Available online: http://journal.ipb.ac.id/index.php/jgizipangan
ISSN 1978-1059 EISSN 2407-0920
J. Gizi Pangan, November 2022, 17(3):139-148
DOI: https://doi.org/10.25182/jgp.2022.17.3.139-148

Systematic Review Article

Effects of COVID-19 Pandemic on Changes in Nutritional Status and Physical Activities of School-Age Children: A Scoping Review

Fajar Ari Nugroho[1*], Annisa Nafilata Ruchaina[2], Angga Galih Luhur Wicaksono[2]
[1]Department of Nutrition, Faculty of Health Sciences, Universitas Brawijaya, Malang 65145, Indonesia
[2]Dietitian Professional Study Program, Department of Nutrition, Faculty of Health Sciences, Universitas Brawijaya, Malang 65145, Indonesia

Article History:
Received *08-06-2022*
Revised *07-08-2022*
Accepted *07-09-2022*
Published *30-11-2022*

Keywords:
COVID-19, nutritional status, physical activities, school-age children, sedentary lifestyle

***Corresponding Author:**
tel: +6281330736005
email: fajar_arinugroho.fk@ub.ac.id

ABSTRACT

This study's objective is to review the consequence of the COVID-19 epidemic on physical activities, sedentary lifestyles, screen time, and changes in the nutritional status of school-age children. The outcomes of this study are intended to be applicable to obesity management in children. This study reviewed full-text articles and open-access publications on the sedentary lifestyle of children during the pandemic. and the data were analyzed using cohort, case-control, and cross-sectional designs. The results of reviewing 17 articles show that school-age children's physical activities and nutritional status have decreased, but their sedentary lifestyle and screen time have increased due to social restrictions during the COVID-19 pandemic. Children's decreased physical activities are caused by the absence of a comparable replacement mechanism as that before the pandemic. Meanwhile, the increasingly sedentary lifestyle highly influences children's physical and mental health. Screen time has also increased and is unavoidable during the pandemic because children's activities were limited and their learning systems are switched to online learning; as a result, their supporting sedentary lifestyle increases while physical activities decrease. These factors have changed the nutritional status of children during the pandemic. These results support the idea that the pandemic will impact the health of school-age children, especially their nutritional status. This review concludes that it is important to establish policies that prevent children's further health effects, such as obesity, caused by COVID-19.

INTRODUCTION

Obesity has become a world health problem, and it is estimated that 39% of people are overweight and obese (Chooi *et al.* 2019). The prevalence of overweight in women is lower than in men; on the contrary, obesity prevalence in women is higher than in men (Chooi *et al.* 2019). The national data show that 10.3% of the prevalence of adult obesity is found in women, and 7.5% of the prevalence of adult obesity is found in men; these numbers are higher than those of the regional data (GNR 2022).

The Indonesian Baseline Health Research reports that the percentage of overweight school children (6–14 years old) has increased from 2007 to 2013 (Megawati *et al.* 2021). Obesity in children has become a major public health problem, particularly in low socioeconomic groups (Sahoo *et al.* 2015).

World Health Organization (WHO) has declared the COVID-19 outbreak a global pandemic in early 2020 (Cucinotta & Vanellli 2020). All authorities respond by stipulating several policies to reduce the transmission rate, such as social restriction, social distancing, temporary school closure, restrictions on public places, restrictions on mass gatherings or crowds, and the obligation to wear masks (Cucinotta & Vanellli 2020). In the end, these policies directly impact society, including school-age children (Arum & Susilaningsih 2020).

A study has reported that school-age children perform a lack of physical activities during the COVID-19 pandemic (Moore *et al.* 2020). Approximately 70% of school-age

children decreased their physical activities due to social restrictions during the pandemic (Zheng *et al.* 2020). This fact is against school-age children's natural characteristics, such as playing, moving, interacting in groups (Chusna & Utami 2020), and more actively exploring many things (Rachmawati *et al.* 2021). Another study has reported that the Body Mass Index (BMI) of children aged 2–19 years and obesity prevalence have increased by 16.1% during the COVID-19 pandemic (Lange *et al.* 2021). Children's limited mobility during the pandemic could lead to a lack of physical activities, a sedentary lifestyle, and changes in the nutritional status (Zheng *et al.* 2020).

