (53.4%)	528 (27.8%)	
<b>Physical activity level</b>				0.98				<0.001
Initially inactive	355 (29.8%)	405 (34.1%)	430 (36.1%)		470 (16.2%)	1,758 (60.6%)	672 (23.2%)	
Initially active	116 (29.3%)	135 (34.1%)	145 (36.6%)		315 (15.8%)	1,103 (55.3%)	577 (28.9%)	
<b>Sitting time</b>				<0.001				<0.001
>6h/day	462 (35.5%)	468 (36.0%)	370 (28.5%)		763 (17.5%)	2,735 (62.6%)	867 (19.9%)	
<6h/day	9 (3.1%)	72 (25.2%)	205 (71.7%)		22 (4.1%)	126 (23.8%)	382 (72.1%)	
<b>Screen time</b>				<0.001				<0.001
>2h/day	87 (31.3%)	140 (50.4%)	51 (18.3%)		488 (14.2%)	2,345 (68.2%)	603 (17.6%)	
<2h/day	384 (29.3%)	400 (30.6%)	524 (40.1%)		297 (20.3%)	516 (35.4%)	646 (44.3%)	
<b>Housing area</b>				<0.001				<0.001
Rural	243 (34.5%)	247 (35.0%)	215 (30.5%)		499 (17.8%)	1,626 (57.8%)	685 (24.4%)	
Suburban	91 (27.3%)	107 (32.0%)	136 (40.7%)		157 (14.9%)	596 (56.6%)	300 (28.5%)	
Urban	137 (25.0%)	186 (34.0%)	224 (41.0%)		129 (12.5%)	639 (61.9%)	264 (25.6%)	
<b>Housing conditions</b>				<0.001				0.004
No outdoor access	9 (11.1%)	24 (29.6%)	48 (59.3%)		13 (7.5%)	105 (60.3%)	56 (32.2%)	
Balcony	33 (20.5%)	49 (30.4%)	79 (49.1%)		43 (11.5%)	232 (62.0%)	99 (26.5%)	
Shared outdoor access	30 (25.9%)	49 (42.2%)	37 (31.9%)		56 (16.2%)	209 (60.2%)	82 (23.6%)	
Individual outdoor access	399 (32.5%)	418 (34.0%)	411 (33.5%)		673 (16.8%)	2,315 (57.9%)	1,012 (25.3%)	

Data are presented as number of subjects (row percentages). Boldfaced values: P &lt; 0.05

adolescents ( $p < 0.001$ ). Concerning children and adolescents who respected the recommendations of 6h/day of sitting time before lockdown, they mainly declared an increase of their sitting time during lockdown (71.7% and 72.1% respectively), while among those who exceeded the 6h/day of sitting time before lockdown, only 28.5% of children and 19.9% of adolescents admitted an increase in their sitting time.

The initial screen time of children and adolescents was also associated with their sitting time during the lockdown ( $p < 0.001$ ). A total of 40.1% children and 44.3% adolescents who were exposed to screens <2h/day declared an increase of their sitting time against respectively 18.3% and 17.6% for those who were exposed to screens >2h/day before the lockdown ( $p < 0.001$  for both children and adolescents).

As presented in Table 3, the housing area (urban, suburban, rural) of adolescents and children was significantly associated with the evolution of their sitting time before and during lockdown ( $p < 0.001$ ). More children who lived in urban areas declared an increased sitting time during lockdown (41.0%) than those who lived rural areas (30.5%) ( $p < 0.001$ ).

The access to an outdoor area was found to be significantly related to the sitting time modifications during the lockdown in children ( $p < 0.001$ ) and adolescents ( $p = 0.004$ ). Indeed, higher proportions of children ( $p < 0.001$ ) and adolescents ( $p = 0.04$ ) who had no access to an outdoor area admitted an increased sitting time during lockdown (59.3% and 32.2% respectively) than those who had access to an individual backyard (33.5% and 25.3% respectively).

### 3.4. Screen time

While only 1.4% of children and 3.2% of adolescents admitted to a decrease their screen time during the lockdown, 62.0% of children and 68.9% of adolescents reported an increased screen time.

