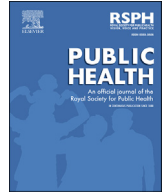




Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Original Research

Correlates of children's physical activity during the COVID-19 confinement in Portugal

A. Pombo ^{a, b, *}, C. Luz ^b, L.P. Rodrigues ^{c, d}, C. Ferreira ^{a, f}, R. Cordovil ^{a, e}^a Faculdade de Motricidade Humana, Universidade de Lisboa, Cruz-Quebrada, 1499-002, Portugal^b Escola Superior Desporto e Lazer de Melgaço, Instituto Politécnico de Viana do Castelo, 4900-347, Portugal^c Escola Superior Desporto e Lazer de Melgaço, Instituto Politécnico de Viana do Castelo, Melgaço, 4960-320, Portugal^d Research Center in Sports Sciences Health Sciences and Human Development, CIDESD, Portugal^e CIPER, Faculdade de Motricidade Humana, Universidade de Lisboa, Cruz-Quebrada, 1499-002, Portugal^f UIDEF, Instituto de Educação, Universidade de Lisboa, 1649-013, Lisboa, Portugal

ARTICLE INFO

Article history:

Received 1 July 2020

Received in revised form

22 August 2020

Accepted 11 September 2020

Available online 22 September 2020

Keywords:

COVID-19

Physical activity

Confinement routines

Working from home

Children

ABSTRACT

Objectives: The aim of the study was to understand the role of household variables on the percentage of physical activity (%PA) during the coronavirus disease 2019 (COVID-19) confinement in Portugal.

Study design: A cross-sectional study design using an anonymous online survey was launched to assess how Portuguese families with children aged younger than 13 years adjusted their daily routines to the confinement.

Methods: Separate analyses of variance were performed to investigate how factors such as the number of children, age, sex, the housing characteristics, and the adults' job situation can affect the percentage of time for PA (%PA).

Results: Findings, based on data from 2159 children, indicate that (1) boys and girls did not differ in the %PA on any of the age-groups; (2) children with an outdoor space and who had other children in the household were significantly more active ($P < .001$); (3) children from families with all adults working from home showed lower levels of %PA; and (4) being younger, having a big outdoor space, having other children in the household, and having at least one adult free from working from home were significant positive predictors of children's %PA, explaining 21% of the overall variance.

Conclusion: Time allocated for PA during this period is reduced compared with what is usually reported on normal days. It is necessary to find strategies to increase children's PA, especially in families in which both parents are working and have no outdoor space.

© 2020 The Royal Society for Public Health. Published by Elsevier Ltd. All rights reserved.

Introduction

In Late December 2019, a series of unexplained cases of pneumonia were reported in the city of Wuhan, China.¹ On January 30, 2020, the World Health Organization (WHO) classified this epidemic as a public health emergency of international interest,^{2,3} and on February 11, the WHO classified the disease as coronavirus disease 2019 (COVID-19). On that same day, the Coronavirus Study Group of the International Committee on Taxonomy of Viruses named it severe acute respiratory syndrome coronavirus 2.⁴

As it continued to spread, on May 27, 2020, it had reached 188 countries, with 5,604,461 cases confirmed, of which 350,752 resulted in death. In Portugal, on this same date, 31,007 cases were registered, 1342 of which resulted in death.⁵ In the absence of effective treatments for this pandemic situation, the best way to control the sources of infection was enforcing social isolation and confinement.⁴ Therefore, in almost all countries, governments declared the 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. Portugal followed this same pattern, as schools, companies, and non-essential public services across the country were closed on March 16, and the state of emergency was declared two days later, on March 18. In addition, the Portuguese government decided that children would have to

* Corresponding author. Escola Superior de Educação de Lisboa, Instituto Politécnico de Lisboa, Campus de Benfica, 1549-003 Lisboa, Portugal.

E-mail address: apombo@esex.ipl.pt (A. Pombo).

undergo stay-at-home schooling until the end of the school year, starting what it seemed to be a long period of movement restriction, without any organized physical activity (PA) or free play time outdoors. Knowing that during long periods without school, children are more susceptible to unhealthy behaviors, such as excessive sedentary behaviors^{6,7} with a negative impact on children's motor competence,⁸ as well on their body composition and cardiovascular fitness,⁹ we aimed to understand how children's daily routines were established during confinement times.