Exploring the effects of the COVID-19 pandemic on school-age children's physical activities, sedentary lifestyle levels, screen time, and changes in nutritional status are pivotal and relevant to current conditions. This review aims to review the latest research results on decreased physical activities, sedentary lifestyle levels, screen time, and changes in nutritional status of school-age children during the pandemic. The results of this study are expected to bring important information to create a strategic solution and combat the effects of COVID-19 on the obesity in school-age children.

METHODS

This scoping review was carried out by involving articles, full-texts, and open access articles on the sedentary lifestyle of children published in 2020–2021. This study employed cohort, case-control, and cross-sectional designs. This study excluded investigation on non-child subjects, review studies, and studies without the cohort, case-control, and cross-sectional designs. The keywords were sedentary, sedentary lifestyle, sedentary behavior, sedentary behavior AND pandemic, COVID-19, COVID AND obesity, obese AND children, child, and school age. The search process was carried out using the Boolean technique on four journal databases: PubMed, ProQuest, ResearchGate, and Sciencedirect. The PRISMA flow diagram was used to ensure the best process of the article selection.

A total of 2,119 articles were identified through a database search. Most of the articles are published by ProQuest for 1,404 articles, followed by Science Direct, Research Gate, and Pubmed. Furthermore, all articles were examined in more detail based on the relevant titles and topics. Therefore, 2,075 articles were excluded. In the next stage,the abstracts of 44 selected articles were examined by considering the inclusion and exclusion criteria; this examination resulted in 28 articles. The next step was examining the full texts of the 28 remained articles. This examination resulted in seven articles for review. The seven articles consisted of six cohort studies and one cross-sectional study. The whole process of the article selection is presented in Figure 1.

RESULTS AND DISCUSSION

Seven selected articles were reviewed and presented descriptively. The impacts of the COVID-19 pandemic on children are grouped into physical activities, sedentary activities, screen time, and nutritional status

Physical activities of children during the COVID-19 pandemic

The effects of COVID-19 on children's physical activities are reported by five of the seven articles reviewed. These five articles mention that children's physical activities have significantly decreased during the pandemic; all p values are <0.01 with a negative association direction (Table 1).

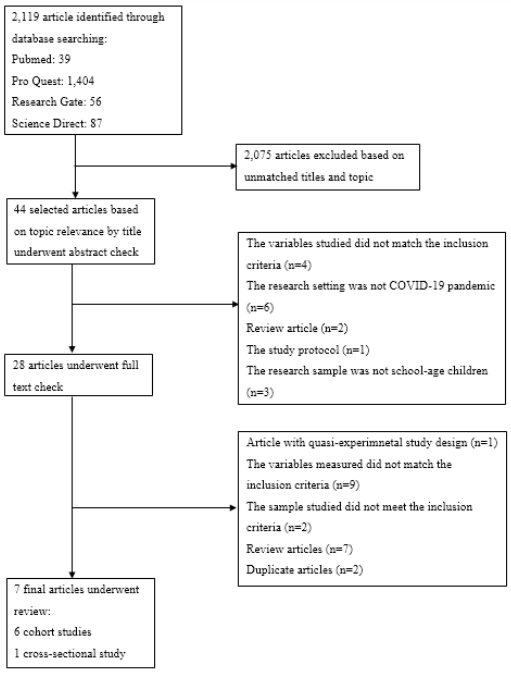

Figure 1. The PRISMA flow article selection diagram

A cohort study in Czech children in 2021 has found children's activities more severely decrease during the pandemic than before (Stverakova *et al.* 2021). The study reported that the children experienced a decline not only in total physical activities but also in spare time, before–school-activities, sports class activities, and rest activities (Stverakova *et al.* 2021). Another study in the Netherlands compared data from two cohorts and report non-converging results (Ten Velde *et al.* 2021). One of the cohort results mentioned that children's total physical activities ($p<0.01$) decrease. However, this result disagrees with another cohort study (Ten Velde *et al.* 2021). Children's decreased physical activities have also been recorded by a previous study which reveals a p-value of 0.002 (Alonso-Martinez *et al.* 2021). This result was supported by another study although it was not significant (Cachon-Zagalaz *et al.* 2021).

