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C Chambonniere, Céline Lambert, S. Nicole Fearnbach, Michèle Tardieu, Alicia Fillon, Pauline M. Genin, Benjamin Larras, Pierre Melsens, Julien Bois, Bruno Pereira, et al.

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1 **Effect of the COVID-19 lockdown on Physical Activity and Sedentary Behaviors in French Children**
2 **and Adolescents: new results from the ONAPS national survey**

3 Chambonniere C^{1,2}, Lambert C^{3,4}, Fearnbach N⁵, Tardieu M³, Fillon A³, Genin P³, Larras B³, Melsens P³,
4 Bois J^{3,6}, Pereira B^{3,4}, Tremblay A^{3,7}, Thivel D^{1,3}, Duclos M^{2,3,8,9}

5 ¹Clermont Auvergne University, EA 3533, Laboratory of the Metabolic Adaptations to Exercise under
6 Physiological and Pathological Conditions (AME2P), CRNH Auvergne, Clermont-Ferrand, France.

7 ²INRAE, UMR 1019, Clermont-Ferrand, France.

8 ³National Observatory for Physical Activity and Sedentary behaviors (ONAPS), Clermont-Ferrand,
9 France.

10 ⁴Clermont-Ferrand University hospital, Biostatistics unit (DRCI), Clermont-Ferrand, France.

11 ⁵Pennington Biomedical Research Center, Baton Rouge, LA, USA.

12 ⁶Universite de Pau & des Pays de l'Adour, e2s UPPA, MEPS, Tarbes, France.

13 ⁷Département de kinésiologie, G1V 0A6, Faculté de médecine, Université Laval, Quebec City. Canada.

14 ⁸University Clermont 1, UFR Medicine, Clermont-Ferrand, France.

15 ⁹Department of Sport Medicine and Functional Explorations, Clermont-Ferrand University Hospital,
16 G. Montpied Hospital, Clermont-Ferrand, France.

17
18 Email addresses, ORCID ID

19 Chambonniere C: camille.CHAMBONNIERE@uca.fr, [0000-0003-4998-6221](https://orcid.org/0000-0003-4998-6221)

20 Lambert C: clambert@chu-clermontferrand.fr, [0000-0002-6459-4800](https://orcid.org/0000-0002-6459-4800)

21 Fearnbach N: Nicole.Fearnbach@pbrc.edu, [0000-0001-9208-830X](https://orcid.org/0000-0001-9208-830X)

22 Tardieu M: m.tardieu@onaps.fr

23 Fillon A: alicia.FILLON@ext.uca.fr, [0000-0002-0614-8909](https://orcid.org/0000-0002-0614-8909)

24 Genin P: p.genin@onaps.fr, [0000-0002-4565-8143](https://orcid.org/0000-0002-4565-8143)

25 Larras B: b.larras@onaps.fr, [0000-0002-9774-1803](https://orcid.org/0000-0002-9774-1803)

26 Melsens P: p.melsens@onaps.fr

27 Bois J: julien.bois@univ-pau.fr, [0000-0003-0659-3954](https://orcid.org/0000-0003-0659-3954)

28 Pereira B: bruno.PEREIRA@ext.uca.fr

29 Tremblay A: angelo.tremblay@kin.ulaval.ca, [0000-0002-0824-0530](https://orcid.org/0000-0002-0824-0530)

30 Thivel D: david.THIVEL@uca.fr, [0000-0003-4687-3555](https://orcid.org/0000-0003-4687-3555)

31 Duclos M: mduclos@chu-clermontferrand.fr, [0000-0002-7158-386X](https://orcid.org/0000-0002-7158-386X)

32
33 **Short title:** Physical activity, Sedentary Time and Covid-19 in children

34 **Corresponding authors**

35 Camille Chambonniere (PhD student)

36 Clermont Auvergne University, EA 3533, Laboratory of the Metabolic Adaptations to Exercise under
37 Physiological and Pathological Conditions (AME2P), BP 80026, F-63171 Aubière cedex, France.

38 Email: camille.CHAMBONNIERE@uca.fr

39 Phone : 06.69.02.04.87

40

1 **Abstract:**

2 *Introduction*

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

7 *Methods*

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

13 *Results*

14 6,491 children were included in this study. Initially active children and adolescents decreased their
15 PA more than those initially inactive ($p > 0.001$), while those who met the sitting time
16 recommendations increased more their sitting time during lockdown ($p < 0.001$). The same applies to
17 screen time ($p < 0.001$). Live in urban was associated with a decrease of PA ($p < 0.001$), an increase of
18 their sitting time ($p < 0.001$) and children's screen time ($p = 0.002$) during lockdown.