For that, and at the exact same week when the Portuguese state of emergency was instated, we started an online survey for home-confined families with children up to 13 years of age, to understand not only the routines that were being established during confinement times but also specifically what, and how much, physical activities children were doing at home. Following the international PA and public health research agenda to inform COVID-19 policies and practices,¹⁰ we created a survey to examine the behaviors of time expenditure by the Portuguese children. The first results showed that children in confinement present high values of sedentary time and playful screen time (without school-related screen time) and low values of PA time,¹¹ in line with the pattern found in Canada¹² and in Italy.¹³ Despite these results, nothing is known on which variables have an impact on children's PA. Thus, in the present study, we intend to investigate if a differential effect of the COVID-19 confinement was felt based on the conditions children live in. Children's families have their own unique characteristics, such as the size of the household,^{14,15} children's age, the presence of siblings in the house,^{16,17} whether or not parents are working at home,¹⁸ the type of house, and whether or not they have their own outdoor space.^{7,19,20} It is expected that some of these variables may affect children's PA. For instance, the amount of home space,^{18,28} the lack of a yard space at home,^{7,19} and being an only child or not¹⁶ can have an impact on children's PA. The parents who perceive PA as important for their children will probably create more opportunities for children's PA at home,²⁹ if they have the time for it.

Knowing which variables are more related to PA is fundamental to better understand this phenomenon and can be helpful to create strategies, as well to prevent future unhealthy behaviors in similar situations of prolonged confinement.

We hypothesized that older and only children, who live in houses with no outdoor space and who have parents working from home, are being particularly affected by the confinement situation, presenting lower levels of PA time than their peers.

Methods

Survey

To assess how children younger than 13 years of age are dealing with the COVID-19 confinement situation, we created a survey on LimeSurvey, hosted on the Faculty of Human Kinetics, University of Lisbon. After a first validation of the questions by a group of five child development experts and a first pilot testing with 23 families, the survey was launched online on March 23, 2020, and publicized through the social media (Facebook, Instagram, WhatsApp) and by e-mail. The survey takes approximately 5 min to complete, it should be completed by the parent/adult responsible for the child(ren), and it comprises four sections:

1. Household: Questions regarding the composition of the household, the number of children and adults who are at home, and how many adults are working from home.
2. Housing characteristics: Type and characteristics of the house (e.g., apartment or detached house; number of rooms) and

existence or not of indoor space for PA (gym or exercise room) and of outdoor space (no outdoor space, small outdoor space—up to 12 m², large outdoor space—more than 12 m²).

3. Household routines: Questions about the level of concern with regard to the situation of COVID-19 and the way routines are being adjusted (i.e., comparison between time spent in different activities before and after confinement).
4. Children's routines: Questions related to the characterization of each child (age, sex, PA before confinement, health status) and the time (reported in minutes) spent in different activities during the previous day.

Variables

Five categories of activities were analyzed:

- a) Intellectual activity (school assignments and online classes)
- b) Playful screen time (games, movies, social networks, Internet, audio and video calls); c) play without PA (reading, drawing, painting, board games, cards, Legos, and so on)
- d) Play with PA (hide and seek, jumping, tag, and so on)
- e) PA (organized PA indoors, PA outdoors, walk the dog)

The first three categories (intellectual activity, playful screen time, and play without PA) were added to calculate overall sedentary time, and the last two categories (play with PA and PA) were added to calculate overall PA time. This value was then converted into a percentage of the total time reported for all categories of the children, from now on called percentage of PA (%PA).

Factors associated with the child (i.e., sex and number of children in the household), the housing characteristics (i.e., existence and dimension of outdoor space), and the adults' job situation (i.e., all adults having to work from home or not) were used to analyze which would influence the %PA.

Participants

The initial data of this survey included 3075 responses given by parents with regard to their children aged younger than 13 years, who were in the household during the second week and beginning of the third week of confinement (between March 23 and April 1, 2020). The inclusion criteria were to have at least one child younger than 13 years and to be spending the confinement period in Portugal. All participants read the information about the study and agreed with the conditions by clicking to proceed on the first page of the survey. Participants could withdraw at any given time by not proceeding or submitting the survey. After cleaning the database for second-time responses ($n = 119$ children) and for missing or obviously wrong information (e.g., more than 24 h reported in a day or no sleep time reported for children; $n = 797$), data regarding 2159 children younger than 13 years (1117 boys and 1042 girls), subdivided into four age-groups (0–2 years: 462; 3–5 years: 765; 6–9 years: 606; and 10–12 years: 326), were used in this study.