Children's physical activities decrease because they do not have alternative substitute activities during the pandemic (Stverakova *et al.* 2021). Children's organized indoor and outdoor activities decline; organized physical activities in distance learning encounter various challenges so that decreased physical activities of children cannot be optimally prevented (Vilchez *et al.* 2021; Gobbi *et al.* 2020). Another study also reported that returning children's physical activity levels to the same level as before the pandemic was probably difficult due to lack of parental support, amount of sleep time, lower energy, and lower time (Moore *et al.* 2020).

This review notes that several selected studies analyse age and gender with mixed results. A recent study states that neither age nor gender was significantly associated with decreased physical activities during the pandemic (Stverakova *et al.* 2021). Another study by Ten Velde *et al. (*2021) agrees that children's age was not associated with decreased physical activities, but data on gender show that girls' physical activities decrease more significantly than boys'. The next cohort study reported that physical activities decrease along with the increasing age; moreover, the study has found that girls' leisure time greatly increases (Dunton *et al.* 2020). A weaker cross-sectional study by Cachon-Zagalaz *et al.* (2021) reported that children's daily activities increased as they got older.

A longitudinal study has found that girls' physical activities have decreased; the older the girls, the greater the decline (Treuth *et al.* 2009). During the pandemic, another study cites children could not fulfil their basic physical activities due to social restrictions (Moore *et al.* 2020). Moore *et al.* (2020) explain that genders showed differences in physical activities; boys are physically more active than girls. The data on age denote that older children experienced a bigger impact of changes in their activity patterns than younger children do (Moore *et al.* 2020).

Sedentary activities of children during the COVID-19 pandemic

The sedentary lifestyle was reviewed from three selected articles (Table 1). An increased sedentary lifestyle was reported by Ten Velde *et al.* (2021) from two cohort results. Moreover, they report that the children's physical activities have lightly, moderately, and vigorously increased during the pandemic ($p<0.01$). The same result was reported by Alonso-Martinez *et al.* (2021) with a p-value of 0.006. Whereas a study has found two types of significant sedentary lifestyles in children: playing computer or video games by boys and talking on the phone or texting by girls (Dunton *et al.* 2020).

Keeping children from experiencing a sedentary lifestyle during the pandemic was proven to protect children's mental well-being (Gilbert *et al.* 2021). Children were the age group who are affected the most by the pandemic (Runacres *et al.* 2021). Runacres *et al.* (2021) stated that the increased sedentary lifestyle negatively impacts children's mental health, depression, anxiety, and quality of life. These problems are influenced by several factors, such as socioeconomic (the main factor), education levels of parents, overweight or obese parents, and parents' high anxiety about COVID-19 (Runacres *et al.* 2021). Runacres *et al.* (2021) have found that gender was not related to an increasingly sedentary lifestyle; however, girls were consistently reported to be more sedentary than boys.

Screen time of children during the COVID-19 pandemic

This review has found two articles reporting changes in screen time of children during the COVID-19 pandemic (Table 1). Ten Velde *et al.* (2021) report several results of screen time. They investigated two cohorts and have found that screen time for school purposes has significantly increased on weekdays and weekends (Ten Velde *et al.* 2021).

Table 1. Extraction results of articles on the impact of the COVID-19 pandemic on physical activity, sedentary lifestyle, screen time, and changes in nutritional status in school-age children