19 *Conclusion*

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

23

24 **Keywords**

25 Physical activity; Sedentary behaviors; Covid-19; Children; Adolescents

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1

2 **Introduction**

3 Since early 2020, the SARS-CoV-2 virus has rapidly spread all over the world, leading governments to
4 take national measures to protect the population's health. The World Health Organization (WHO)
5 officially declared the global Covid-19 pandemic on March 11, 2020. Since the first confirmed case,
6 more than 63 million Covid-19 infections have been identified and more than 2,000,000 people have
7 died over the globe (as of February 1, 2020) [1]. In addition to the high rate of Covid-19-related
8 deaths, some collateral damages to physical and mental health during the imposed lockdown have
9 been identified, such as increased anxiety, depression, or stress [2,3].

10 In France, stage 3 was reached on March 14, 2020 (corresponding to the free circulation of the Covid-
11 19 virus on national territory), and a national lockdown was imposed 3 days later for a total of 55
12 days, in attempts to prevent the spread of the Covid-19 virus. All primary and secondary schools
13 were completely closed and all the teaching activities were conducted virtually. As a direct
14 consequence, physical activity (PA) and sedentary behaviors (SB) have been negatively affected,
15 which has been associated with impaired well-being, mental, physical, and metabolic health [4–8].

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

22 Although the majority of studies have been conducted among adults, some results are available
23 among children and adolescents. A Canadian study conducted among 1,472 parents of children and
24 youth aged 5-17 years showed that only 4.8% (2.8% girls, 6.5% boys) of children (5-11 years) and
25 0.6% (0.8% girls, 0.5% boys) of youth (12-17 years) have reached the recommendations for a healthy
26 lifestyle (24h movement guidelines) during this lockdown [10]. According to this research group,
27 having parents who encourage and are involved in PA [10,11], having a domestic animal that needs
28 to be walked [10], having an environment and neighborhood favoring PA [12] have been key
29 determinants. This survey also revealed an increase in screen time among the youngest children [10–
30 12] and determined the parents' ability to restrict screen time as the major factor associated with
31 this progression [11]. Similar results have been observed among 12-year-olds (n=113) [13] Spanish
32 youth ages 3 to 16 years (n=860) [14]; adolescents from Bosnia-Herzegovina (n=688, 15-18 years old)
33 [15], and youth from Egypt [16]. While Pombo et al. obtained similar results regarding the effect of

1 the lockdown of Portuguese children's PA level (n=2,159; mean age of 13 years), the authors also
2 found that the access to a large outdoor area, having at least one parent who did not have to work
3 from home, or sharing the house with other kids were strong positive predictors of PA during the
4 lockdown [17].

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

10

11 **Methods**

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

17 *Elaboration of the survey*

18 Different questionnaires following the same internal structure have been developed for children
19 between the age of 6 and 10 years and for adolescents (11-17 years old). The questionnaires and
20 their methodology have been adapted and inspired from the IPAQ[18] and ONAPS-Q (in progress)
21 questionnaires in adults and YRBSS (Youth Risk Behavior Surveillance System) investigation in
22 children and adolescents[19]. Briefly, the internal structure of the questionnaires have been
23 developed using the same type of questions and structure of possible answers (for instance: time
24 being active over a period of 7 days; screen time per day; etc.). Geographical, socio-demographic,
25 and health status information were first requested before properly addressing the participants'
26 behaviors in terms of PA levels, sitting time and screens time. The participants were also asked to
27 indicate whether they increased or decreased their time devoted to PA and SB compared with their
28 lockdown down habits. Concerning PA, participants are consider as initially inactive if they did not
29 engage in at least 5 hours and 30 minutes per week of moderate to vigorous PA (5 hours and 30
30 minutes being the highest range proposed in by questionnaire). Concerning SB we used the
31 recommendations thresholds like not exceed 2h/day of screen time [11]. More precisely, the
32 participants were asked to declare their (or their children's) PA and sedentary habits at the time of
33 the lockdown (when they completed the questionnaires) and retrospectively, what they were doing

1 before the lockdown. Parents of children below 10 years of age were asked to fill out the
2 questionnaires while older children and adolescents completed the questionnaire themselves. The
3 final version of these questionnaires resulted from a back-and forth consultation between the
4 members of the expert committee, until a consensus was reached.

5

6 *Launch and relaunch of the questionnaires*

7 The survey was made available online at the ONAPS website (<http://www.onaps.fr/>) on April 1st,
8 2020 (after 15 days of lockdown). Social media platforms were used to promote the survey regularly
9 until May 6th, 2020, the date at which the survey was closed. Social media (Facebook, LinkedIn for
10 example) and other networks were used for its promotion. Several types of online media were used
11 to disseminate the survey, targeting different kinds of professional, associative, demographical and
12 geographical networks and areas. In the context of the Covid-19 lockdown, particular efforts were
13 deployed to reach a large and representative sample. To do so, several types of online media were
14 used to disseminate the survey, targeting different kinds of professional, associative, demographical
15 and geographical networks and areas. On a regular basis (April 6th, 16th, 24th, 28th, May 6th (the last
16 day of the lockdown)), the operational office of the ONAPS made relaunches in order to optimize the
17 success of the questionnaires. The survey was closed 36 days after it officially started (on May 6th),
18 one week before the end of the lockdown.