Statistical analysis

Descriptive statistics and frequency analysis were used for the initial characterization of the 2159 children divided by age-groups, their household conditions, and housing characteristics.

An a priori power analysis was conducted using G*Power3 (Faul, Erdfelder, Lang, & Buchner, 2007)³⁰ to test the difference between four independent group means using a two-tailed test, a medium effect size ($d = .50$), and an alpha of .05. The result showed that a sample of 74 participants was required to achieve a power of .80.

Separate analyses of variance (ANOVAs) were performed to investigate how different factors associated with the child (i.e., sex and number of children in the household), the housing characteristics (i.e., existence and dimension of outdoor space), and the adults' job situation (i.e., all adults having to work from home or not) affected the %PA by age-group. Age-groups were considered as follows: group 1 = 0–2 years, n = 462; group 2 = 3–5 years, n = 765; group 3 = 6–9 years, n = 606; and group 4 = 10–12 years, n = 326. Finally, a forward stepwise regression (*P* to enter <.05, *P* to remove >.10) was performed to investigate the best predictors for the %PA performed by children. Age of the child and the variables previously investigated in the ANOVAs were entered into the model. Qualitative variables (sex, outdoor spaces, and work from home) were transformed into dummy variables before entering the regression. A pairwise deletion method was used in the regression to accommodate for missing values. SPSS for Mac (version 25) was used for analyses.

Results

Descriptive data regarding the factors associated with the children (age-group, gender, health status, and number of children at home), the housing characteristics (type of house and availability of outdoor space), and the adults' job situation (working status of the adults) are presented in Table 1.

When analyzing the %PA by age-group (Table 2), we found that the youngest age-group (0–2 years) presented the highest values of %PA, followed by the 3–5, 6–9, and 10–12 age-groups. In addition, four ANOVAs testing for differences on daily PA based on sex, space, number of children in the house, and whether or not parents are working from home revealed significant main effects for all tested factors (all *P*'s < .002), except for sex (*P* = .068), and no interaction effects (see Table 2 and Fig. 1).

Boys and girls did not differ in the %PA in any of the age-groups. Furthermore, the PA average time for both sexes was about 2 h (2.2 h and 2.3 h, respectively, for girls and boys; data not shown).

Considering the typology of house space, we found that having a big outdoor space plays an important role, positively influencing PA

mainly between 3–9 years of age (compared with all other typologies, *P* < .001). This influence can also be seen in the younger age-group because having a big outdoor space is significantly different than having no outdoor space (*P* < .001). No differences were found between the three typologies of outdoor space for the older age-groups.

When analyzing the number on children in the household, we can see that being an only child is a disadvantage with regard to the %PA. Higher values of %PA were found when more children were present in the household, and it was true for all groups of ages (*P*'s < .001 in the first 3 age-groups), except in the older age-groups, in which no significant differences were found. In addition, children from families who had all the adults working from home showed lower levels of %PA.

A linear regression analysis (Table 3) showed that age, typology of spaces, number of children in the household, and all adults working from home were significant predictors of children's %PA, explaining 21% of the overall variance.

When looking for the predicting effect of each independent variable, we can see that age was the strongest predictor, suggesting a decrease of 2.1% in %PA for each year of age. In addition, having a big outdoor space presented the second highest predicting effect, with an increase of 9.2% in %PA.

The number of children in the household and having all adults working from home presented the smallest predicting values. In addition, it further verified an increase of 3.1% in the %PA per child and a decrease of 3.8% if all adults were working from home in the %PA.

Discussion

Our aim was to understand the role of household variables on the %PA in this confinement situation. The results showed that being younger was the strongest predictor for %PA, followed by having a big outdoor space, having more children in the household, and not having all adults working from home. The effect of the different variables on children's %PA is discussed in the next topics.