Title (Author; Year)	Country (Participant)	Type of study	Variable	Result	Association		
					Significancy	Type	Direction
Physical activity							
The impact of COVID-19 on physical activity of Czech children (Stverakova *et al.* 2021)	Czech Republic (Children aged 8–12 years (n=98) during lockdown and (n=206) pre-COVID)	Cohort	Pre COVID vs during COVID	The mean PAQ-C (physical activity) total score	Significant (p<0.001)	Decreased	(-)
				Spare time (activities during leisure time)	Significant (p=0.001)	Decreased	(-)
				Activities before school	Significant (p=0.003)	Decreased	(-)
				Activities during sports learning	Significant (p<0.001)	Decreased	(-)
				Activity at Rest	Significant (p<0.001)	Decreased	(-)
			Pre COVID vs during COVID by gender	The PAQ-C scores between gender	No data mentioned	n/a	n/a
			Pre COVID vs during COVID by age	The PAQ-C scores between age	Not significant (p=0.217)	n/a	n/a
Physical activity behaviour and screen time in Dutch children during the COVID-19 pandemic: Pre-, during- and post-school closures (Ten Velde *et al*. 2021)	Netherland (Cohort A=children aged 4–18 years participating in children obesity and lifestyle during COVID-19 (COLC) (n=102) Cohort B=children ages 7–12 years from clinicatrial.gov study: NCT03440580 (n=131)	Cohort	Before COVID vs during COVID based on subjective measurement	The total time of physical activity - Cohort A	Significant (p<0.01)	Decreased	(-)
				- Cohort B	Not significant	n/a	n/a
				School activities - Cohort A	Significant (p<0.01)	Decreased	(-)
				- Cohort B	Not significant	n/a	n/a
				Sport activities - Cohort A	Significant (p<0.01)	Decreased	(-)
				- Cohort B	Significant (p<0.01)	n/a	n/a
				Leisure activities - Cohort A	Significant (p<0.01)	n/a	n/a
				- Cohort B	Not significant	n/a	n/a
			Before COVID vs during COVID by age	Total physical activity	Not significant	n/a	n/a
			Before COVID vs during COVID by gender	Light physical activity between boys and girls	Significant (p<0.02)	Decreased (girls>boys)	(-)

Continue from Table 1

Title (Author; Year)	Country (Participant)	Type of study	Variable	Result	Association		
					Significancy	Type	Direction
Screen time							
Physical activity behaviour and screen time in Dutch children during the COVID-19 pandemic: pre-, during-and post-school closures (Ten Velde *et al.* 2021)	Netherland (Cohort A= children aged 4–18 years participating in Children Obesity and Lifestyle during COVID-19 (COLC) (n=102); Cohort B= children ages 7–12 years from clinicatrial.gov study: NCT03440580 (n=131)	Cohort	Before COVID vs during COVID	Screen time related to school			
				- Cohort A	Significant (p=0.04)	Increased	(+)
				- Cohort B	No data	n/a	n/a
				Weekday screen time			
				- Cohort A	Not significant	n/a	n/a
				- Cohort B	Significant (p<0.01)	Increased	(+)
Physicalactivity and Daily Routine among Children Aged 0–12 during the COVID-19 Pandemic in Spain (Cachon-Zagalaz *et al.* 2021)	Spain (Children aged 0–12 years (n=837), 50.2% boys (n=420) and 49.8% girls (n=417))	Cross-sectional	Screen time during COVID-19	Screen time	Significant (p=0.013)	Increased (boys>girls)	(+)
			Screen time during COVID-19 by age	Daily screen time	Significant (p=0.000)	Increased (older>younger)	(+)
			Screen time during COVID-19 by family type	The highest screen time was in children with single parents compared to other children	Significant (p=0.043)	n/a	n/a
			Screen time during COVID-19 by children's level of active	The more active children, the screen time will decrease	Significant (p=0.018)	Decreased	(-)
Nutritional status							
Paediatric BMI changes during COVID-19 pandemic: An electronic health record-based retrospective cohort study (Brooks *et al.* 2021)	United State of America (Children aged 6–17 years (n=191,846) with details taken from the results of the WCC U.S Electronic Health Record (EHR) data from Optum 2017–2019 (n=144,714) and 2020 data (n=47,132)	Cohort	BMI changes (ΔBMI) vs age group	Children aged 6–9 years	Significant (p=0.002)	Increased	Potentially (+)
				Children aged 10–13 years	Significant (p=0.003)	Increased	Potentially (+)
				Children aged 14–17 years	Not significant	n/a	n/a
Projecting the impact of the coronavirus disease (continue)	United State of America (Children who come from various (continue)	Cohort	BMI and Childhood Obesity Prevalence	BMI in girls in the group of children with COVID-19 compared to the control	Significant (p<0.05)	Increased	(+)