19

20 *Ethical consideration*

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

23

24 *Data management*

25 The survey was administered online using the LimeSurvey software version 2.67.3. Data were
26 collected anonymously and none of the provided answers allowed any potential for participant
27 identification. Of the 22,895 properly completed questionnaires, 1,588 concerned children ages 6 to
28 10 years old and 4,903 were completed by adolescents (11-17 years old). Three indicators (physical
29 activity levels, sitting time and screen time) have been transformed into quantitative data by taking

1 the central value of each class (example: less than 30 minutes per week were encoded as 15 minutes
2 of PA per week). Originally we had chosen to propose qualitative values in order to avoid
3 inconsistent values and data entry errors. Data were then gathered into an Excel sheet before being
4 analyzed by the biostatistician team (CL, BP).

5

6

7 *Statistical considerations*

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

13

14 **Results**

15 *Description of sample*

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

19 A total of 5.1% of the children and 3.6% of the adolescents did not have access to an outdoor area
20 during the lockdown, while 10.1% of children and 7.6% of adolescents had access to a balcony only,
21 7.3% of children and 7.1% of adolescents disposed of a collective outdoor area and 77.5% of children
22 and 81.7% of adolescents lived in an accommodation with an individual backyard. Concerning the
23 housing area, 34.6% of children and 21.1% of adolescents lived in an urban area, 44.4% of children
24 and 57.4% of adolescents lived in rural areas, and 21.0% of children and 21.5% of adolescents lived in
25 a suburban area.

26

27 *Physical activity*

28 A total of 42.0% of children and 58.7% of adolescents reported decreased PA during the lockdown,
29 compared to 21.3% of children and 21.8% of adolescents maintained a similar volume of PA, and
30 36.7% of children and 19.6% of adolescents declared increased their PA. The proportion of
31 participants who increased, decreased or did not change their PAL during the lockdown was

1 significantly associated with gender in adolescents ($p < 0.001$) but not in children ($p = 0.10$). The table 1
2 presents the proportions of children and adolescents who declared increased, decreased or
3 unchanged overall level of PA depending on gender and initial level of PA.

4

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

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

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

28

29 *Sitting time*

30 Based on our results, as presented in the table 3, not exceeding sitting time recommendations
31 (<6h/day) before the lockdown was associated with the sitting time during lockdown t of both
32 children and adolescents ($p < 0.001$). Concerning children and adolescents who respected the

1 recommendations of 6h/day of sitting time before lockdown, they mainly declared an increase of
2 their sitting time during lockdown (71.7% and 72.1% respectively), while among those who exceeded
3 the 6h/day of sitting time before lockdown, only 28.5% of children and 19.9% of adolescents
4 admitted an increase of their sitting time.

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

10

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

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

20

21 *Screen time*

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

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

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

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

3 Meeting the sitting time recommendations ($< 6\text{h/day}$) before the quarantine was significantly
4 associated with the screen time during lockdown in children ($p = 0.02$) and adolescents ($p < 0.001$). A
5 higher proportion of adolescents who had a sitting time $> 6\text{h/day}$ before the lockdown declared an
6 increase of their screen time during lockdown (70.3%) compared to those who showed a sitting time
7 $< 6\text{h/day}$ before the lockdown (57.6%) ($p < 0.001$).

8 The housing area of children was significantly associated with their screen time during the
9 quarantine ($p = 0.002$), but not in adolescents ($p = 0.10$). All of them declared an increase of their
10 screen time during the lockdown but the higher proportion of children and adolescents who lived in
11 urban areas reported an increase of their time spent in front of screen (respectively 66.4% and
12 70.6%) compared 56.7% and 67.4% of those who live in the countryside respectively.

13 Access to outdoor areas was significantly associated with changes in screen time for both children
14 and adolescents ($p = 0.01$ and $p = 0.002$, respectively). Higher proportion of children and adolescents
15 who had not access to an outdoor before the lockdown admitted to increase their screen time (Table
16 4).