Children's sex

Normal activities such as walking to school, engaging in physical education classes, playing in recess, going to sport clubs, and so on were totally forbidden in this confinement situation. Owing to this and although it was expected that %PA would decrease along the growing age-groups, given the knowledge we have on PA behavior of children,²³ the findings that boys and girls present no differences on this decreasing trend is somehow new and not fully anticipated.^{15–17}

We know that boys use more play areas and equipment, and they tend to display higher levels of moderate to vigorous PA while using them²⁴ and seem to be more physically intense on the exploration of playground features, whereas girls experience a higher enjoyment for activities such as playing tag games, walking, creative tasks, climbing, sliding, hiding, sitting, and relaxing.²⁵ The same tendency occurs in organized sport participation during childhood, with boys engaging more often in organized and high physically intense sports than girls.²² In our results, girls and boys showed equal participation in organized physical activities before confinement (66% and 67% reported, respectively, for girls and boys); in addition, the fact that they are all 'in the same boat,' without access to the kind of space, equipment, or social organization that usually afford sex-biased movement differences in the normal day time, can help to explain why both sexes showed similar PA behavior along the age-groups. Furthermore, the non-existence of sex differences in PA might be related to the fact that

Table 1
Descriptive data of the sample with regard to the factors associated with the children, the housing characteristics, and the adults' job situation.

Children's Factors	Frequency (%)
Children's age-group	
0–2 years	21.4
3–5 years	35.5
6–9 years	28.1
10–12 years	15.0
Children's gender	
Boys	51.7
Girls	48.3
Children's health status	
Healthy at the moment	99.3
Not healthy at the moment	.7
Number of children at home	
Only child	36.7
2–5 children at home	63.3
Type of house	
Apartment	60.3
House	39.7
Availability of outdoor space	
No outdoor space	26.4
Small outdoor space (<12 m ²)	37.6
Large outdoor space (>12 m ²)	36.0
Adults' job situation	
All adults working from home	33.7
At least one free adult	66.3

Table 2
Descriptive statistics and ANOVA results with regard to the effect of sex, available outdoor space, number of children, and adults working from home on children's daily percentage of physical activity (%) reported by parents.

Variables	Variables	Daily physical activity (%)				Two-way ANOVA
		Age-groups				
		0–2 years	3–5 years	6–9 years	10–12 years	
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Sex	Boys	38.80 ± 26.15	29.35 ± 16.82	22.19 ± 15.14	16.42 ± 13.39	Fage (3, 2085) = 97.798, <i>P</i> < .001 Fsex (1,2085) = 3.449, <i>P</i> = .063 Fage × sex (3, 2085) = .884, <i>P</i> = .449
	Girls	36.23 ± 27.62	26.31 ± 15.53	21.80 ± 14.31	16.22 ± 13.88	
Available outdoor space	No outdoor space	32.38 ± 26.88	21.61 ± 14.48	15.96 ± 12.24	11.69 ± 10.85	Fage (3, 2089) = 107.917, <i>P</i> < .001 Fspace (2,2089) = 69.275, <i>P</i> < .001 Fage × space (6, 2085) = 1.385, <i>P</i> = .217
	Small outdoor space	36.22 ± 27.06	25.35 ± 14.32	18.69 ± 12.69	16.25 ± 13.45	
	Big outdoor space	43.19 ± 25.70	35.34 ± 14.31	28.95 ± 15.27	19.90 ± 14.60	
Number of children	Only child	31.71 ± 22.48	24.86 ± 15.17	18.90 ± 13.91	13.46 ± 10.82	Fage (3, 2093) = 88.446, <i>P</i> < .001 Fchildren (1,2093) = 46.330, <i>P</i> < .001 Fage × children (3, 2093) = 1.474, <i>P</i> = .220
	2–5 children	40.83 ± 28.62	29.98 ± 16.65	23.69 ± 14.93	17.76 ± 14.62	
Adults working from home	All adults	33.18 ± 27.92	25.98 ± 15.53	20.77 ± 12.72	10.84 ± 10.25	Fage (3, 569) = 21.520, <i>P</i> < .001 Fwork (1,569) = 9.755, <i>P</i> = .002 Fage × work (3, 569) = .393, <i>P</i> = .758
	At least one free adult	38.85 ± 27.68	29.34 ± 17.86	25.02 ± 15.09	18.98 ± 13.07	

SD = standard deviation; ANOVA = analysis of variance.