Continue from Table 1

Title (Author; Year)	Country (Participant)	Type of study	Variable	Result	Association		
					Significancy	Type	Direction
			Physical activity during COVID-19 by family type	The highest sleep time per day was recorded in children living with several families	Significant (p=0.025)	n/a	n/a
				The highest daily activity was recorded in children with divorced parents	Significant (p=0.010)	n/a	n/a
			Physical activity during COVID-19 by children's level of active	The more active children, the daily physical activity will increase	Significant (p=0.000)	Increased	(+)
Sedentary lifestyle							
Physical activity behaviour and screen time in Dutch children during the COVID-19 pandemic: pre-, during-and post-school closures (Ten Velde *et al.* 2021)	Netherland (Cohort A= children aged 4–18 years participating in Children Obesity & Lifestyle during COVID-19 (COLC) (n=102); Cohort B=children ages 7–12 years from clinicatrial.gov study: NCT03440580 (n=131)	Cohort	Before COVID vs during COVID based on objective measurement	Sedentary time	Significant (p<0.01)	Increased	(+)
				Light physical activity	Significant (p<0.01)	Decreased	(-)
				Moderate to vigorous physical activity	Significant (p<0.01)	Decreased	(-)
Early effects of the COVID-19 pandemic on physical activity and sedentary behaviour in children living in the US (Dunton *et al.* 2020)	USA (211 children aged 5–13 years through an online survey reported by parents)	Cohort	Type of sedentary lifestyle by gender	Playing computer or video games	Significant (0.006)	Increased (boys>girls)	(+)
				Talking on phone/texting	Significant (0.008)	Increased (girls>boys)	(+)
Physical activity, sedentary behaviour, sleep, and sleep-regulation in Spanish pre-schoolers during the COVID-19 lockdown (Alonso-Martinez *et al.* 2021)	Spain (Children aged 4 to 6 years from 3 (three) different schools (n=268). The data comes from the initial assessment (September–December 2019) and the second evaluation in March–April 2020)	Cohort	Children experience during lockdown	Sedentary time	Significant (p=0.006)	Increased	(+)

Continue from Table 1

Title (Author; Year)	Country (Participant)	Type of study	Variable	Result	Association		
					Significancy	Type	Direction
Screen time							
Physical activity behaviour and screen time in Dutch children during the COVID-19 pandemic: pre-, during-and post-school closures (Ten Velde *et al.* 2021)	Netherland (Cohort A= children aged 4–18 years participating in Children Obesity and Lifestyle during COVID-19 (COLC) (n=102); Cohort B= children ages 7–12 years from clinicatrial.gov study: NCT03440580 (n=131)	Cohort	Before COVID vs during COVID	Screen time related to school			
				- Cohort A	Significant (p=0.04)	Increased	(+)
				- Cohort B	No data	n/a	n/a
				Weekday screen time			
				- Cohort A	Not significant	n/a	n/a
				- Cohort B	Significant (p<0.01)	Increased	(+)
Physicalactivity and Daily Routine among Children Aged 0–12 during the COVID-19 Pandemic in Spain (Cachon-Zagalaz *et al.* 2021)	Spain (Children aged 0–12 years (n=837), 50.2% boys (n=420) and 49.8% girls (n=417))	Cross-sectional	Screen time during COVID-19	Screen time	Significant (p=0.013)	Increased (boys>girls)	(+)
			Screen time during COVID-19 by age	Daily screen time	Significant (p=0.000)	Increased (older>younger)	(+)
			Screen time during COVID-19 by family type	The highest screen time was in children with single parents compared to other children	Significant (p=0.043)	n/a	n/a
			Screen time during COVID-19 by children's level of active	The more active children, the screen time will decrease	Significant (p=0.018)	Decreased	(-)
Nutritional status							
Paediatric BMI changes during COVID-19 pandemic: An electronic health record-based retrospective cohort study (Brooks *et al.* 2021)	United State of America (Children aged 6–17 years (n=191,846) with details taken from the results of the WCC U.S Electronic Health Record (EHR) data from Optum 2017–2019 (n=144,714) and 2020 data (n=47,132)	Cohort	BMI changes (ΔBMI) vs age group	Children aged 6–9 years	Significant (p=0.002)	Increased	Potentially (+)
				Children aged 10–13 years	Significant (p=0.003)	Increased	Potentially (+)
				Children aged 14–17 years	Not significant	n/a	n/a
Projecting the impact of the coronavirus disease (continue)	United State of America (Children who come from various (continue)	Cohort	BMI and Childhood Obesity Prevalence	BMI in girls in the group of children with COVID-19 compared to the control.	Significant (p<0.05)	Increased	(+)