17

18

19 **Discussion**

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

28 In line with national and international statistics [20,21], a large proportion of the children and
29 adolescents who composed our sample were identified as inactive before the lockdown (75.0% of
30 children and 59.3% of adolescents). Considering the strong associations between health and healthy
31 movement behaviors [22,23], the situation was already alarming in youth before the institution of

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

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

27 Although our results show that 22% of children and 27.9% of adolescents admitted to increase
28 their sitting time during the French lockdown, they also underline an alarming increase in screen
29 time among 62% and 68.9% of children and adolescents, respectively. This finding is in line with
30 previously published results from other counties showing an increase of the time exposed to screens
31 [10–14], which is at least partly attributable to the immediate transition to home-based virtual
32 schooling. This was true among Chinese youth, with an increase in screen time of more than 4 hours
33 per day reported during the lockdown [25]. Moreover, Pietrobelli and colleagues underlined that
34 while 60.3% of the Italian children and adolescents already exceed the screen time

1 recommendations, 68.9% of adolescents with obesity increased screen time during the first Covid-
2 19-related lockdown [26]. As for PA, our results also underline that this increased sitting and screen
3 time affects children and adolescents independently of previously meeting recommendations for
4 time spent in SB. Interestingly, sitting and screen time were also similarly increased regardless of
5 initial PA levels. As already noted for PAL, our results reinforce the important role of the living
6 conditions on both sitting and screen time during the lockdown, with children from urban areas most
7 affected. Similarly, higher proportions of both children and adolescents who had no or limited access
8 to outdoor areas reported an increase in sitting and screen time.

9 As most of the surveys were conducted during the lockdown period, the online and self-reported
10 nature of the collected data and the use of subjective self-reported questionnaires are the main
11 limitations of the current study. The questionnaire was submitted online, which may have limited
12 access for poorer and migrant sectors of the population without internet access. However,
13 conducting and analysing the data for a large-scale national survey can be logistically challenging, and
14 conducting it online makes it feasible. Another limitation lies in the categorization of PAL and SB that
15 do not showed changes in levels within a category, a child may have increased or decreased his PAL
16 or SB without changing categories and therefore without this being apparent. The large number of
17 participants who completed this French national survey however, should be considered as a strength
18 of this work, with more than 6400 children and adolescents, making this survey one of the largest
19 samples worldwide. Importantly, while previous questionnaires addressing healthy behaviors might
20 attract people who are interested in and concerned by such behaviors. The proportion of youth
21 determined as inactive or did not meet the sedentary guidelines prior to the Covid-19 pandemic
22 indicates that our sample might be slightly different of the general French population concerning PA
23 in children (25% of active against 67% in the ESTEBAN survey), while closer among adolescents (40%
24 vs. 30%)[27] and widely different concerning screen time in children, (25% who do not exceed 2h/day
25 against 55% do not exceed 3h/day in ESTEBAN survey) and adolescent (41% against 74%)[27]. These
26 differences can be explained by the threshold used to identify participants as active or inactive
27 (5h30min per week of PA in the present work against 7h/week for the general recommendations),
28 the evolution of screen time recommendations (2h/day and 3h/day) and the retrospective nature of
29 the data collected. The threshold used for PA (5h30min /week) is one of the main limitation of the
30 present work that is due to the internal construction of the survey, and that must be considered
31 when interpreting our results. Concerning living conditions, large differences were observed
32 between the proportion of children and adolescents who lived in urban areas (34.6% against 21.1%)
33 and rural areas (44.4% against 57.4% of adolescents), which can be explained by the different
34 number of respondents (1586 children and 4895 adolescents). The lack of information regarding the

1 geographical situation of the participants, and the lack of anthropometric information, also compose
2 some limitations of the present analysis. Finally, the retrospective nature of the estimation of the
3 participants' physical activity level and sedentary time before the lockdown composes another
4 important limitation of the present analysis that must be considered.

5 **Conclusion**

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

15 16 **Authors' contribution**

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18 **Camille Chambonniere:** Formal analysis, Project administration, Writing - original draft.: **Celine**
19 **Lambert:** Data curation, Formal analysis, Methodology, Writing - original draft.: **Nicole Fearnbach:**
20 Writing - original draft.: **Michele Tardieu :** Conceptualization, Funding acquisition, Investigation,
21 Project administration, Writing - review & editing.: **Alicia Fillon:** Data curation, Methodology, Project
22 administration, Writing - review & editing.: **Pauline Genin:** Data curation, Formal analysis,
23 Methodology, Project administration, Writing - original draft.: **Benjamin Larras:** Data curation,
24 Project administration, Writing - review & editing.: **Pierre Melsens:** Data curation, Resources.: **Julien**
25 **Bois:** Funding acquisition, Resources.: **Bruno Pereira:** Conceptualization, Formal analysis,
26 Methodology, Resources.: **Angelo Tremblay:** Funding acquisition, Resources, Writing - review &
27 editing.: **David Thivel:** Formal analysis, Investigation, Resources, Writing - original draft.: **Martine**
28 **Duclos:** Conceptualization, Funding acquisition, Investigation, Writing - original draft.

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2 The authors have no conflict of interest to disclose.

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4
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7
8 **Data availability**

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

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