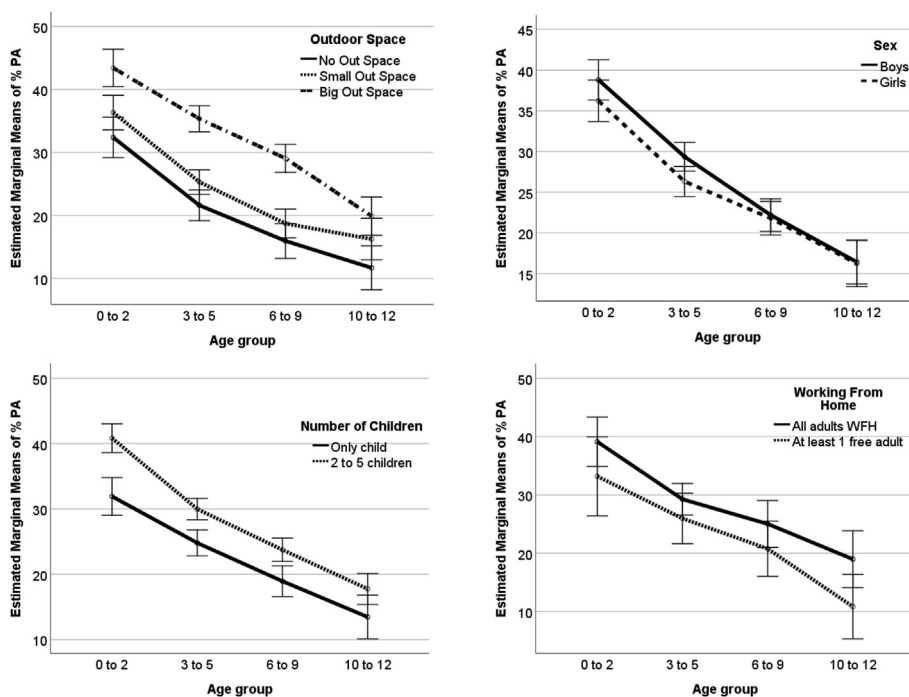


Fig. 1. Descriptive statistics and ANOVA results with regard to the effect of sex, available outdoor space, number of children, and adults working from home on children's daily percentage of physical activity (%) reported by parents. ANOVA = analysis of variance; %PA = percentage of physical activity.

the majority of activities reported during confinement are probably of light intensity, which is usually not significantly different between boys and girls.^{26,27}

Living conditions

Although the government's decision was the same for all people, it is wrong to think that this decision affects all equally. Most of the children in our study live in apartments (60.2%), and we found that having an outdoor space influences the %PA positively. The home environment is an important influence on the PA and sedentary behavior of children, being especially relevant for those who have limited independent mobility and spend much of their time at home and indoors.^{14,15} Although our results indicate that having a

small outdoor space at home (up to 12 m²) did not make a difference, having a larger space positively impacted the %PA. These results are in line with other studies that mention that the amount or lack of outdoor space can have a great impact on children's PA.^{7,18–20} Some studies showed that as the amount of home space increased, children's PA increased,^{18,28} and the lack of a yard space at home was identified as a barrier to PA and active play of children.^{7,19} Yard features were positively associated with the minutes per day preschoolers spent in home-based outdoor play.²⁹ We believe that the results are in accordance with the knowledge that both boys and girls of lower socio-economic status areas have decreased odds of spending more than 2 h outdoors on weekends³¹ and lower levels of fitness and activity compared with their peers from higher socio-economic status areas.^{32–34}

Table 3
Summary of linear regression analysis for factors predicting %PA.

Predictors	β	Beta	T	P-value	F	R ²
					38.230***	.21
Age	−2.057	−.357	−9.517	<.001		
Big outdoor space	9.191	.229	6.130	<.001		
Number of children	3.091	.114	3.062	.002		
All adults working from home	−3.703	−.091	−2.421	.016		

%PA = percentage of physical activity, *** represents the $p < 0,001$.

Siblings

Having siblings in the house can also affect the %PA. Only children have significantly lower levels of moderate to vigorous PA¹⁶ and are more prone to have higher sedentary time¹⁷ than children with siblings. It seems that PA of younger siblings benefits from the presence of their older siblings during summer (non-school) time.^{35,36} In fact, a recent systematic review and meta-analysis³⁷ found a significantly higher likelihood of being overweight and obese in only children. This lack of peer modeling and company in the confined house certainly helps to understand that only children had a negative effect on the time spent on PA, independently of gender and age.