Continue from Table 1

Title (Author; Year)	Country (Participant)	Type of study	Variable	Result	Association		
					Significancy	Type	Direction
(continue) 2019 pandemic on childhood obesity in the United States: a microsimulation model (An 2020)	(continue) economic backgrounds, races, regions (n=15.631), were taken from data from the Early Childhood Longitudinal Study, Kindergaten class of 2010–2011 (ECLS-KC:2011)			The prevalence of obesity in the group of girls with COVID-19 compared to the control group	Significant ($p<0.05$)	Increased	(+)

Another cross-sectional study by Cachon-Zagalaz *et al.* (2021) noted several results. They reported that screen time significantly increases in boys and girls. However, boys experienced a higher increase in screen time than girls do. An identical condition has also been found in older children compared to younger ones (Cachon-Zagalaz *et al.* 2021). Children with a single parent have more screen time than other children do although the difference was not significant ($p=0.043$). Meanwhile, active children have shown less screen time than physically not active children with a p-value of 0.018 (Cachon-Zagalaz *et al.* 2021).

According to Musa *et al.* (2021), screen use was necessary during the COVID-19 pandemic. Parents are strongly advised to have vigilance of screen-time sedentary behaviour as a precursor of NCDs (Musa *et al.* 2022). Another study deploys that increasing screen time in children during the pandemic is unavoidable, but screen time not for school purposes or learning activities should be limited (Olive *et al.* 2021). Olive *et al.* (2021) mentioned that an increase in screen time can usually be accompanied by sleep disturbances, mental health problems, and physical activity issue that strongly urge all families to significantly deal with this issue (Olive *et al.* 2021).

Nutritional status of children during the COVID-19 pandemic

Two studies reported a significant increase in children's BMI as presented in Table 1. Brooks *et al.* (2021) report that children aged 6–9 years and 10–13 years significantly increased their BMI; this condition did not occur among children aged 14–17 years. An (2020) reports that girls have experienced an increase in BMI during the COVID-19 pandemic. Both studies also reported that obesity prevalence has inclined in girls and boys.

Lange *et al.* (2021) have found increase in children's BMI values. The BMI of children aged 2-19 years has doubled during the COVID-19 pandemic (Lange *et al.* 2021). Children who were initially overweight or obese before the pandemic experienced a higher average BMI increase than children with a normal weight do (Lange *et al.* 2021). The increased BMI is triggered by an online or hybrid environment which reduces children's opportunities to do physical activities or obtain healthy food as provided at school (Lange *et al.* 2021).

Another study has revealed a change in the Z-score of children during the pandemic (Weaver *et al.* 2021). Weaver *et al.* (2021) also state that girls have a higher increment of the z-score than boys do. They argue that this change was caused by children's difficulty to access scheduled regular activities, compulsory physical activities, and physical education at school (Weaver *et al.* 2021). Children also experienced food insecurity since they cannot access healthy food usually provided by the school as well as experience changes in sleeping time; both were factors triggering overweight and obesity (Weaver *et al.* 2021).

CONCLUSION

This review has generally shown the advanced risk of overweight and obesity in childhood during the pandemic. The results of the review strengthen other studies that underline

a potentially grown prevalence of overweight and obesity. Therefore, the results of this review could serve as a consideration to determine a better preventive strategy for dealing with the prevalence of overweight and obesity in children. Some strategies include adding or activating children's daily physical activities at home and at school. The unavoidable increase in screen time due to the pandemic must be immediately addressed to increase children's physical activities outside school hours at home. All parties must respond to changes in the nutritional status of children by suppressing the causative factors, such as low physical activities, increased sedentary lifestyle, and screen time, during the pandemic.