As displayed in Table 4, adherence to screen time recommendations before lockdown (<2h/day) influenced changes in screen time during lockdown in both children and adolescents ( $p < 0.001$ ). A higher proportion of children and adolescents who complied with the recommendations before lockdown reported an increase in their screen time (65.0% and 78.7% respectively) compared to those who exceeded the 2h/day of screen time before the lockdown (respectively 47.8% and 64.8%).

According to our results, the PAL before lockdown was significantly associated with the screen time of adolescents during lockdown ( $p < 0.001$ ) but not for children ( $p = 0.62$ ). A total of 64.2% of initially

inactive adolescents before the lockdown reported an increase of their screen time during lockdown against 75.8% of the initially active participants ( $p < 0.001$ ).

Meeting the sitting time recommendations (<6h/day) before the quarantine was significantly associated with the screen time during lockdown in children ( $p = 0.02$ ) and adolescents ( $p < 0.001$ ). A higher proportion of adolescents who had a sitting time >6h/day before the lockdown declared an increase of their screen time during lockdown (70.3%) compared to those who showed a sitting time <6h/day before the lockdown (57.6%) ( $p < 0.001$ ).

The housing area of children was significantly associated with their screen time during the quarantine ( $p = 0.002$ ), but not for adolescents ( $p = 0.10$ ). All declared an increase in their screen time during the lockdown but the higher proportion of children and adolescents who lived in urban areas reported an increase in their time spent in front of screen (respectively 66.4% and 70.6%) compared 56.7% and 67.4% of those who lived in the countryside respectively.

Access to outdoor areas was significantly associated with changes in screen time for both children and adolescents ( $p = 0.01$  and  $p = 0.002$ , respectively). Higher proportions of children and adolescents who had not access to an outdoor before the lockdown admitted to increasing their screen time (Table 4).

## 4. Discussion

The global pandemic of COVID-19 led to lockdown of the national and international populations. A large number of regional and national surveys have been carried out during and following this lockdown to assess its impact on individual movement behaviors, collectively describing an overall decline in PA levels, combined with an increased time devoted to SB, particularly screen time. Since most of these surveys have been conducted in adults, less is known regarding the impact of this quarantine on movement behaviors in children and adolescents. In that context, based on the French National ONAPS Covid-19 Survey, the present work evaluated the effect of the quarantine on PA and SB of children (aged 6 to 10 years old) and adolescents (11-17 years old).

In line with national and international statistics [20,21], a large proportion of the children and adolescents who composed our sample were identified as inactive before the lockdown (75.0% of children and 59.3% of adolescents). Considering the strong associations between health and



**Table 4**

Changes in screen time during the lockdown confinement by gender, initial PAL, sitting time, screen time and housing situation of the children and adolescents.

	Children			p	Adolescents			p
	Decreased	Similar	Increased		Decreased	Similar	Increased	
<b>Sex</b>				0.15				<b>0.02</b>
Girls	7 (1.0%)	283 (38.6%)	443 (60.4%)		99 (3.3%)	792 (26.4%)	2105 (70.3%)	
Boys	15 (1.8%)	298 (34.9%)	540 (63.3%)		58 (3.0%)	571 (30.1%)	1270 (66.9%)	
<b>Physical activity level</b>				0.62				<b>&lt;0.001</b>
Initially inactive	18 (1.5%)	430 (36.1%)	752 (62.4%)		122 (4.2%)	915 (31.6%)	1,863 (64.2%)	
Initially active	4 (1.0%)	151 (38.0%)	241 (60.9%)		35 (1.8%)	448 (22.4%)	1,512 (75.8%)	
<b>Sitting time</b>				<b>0.02</b>				<b>&lt;0.001</b>
>6h/day	21 (1.6%)	459 (35.3%)	820 (63.1%)		149 (3.4%)	1,146 (26.3%)	3,070 (70.3%)	
< 6h/day	1 (0.4%)	122 (42.6%)	163 (57.0%)		8 (1.5%)	217 (40.9%)	305 (57.6%)	
<b>Screen time</b>				<b>&lt;0.001</b>				<b>&lt;0.001</b>
>2h/day	22 (7.9%)	123 (44.3%)	133 (47.8%)		157 (4.6%)	1,052 (30.6%)	2,227 (64.8%)	
<2h/day	0 (0.0%)	458 (35.0%)	580 (65.0%)		0 (0.0%)	311 (21.3%)	1,148 (78.7%)	
<b>Housing area</b>				<b>0.002</b>				0.10
Rural	8 (1.1%)	297 (42.2%)	400 (56.7%)		95 (3.4%)	820 (29.2%)	1,895 (67.4%)	
Suburban	4 (1.2%)	110 (32.9%)	220 (65.9%)		34 (3.2%)	268 (25.5%)	751 (71.3%)	
Urban	10 (1.8%)	174 (31.8%)	363 (66.4%)		28 (2.7%)	275 (26.7%)	729 (70.6%)	
<b>Housing conditions</b>				<b>0.01</b>				<b>0.002</b>
No outdoor access	0 (0.0%)	27 (33.3%)	54 (66.7%)		7 (4.0%)	36 (20.7%)	131 (75.3%)	
Balcony	3 (1.9%)	43 (26.7%)	115 (71.4%)		8 (2.1%)	105 (28.1%)	261 (69.8%)	
Shared outdoor access	4 (3.5%)	35 (30.1%)	77 (66.4%)		18 (5.2%)	121 (34.9%)	208 (59.9%)	
Individual outdoor access	15 (1.2%)	476 (38.8%)	737 (60.0%)		124 (3.1%)	1,101 (27.5%)	2,775 (69.4%)	