Parents working from home

Parents have an important role in supporting or restricting children's sedentary behaviors. If they perceive PA as important for their children, they will probably create more opportunities for children's PA at home²⁹ and will organize more active family activities.³⁸

Having all adults in the household working from home can surely be a stressful situation for a home-confined family, and this has been related to an increase in depressive symptoms among working women with young children.³⁹ The number of tasks that parents have to undertake at this time is immense, they have work tasks, house tasks, children's school tasks, meal-related tasks, and so on, as well as all this while trying to give emotional support to their kids and family. This can be a challenge for promoting PA as fatigue is reported as a health barrier to be active with their children.⁴⁰ Furthermore, with no parent free to engage in interaction with children and the need for a quiet work environment at home, surely those children's movement and noise inside the house are heavily censured.

Limitations of the study

Although this study provides important information with regard to the role of several variables on the %PA during this confinement situation, it is important to highlight that it has some limitations. First, it is a cross-sectional study design and thus susceptible to biases. Second, it is a parental report online and not a direct or quantifiable observation of children's time. Quantitative information about the intensity levels of PA was not gathered in the present study. Although apparatuses such as Fitbit and similar ones can be used for addressing PA in the adult population,²¹ it is unusual to have these types of gadgets used by children, and in the wake of the sudden situation, it was not possible to distribute such apparatuses to families. Regardless, in our results, the value found in the PA average time for both sexes is less than half of the total time of PA reported by accelerometry for Portuguese children (5.0 h for boys and 4.5 h for girls).²² We believe that these methodological options (i.e., the cross-sectional study based on parental reports) were necessary considering the confinement situation. Finally, despite

the good response rate, we cannot consider this survey to be representative of Portugal because it is not possible to assure that the coverage area was the entire country.

Conclusion

This study was the first to reveal the differential effect of the COVID-19 confinement in Portugal based on the conditions in which children live. Our findings showed that, although confined to their house, boys and girls still allocate some time to PA tasks (movement play and physical exercise). The daily %PA reduces with age, but boys and girls showed no differences unlike what is usually reported for normal days. For children of both sexes and of all ages, the %PA was shown to be positively affected by the existence of a big outdoor space in the house and by the presence of other children in the house. On the opposite side, a negative effect was found when all adults were working from home, probably because of the relative lack of attention to children and the need for a quiet home environment.

These results are of utmost importance for parents and policymakers. Nobody can change the size of his/her house or add an outdoor area instantaneously, but governments can regulate about both parents working from home when there are children confined with them. Parents must be aware of the need to prioritize PA time for their children because they are not getting the usual stimulation during this period. This effort should be even greater for parents of older children with no outdoor space available, especially because this can constitute a double burden situation when the family already presents a socio-economic profile at risk. Furthermore, in the postconfinement stage, additional efforts will be required to offer PA and outdoor play opportunities for children who were most affected by the COVID-19 pandemic response.

Author statements

Ethical approval

The survey was approved by the Faculty of Human Kinetics Ethics Committee.

Funding

Two of the authors were partly supported by the Portuguese Foundation for Science and Technology, under Grantgrant UIDB/00447/2020 to CIPER - Centro Interdisciplinar para o Estudo da Performance Humana (unit 447) and under project UID04045/2020.

Competing interests

None declared.

Acknowledgments

All the authors participated in the conceptualization of the study, the design, coordination and completion of data collections and drafting of the manuscript. All authors have read and approved the final version of the manuscript and agree with the order of presentation of the authors.