ACKNOWLEDGEMENT

The authors would like to thank the Professional Study Program, Department of Nutrition, Faculty of Health Sciences, Universitas Brawijaya Malang for their support.

DECLARATION OF CONFLICT OF INTERESTS

The authors state that there is no conflict of interest in the implementation of this research from start to finish.

REFERENCES

Alonso-Martinez AM, Ramirez-Velez R, Garcia-Alonso Y, Izquierdo M, Garcia-Hermoso A. 2021. Physical activity, sedentary behavior, sleep and self-regulation in Spanish preschoolers during the covid-19 lockdown. Int J Environ Res Public Health 18(2):693. https://doi.org/10.3390/ijerph18020693

An R. 2020. Projecting the impact of the coronavirus disease-2019 pandemic on childhood obesity in The United States: A microsimulation model. J Sport Health Sci 9:302–312. https://doi.org/10.1016/j.jshs.2020.05.006

Arum AE, Susilaningsih E. 2020. Pembelajaran Daring dan Kajian Dampak Pandemi Covid-19 di Sekolah Dasar Kecamatan Muncar Prosiding Seminar Nasional Pascasarjana (page 438–444), 2020. Semarang (ID): UNNES.

Brooks CG, Spencer JR, Sprafka JM, Roehl KA, Ma J, Londhe AA, He F, Cheng A, Brown CA, Page J. 2021. Pediatric bmi changes during covid-19 pandemic: An electronic health record-based retrospective cohort study. Eclinicalmedicine 38:101026. https://doi.org/10.1016/j.eclinm.2021.101026

Cachon-Zagalaz J, Zagalaz-Sanchez Ma, Arufe-Giraldez V, Sanmiguel-Rodriguez A, Gonzalez-Valero G. 2021. Physical activity and daily routine among children aged 0–12 during the covid-19 pandemic in Spain. Int J Environ Res Public Health 18(2):703. https://doi.org/10.3390/ijerph18020703

Chooi YC, Ding C, Magkos F. 2019. The epidemiology of obesity. Metabolism 92:6–10. https://doi.org/10.1016/j.metabol.2018.09.005

Chusna PA, Utami ADM. 2020. Dampak pandemi COVID-19 terhadap peran orang tua dan guru dalam meningkatkan kualitas pembelajaran daring anak usia sekolah dasar. Premiere: Journal of Islamic Elementary Education 2(1):11–30. https://doi.org/10.51675/jp.v2i1.84

Cucinotta D, Vanellli M. 2020. Who declares covid-19 a pandemic. Acta Biomedi 91(1):157–160. https://doi.org/10.23750/abm.v91i1.9397

Dunton GF, Do B, Wang SD. 2020. Early effects of the covid-19 pandemic on physical activity and sedentary behavior in children living in the US. BMC Public Health 20(1):1–13. https://doi.org/10.1186/s12889-020-09429-3

[GNR] Global Nutrition Report. 2022. Country nutrition profiles. GNR https://globalnutritionreport.org/resources/nutrition-profiles/asia/south-eastern-asia/indonesia [Accessed 28th April 2022].

Gilbert AS, Schmidt L, Beck A, Kepper MM, Mazzucca S, Eyler A. 2021. Associations of physical activity and sedentary behaviors with child mental well-being during the covid-19 pandemic. BMC Public Health 21(1):1–12. https://doi.org/10.1186/s12889-021-11805-6

Gobbi E, Maltagliati S, Sarrazin P, Di Fronso S, Colangelo A, Cheval B, Escriva-Boulley G, Tessier D, Demirhan G, Erturan G *et al.* 2020. Promoting physical activity

during school closures imposed by the first wave of the covid-19 pandemic: Physical education teachers' behaviors in France, Italy and Turkey. Int J Environ Res Public Health 17(24):9431. https://doi.org/10.3390/ijerph17249431