Data are presented as number of subjects (row percentages).

healthy movement behaviors [22,23], the situation was already alarming in youth before the institution of social and physical restrictions. Based on the current results, 42% of children and 58.7% of adolescents reported a decrease in PA during the lockdown, which was particularly pronounced among adolescents girls (59.7%). These results are in line with what has been observed in other countries such as Spain [13,14], Bosnia- Herzegovina [15], Egypt [16] or Canada [10–12] among others. Gilic et al. estimated that 50% of their Bosnian adolescents reached PA recommendations before the lockdown, dropping to only 24% during the lockdown [15]. Interestingly, our results are the first to evaluate the effect of this COVID-19-related lockdown stratified by the initial (pre-lockdown) level of PA in youth. Our results show that this drastic global decline in PA during this particular period affected both initially active and inactive children and adolescents. Indeed, high proportions of both active (45.6% in children and 65.9% in adolescents) or inactive (40.8% of children and 53.7% of adolescents) youth reported a decrease in PA levels. Importantly, our survey also highlights that none of the children and adolescents initially (before the lockdown) identified as inactive, reported an increase of their PA during this lockdown. While our results clearly highlight that initially inactive youth might be particularly concerned by the deleterious effects of such lockdown, they also show that a higher initial level of PA of children and adolescents might not prevent them from decreasing their PA during the lockdown. Indeed, some may argue that they have “more to lose” when it comes to declines in PA. While some authors previously underlined the role of the parental encouragement [10,11] or a family’s neighborhood [12] to avoid such a decrease in PA, our results also identified the living conditions (rural-urban) of the accommodation and the access to outdoor facilities as primary influences. High proportions of children (47.9%) and adolescents (63.5%) living in urban areas or whose accommodation did not allow access to outdoor facilities (64.2% and 63.8%, respectively), declared a significant decrease in PA as a result of stay-at-home orders.

These results are in line with those from Zenic et al., who also described adolescents living in urban areas as more prone to reduce their PA levels during the lockdown when compared with their counterparts living in rural areas [24]. Our findings also align with results from Canada, identifying the access to outdoor (as parks) as influences on PA during periods of home lockdown [12].

Although our results show that 22% of children and 27.9% of adolescents admitted to increase their sitting time during the French lock-

down, they also underline an alarming increase in screen time among 62% and 68.9% of children and adolescents, respectively. This finding is in line with previously published results from other counties showing an increase of the time exposed to screens [10–14], which is at least partly attributable to the immediate transition to home-based virtual schooling. This was true among Chinese youth, with an increase in screen time of more than 4 hours per day reported during the lockdown [25]. Moreover, Pietrobelli and colleagues underlined that while 60.3% of the Italian children and adolescents already exceed the screen time recommendations, 68.9% of adolescents with obesity increased screen time during the first COVID-19-related lockdown [26]. As for PA, our results also underline that this increased sitting and screen time affects children and adolescents independently of previously meeting recommendations for time spent in SB. Interestingly, sitting and screen time were also similarly increased regardless of initial PA levels. As already noted for PAL, our results reinforce the important role of the living conditions on both sitting and screen time during the lockdown, with children from urban areas most affected. Similarly, higher proportions of both children and adolescents who had no or limited access to outdoor areas reported an increase in sitting and screen time.