References

- Tang X, Wu C, Li X, et al. On the origin and continuing evolution of SARS-CoV-2. *Natl Sci Rev* 2020. <https://doi.org/10.1093/nsr/nwaa036>.
- Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med* 2020;**382**(8):727–33. <https://doi.org/10.1056/NEJMoa2001017>.
- Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020;**395**(10223):497–506. [https://doi.org/10.1016/S0140-6736\(20\)30183-5](https://doi.org/10.1016/S0140-6736(20)30183-5).
- Sun P, Lu X, Xu C, Sun W, Pan B. Understanding of COVID-19 based on current evidence. *J Med Virol* 2020. <https://doi.org/10.1002/jmv.25722>.
- Coronatracker. *Corona tracker*. Published, <https://www.coronatracker.com/analytics/>; 2020.
- Carrel AL, Clark RR, Peterson S, Eickhoff J, Allen DB. School-based fitness changes are lost during the summer vacation. *Arch Pediatr Adolesc Med* 2007. <https://doi.org/10.1001/archpedi.161.6.561>.
- Hesketh KR, Lakshman R, van Sluijs EMF. Barriers and facilitators to young children's physical activity and sedentary behaviour: a systematic review and synthesis of qualitative literature. *Obes Rev* 2017;**18**(9):987–1017. <https://doi.org/10.1111/obr.12562>.
- Vandorpe B, Vandendriessche J, Lefevre J, et al. The KörperkoordinationsTest für Kinder: reference values and suitability for 6-12-year-old children in Flanders. *Scand J Med Sci Sports* 2011;**21**(3):378–88. <https://doi.org/10.1111/j.1600-0838.2009.01067.x>.
- Tomkinson GR, Olds TS. Secular changes in aerobic fitness test performance of Australasian children. *Med Sport Sci* 2007;**50**:168–82. <https://doi.org/10.1159/0000101361>.
- Sallis JF, Adlakha D, Oyeyemi A, Salvo D. An international physical activity and public health research agenda to inform COVID-19 policies and practices. *J Sport Heal Sci* 2020. <https://doi.org/10.1016/j.jshs.2020.05.005>.
- Pombo A, Luz C, Paulo Rodrigues L. *COVID-19 confinement in Portugal: effects on the household routines of children under 13*. 2020. <https://doi.org/10.21203/rs.3.rs-45764/v1>.
- Moore SA, Faulkner G, Rhodes RE, et al. Impact of the COVID-19 virus outbreak on movement and play behaviours of Canadian children and youth: a national survey. *Int J Behav Nutr Phys Activ* 2020;**17**(1). <https://doi.org/10.1186/s12966-020-00987-8>. 85–85.
- Pietrobelli A, Pecoraro L, Ferruzzi A, et al. Effects of COVID-19 lockdown on lifestyle behaviors in children with obesity living in Verona, Italy: a longitudinal study. *Obesity* 2020;**28**(8):1382–5. <https://doi.org/10.1002/oby.22861>.
- Carver A, Timperio A, Crawford D. Playing it safe: the influence of neighbourhood safety on children's physical activity-A review. *Health Place* 2008;**14**: 217–27. <https://doi.org/10.1016/j.healthplace.2007.06.004>.
- Karsten L. It all used to be better? different generations on continuity and change in urban children's daily use of space. *Child Geogr* 2005;**(3)**:275–90. <https://doi.org/10.1080/14733280500352912>.
- Kracht CL, Sisson SB, Guseman EH, et al. Difference in objectively measured physical activity and obesity in children with and without siblings. *Pediatr Exerc Sci* 2019. <https://doi.org/10.1123/pes.2018-0184>.
- Atkin A, van Sluijs E, Corder K, Ekelund U, Wijndaele K, Griffin S. Determinants of change in children's objectively measured sedentary time. *J Sci Med Sport* 2012;**8**(6). <https://doi.org/10.1016/j.jsams.2012.11.017>. e6762.
- Neshteruk CD, Mazzucca S, Østbye T, Ward DS. The physical environment in family childcare homes and children's physical activity. *Child Care Health Dev* 2018;**44**(5):746–52. <https://doi.org/10.1111/cch.12578>.
- Veitch J, Bagley S, Ball K, Salmon J. *Where do children usually play? A qualitative study of parents' perceptions of influences on children's active free-play*. Health Place; 2006. <https://doi.org/10.1016/j.healthplace.2005.02.009>.
- Spurrier NJ, Magarey AA, Golley R, Curnow F, Sawyer MG. Relationships between the home environment and physical activity and dietary patterns of preschool children: a cross-sectional study. *Int J Behav Nutr Phys Activ* 2008;**5**(31). <https://doi.org/10.1186/1479-5868-5-31>.
- Fitbit, Inc. *The impact of coronavirus on global activity* (Online). 2020. Published, <https://blog.fitbit.com/covid-19-global-activity/>. [Accessed 9 June 2020].