Lange SJ, Kompaniyets L, Freedman DS, Kraus EM, Porter R, Black HM, Goodman AB. 2021. Longitudinal trends in body mass index before and during the covid-19 pandemic among persons aged 2–19 years-United States, 2018–2020. Morb Mortal Wkly Rep 70(37):1278–1283. https://doi.org/10.15585/mmwr.mm7037a3

Megawati RN, Norazizah R, Sofia N. 2021. Pengaruh sedentary behavior terhadap obesitas pada anak sekolah. Jurnal Kebidanan 11(2):651–661. https://doi.org/10.33486/jurnal_kebidanan.v11i2.152

Moore SA, Faulkner G, Rhodes RE, Brussoni M, Chulak-Bozzer T, Ferguson LJ, Mitra R, O'reilly N, Spence JC, Vanderloo LM, Tremblay MS. 2020. 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 Act 17(1):1–11. https://doi.org/10.1186/s12966-020-00987-8

Musa S, Elyamani R, Dergaa I. 2022. Covid-19 and screen-based sedentary behaviour: Systematic review of digital screen time and metabolic syndrome in adolescents. Plos One 17(3):e0265560. https://doi.org/10.1371/journal.pone.0265560

Olive LS, Sciberras E, Berkowitz TS, Hoare E, Telford RM, O'neil A, Mikocka-Walus A, Evans S, Hutchinson D, Mcgillivray JA *et al.* 2021. Child and parent physical activity, sleep, and screen time during covid-19 and associations with mental health: Implications for future psycho-cardiological disease? Front Psychiatry 2332. https://doi.org/10.3389/fpsyt.2021.774858

Rachmawati Y, Kurniawati L, Suardi M. 2021. Curiosity in young children. Proceedings of The 5th International Conference on Early Childhood Education (Icece 2020), 15–16 October. Bandung (ID): UPI.

Runacres A, Mackintosh KA, Knight RL, Sheeran L, Thatcher R, Shelley J, Mcnarry MA. 2021. Impact of the covid-19 pandemic on sedentary time and behaviour in children and adults: A systematic review and meta-analysis. Int J Environ Res Public Health 18(21):11286. https://doi.org/10.3390/ijerph182111286

Sahoo K, Sahoo B, Choudhury AK, Sofi NY, Kumar R, Bhadoria AS. 2015. Childhood obesity: Causes and consequences. J Family Med Prim Care 4(2):187–192. https://doi.org/10.4103/2249-4863.154628

Stverakova T, Jacisko J, Busch A, Safarova M, Kolar P, Kobesova A. 2021. The impact of covid-19 on physical activity of Czech Children. Plos One 16(7):e0254244. https://doi.org/10.1371/journal.pone.0254244

Ten Velde G, Lubrecht J, Arayess L, Van Loo C, Hesselink M, Reijnders D, Vreugdenhil A. 2021. Physical activity behaviour and screen time in Dutch Children during the covid-19 pandemic: Pre-, during- and post-school closures. Pediatr Obes 16(9):e12779. https://doi.org/10.1111/ijpo.12779

Treuth MS, Baggett CD, Pratt CA, Going SB, Elder JP, Charneco EY, Webber LS. 2009. A longitudinal study of sedentary behavior and overweight in adolescent girls. Obesity 17(5):1003–1008. https://doi.org/10.1038/oby.2008.598

Vilchez JA, Kruse J, Puffer M, Dudovitz RN. 2021. Teachers and school health leaders' perspectives on distance learning physical education during the covid-19 pandemic. J Sch Health 91(7):541–549. https://doi.org/10.1111/josh.13030

Weaver RG, Hunt ET, Armstrong B, Beets MW, Brazendale K, Turner-Mcgrievy G, Pate RR, Youngstedt SD, Dugger R, Parker H *et al.* 2021. Covid-19 leads to accelerated increases in children's bmi z-score gain: An interrupted time-series study. Am J Prev Med 61(4):e161–e169. https://doi.org/10.1016/j.amepre.2021.04.007

Zheng C, Huang WY, Sheridan S, Sit CH, Chen XK, Wong SH. 2020. Covid-19 pandemic brings a sedentary lifestyle In Young Adults: A cross-sectional and longitudinal study. medRxiv. https://doi.org/10.1101/2020.05.22.20110825