As most of the surveys were conducted during the lockdown period, the online and self-reported nature of the collected data and the use of subjective self-reported questionnaires are the main limitations of the current study. Questionnaires were submitted online, which may have limited access for poorer and migrant sectors of the population without internet access. However, conducting and analysing the data for a large-scale national survey can be logistically challenging, and conducting it online makes it feasible. Another limitation lies in the categorization of PAL and SB that do not showed changes in levels within a category, a child may have increased or decreased his PAL or SB without changing categories and therefore without this being apparent. The large number of participants who completed this French national survey however, should be considered as a strength of this work, with more than 6400 children and adolescents, making this survey one of the largest samples worldwide. Importantly, while previous questionnaires addressing healthy behaviors might attract people who are interested in and concerned by such behaviors. The proportion of youth determined as inactive or did not meet the sedentary guidelines prior to the COVID-19 pandemic indicates that our sample might be slightly different of the general French population concerning PA in children (25% of active against

67% in the ESTEBAN survey), while closer among adolescents (40% vs. 30%)[27] and widely different concerning screen time in children, (25% who do not exceed 2h/day against 55% do not exceed 3h/day in ESTEBAN survey) and adolescent (41% against 74%)[27]. These differences can be explained by the threshold used to identify participants as active or inactive (5h 30min per week of PA in the present work against 7h/week for the general recommendations), the evolution of screen time recommendations (2h/day and 3h/day) and the retrospective nature of the data collected. The threshold used for PA (5h 30min /week) is one of the main limitations of the present work that is due to the internal construction of the survey, and that must be considered when interpreting our results. Concerning living conditions, large differences were observed between the proportion of children and adolescents who lived in urban areas (34.6% against 21.1%) and rural areas (44.4% against 57.4% of adolescents), which can be explained by the different number of respondents (1586 children and 4895 adolescents). The lack of information regarding the geographical situation of the participants, and the lack of anthropometric information, also impose some limitations of the present analysis. Finally, the retrospective nature of the estimation of the participants' physical activity level and sedentary time before the lockdown imposes another important limitations of the present analysis that must be considered.

## 5. Conclusion

In line with previously published results in other countries, the present results confirm the negative impact of the first COVID-19-related lockdown period on movement behaviors in children and adolescents. Our study reinforces the need to orient future public health policies towards improving the accessibility of outdoor facilities, particularly in urban areas, in order to encourage greater physical activity. It also indicates that such a period of isolation has deleterious effects on both physical activity and sedentary behaviors among youth, regardless of whether or not they were previously meeting public health guidelines. Finally, there is a need for more informative and preventive public health strategies clearly warning the population that every child, regardless of age or usual movement behaviors, may be negatively impacted by physical and social restrictions.

## Author contribution

**Camille Chambonniere:** Formal analysis, Project administration, Writing - original draft. **Céline Lambert:** Data curation, Formal analysis, Methodology, Writing - original draft. **Nicole Fearnbach:** Writing - original draft. **Michèle Tardieu:** Conceptualization, Funding acquisition, Investigation, Project administration, Writing - review & editing. **Alicia Fillon:** Data curation, Methodology, Project administration, Writing - review & editing. **Pauline Genin:** Data curation, Formal analysis, Methodology, Project administration, Writing - original draft. **Benjamin Larras:** Data curation, Project administration, Writing - review & editing. **Pierre Melsens:** Data curation, Resources. **Julien Bois:** Funding acquisition, Resources. **Bruno Pereira:** Conceptualization, Formal analysis, Methodology, Resources. **Angelo Tremblay:** Funding acquisition, Resources, Writing - review & editing. **David Thivel:** Formal analysis, Investigation, Resources, Writing - original draft. **Martine Duclos:** Conceptualization, Funding acquisition, Investigation, Writing - original draft.

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Data availability

Complementary data (questionnaires) are supplied as a supplementary file.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.eujim.2021.101308.

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