- Marques A, Ekelund U, Sardinha LB. Associations between organized sports participation and objectively measured physical activity, sedentary time and weight status in youth. *J Sci Med Sport* 2016. <https://doi.org/10.1016/j.jsams.2015.02.007>.
- Chong KH, Parrish AM, Cliff DP, Kemp BJ, Zhang Z, Okely AD. Changes in physical activity, sedentary behaviour and sleep across the transition from primary to secondary school: a systematic review. *J Sci Med Sport* 2019;**23**(5): 498–505. <https://doi.org/10.1016/j.jsams.2019.12.002>.
- Anthamatten P, Brink L, Kingston B, Kutchnan E, Lampe S, Nigg C. An assessment of schoolyard features and behavior patterns in children's utilization and physical activity. *J Phys Activ Health* 2014;**11**:564–73. <https://doi.org/10.1123/jpah.2012-0064>.
- Hyndman B, Chancellor B. Engaging children in activities beyond the classroom walls: a social-ecological exploration of Australian primary school children's enjoyment of school play activities. *J Play Pract* 2015. <https://doi.org/10.1332/205316215x14454218579212>.
- Júdice PB, Silva AM, Berria J, Petroski EL, Ekelund U, Sardinha LB. Sedentary patterns, physical activity and health-related physical fitness in youth: a cross-sectional study. *Int J Behav Nutr Phys Activ* 2017. <https://doi.org/10.1186/s12966-017-0481-3>.
- Baptista F, Silva AM, Santos DA, Mota J, Santos R, Vale S, et al. *Livro Verde Da Actividade Física*. 2011.
- Gunter KB, Rice KR, Ward DS, Trost SG. Factors associated with physical activity in children attending family child care homes. *Prev Med* 2012. <https://doi.org/10.1016/j.jpmed.2011.12.002> (Baltim).
- Armstrong GP, Maitland C, Lester L, et al. Associations between the home yard and preschoolers' outdoor play and physical activity. *Public Heal Res Pract* 2019. <https://doi.org/10.17061/phrp2911907>.
- Faul F, Erdfelder E, Lang AG, Buchner A. *G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences*. *Behavior Research Methods* 2007;**39**(2):175–91.
- Delisle Nyström C, Barnes JD, Blanchette S, et al. Relationships between area-level socioeconomic status and urbanization with active transportation, independent mobility, outdoor time, and physical activity among Canadian children. *BMC Publ Health* 2019. <https://doi.org/10.1186/s12889-019-7420-y>.
- Bowser J, Martinez-Donate AP, Carrel A, Allen DB, Paul Moberg D. Disparities in fitness and physical activity among children. *Wis Med J* 2016;**115**(5):245–50. <https://pubmed.ncbi.nlm.nih.gov/29095586/>. [Accessed 9 June 2020].
- Stalsberg R, Pedersen AV. Effects of socioeconomic status on the physical activity in adolescents: a systematic review of the evidence. *Scand J Med Sci Sports* 2010. <https://doi.org/10.1111/j.1600-0838.2009.01047.x>.
- Fahlman MM, Hall HL, Lock R. Ethnic and socioeconomic comparisons of fitness, activity levels, and barriers to exercise in high school females. *J Sch Health* 2006. <https://doi.org/10.1111/j.1746-1561.2006.00061.x>.
- Ylitalo KR, Bridges CN, Gutierrez M, Sharkey JR, Meyer MRU. Sibship, physical activity, and sedentary behavior: a longitudinal, observational study among Mexican-heritage sibling dyads. *BMC Publ Health* 2019. <https://doi.org/10.1186/s12889-019-6521-y>.
- Stanley RM, Boshoff K, Dollman J. Voices in the playground: a qualitative exploration of the barriers and facilitators of lunchtime play. *J Sci Med Sport* 2012. <https://doi.org/10.1016/j.jsams.2011.08.002>.
- Meller FO, de Mola CL, Assunção MCF, Schäfer AA, Dahly DL, Barros FC. Birth order and number of siblings and their association with overweight and obesity: a systematic review and meta-analysis. *Nutr Rev* 2018;**76**(2):117–24. <https://doi.org/10.1093/nutrit/nux060>.
- Rhodes RE, Spence JC, Berry T, et al. Predicting changes across 12 Months in three types of parental support behaviors and mothers' perceptions of child physical activity. *Ann Behav Med* 2015. <https://doi.org/10.1007/s12160-015-9721-4>.
- Shepherd-Banigan M, Bell JF, Basu A, Booth-LaForce C, Harris JR. Workplace stress and working from home influence depressive symptoms among employed women with young children. *Int J Behav Med* 2016;**23**(1):102–11. <https://doi.org/10.1007/s12529-015-9482-2>.
- Rhodes RE, Lim C. Promoting parent and child physical activity together: elicitation of potential intervention targets and preferences. *Health Educ Behav* 2018;**45**(1):112–23. <https://doi.org/10.1177/1090198117704266>.