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Trabajo Original

Pediatría

Effects of COVID-19 lockdown on children´s sleep quality, physical activity, screen time, and diet

Efectos del confinamiento por COVID-19 en la calidad del sueño, la actividad física, el tiempo de pantallas y la alimentación en los niños

Roberto López-Iracheta[1], Nerea Martín-Calvo[2,3], Laura Moreno-Galarraga[3,4], José Manuel Moreno Villares[5]

[1]Department of Pediatrics. Clínica Universidad de Navarra. Pamplona, Spain. [2]IdiSNA - Instituto de Investigación Sanitaria de Navarra. Pamplona, Spain. [3]Department of Preventive Medicine and Public Health. School of Medicine. Universidad de Navarra. Pamplona, Spain. [4]Department of Pediatrics. Hospital Universitario de Navarra. Navarra, Spain. [5]Department of Pediatrics. Clínica Universidad de Navarra. Madrid, Spain

Abstract

Background: this study aimed to assess how the COVID-19 lockdown (March to June 2020) affected children's sleep quality, physical activity, screen time, and nutrition.

Material and methods: the survey consisted of 479 children from the SENDO project, a pediatric cohort in Spain, aged 4-5 years. The BEAR questionnaire was used to evaluate sleep quality. Hierarchical models with two-level clustering were used to account for intra-cluster correlation between siblings, and the difference regression method was used to study the association between changes in screen consumption and physical activity and changes in sleep quality.

Results: the results showed an increase in the consumption of homemade pastries and snacks. Sleep quality worsened significantly during confinement, with a mean score on the BEAR scale of 0.52 before, 1.43 during, and 1.07 after confinement. Although sleep quality improved significantly after the end of confinement, it remained worse than before. The average daily screen time increased from 1.13 hours before confinement to 2.65 hours during confinement. Physical activity decreased during confinement, with the mean number of hours per day decreasing from 1.27 to 0.79. Children who spent more time on screens during confinement had worse sleep quality, as indicated by their higher scores on the BEAR scale. We used the difference regression method to identify a statistically significant association between the increased screen time for leisure hours and the worsening of children's sleep quality during confinement.

Conclusion: we observed a significant relationship between confinement and reduced sleep quality. Although the end of the lockdown led to a slight improvement, the average BEAR scale score remained higher post-confinement, suggesting that the consequences of the lockdown may persist over time.

Keywords:

Sleep quality. Screen time. Physical activity. Food. Confinement. SENDO project.

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Correspondence:
Roberto López-Iracheta. Department of Preventive Medicine and Public Health. School of Medicine. Universidad de Navarra. C/ Irunlarrea, 1.
31080 Pamplona, Spain
e-mail: rlopezi@unav.es

Resumen

Introducción: el objetivo del estudio es evaluar el impacto del confinamiento por COVID-19 (marzo-junio 2020) en la calidad de sueño, actividad física, tiempo de pantallas y alimentación de los niños.

Material y métodos: los participantes son 479 niños del proyecto SENDO. Los criterios de inclusión en el Proyecto fueron niños de 4-5 años, residentes en España, con un seguimiento periódico por medio de cuestionarios. Se utilizó el cuestionario BEAR para valorar la calidad del sueño. Se utilizaron modelos jerárquicos teniendo en cuenta la correlación entre hermanos, método de regresión de diferencias y la regresión lineal múltiple.

Resultados: se objetiva un aumento de consumo de bollería casera y *snacks*. La puntuación media de la escala BEAR fue de 0,52; 1,43; y 1,07 antes, durante y después del confinamiento, respectivamente, por lo que la calidad de sueño empeoró significativamente durante el confinamiento y mejoró tras el fin, pero persistiendo peor que previo al mismo. El tiempo medio de pantallas por ocio al día es de 1,13 horas previo al confinamiento, con aumento significativo durante el mismo a 2,65. La media de horas al día de actividad física previo al confinamiento es de 1,27 descendiendo a 0,79 durante el mismo. Los niños que se encuentran en el tercil superior de consumo de pantallas tienen significativamente ($p < 0,05$) mayor puntuación en la escala BEAR (peor calidad de sueño). Observamos una asociación estadísticamente significativa entre el aumento de exposición a pantallas y el empeoramiento de la calidad de sueño.

Conclusiones: el periodo de confinamiento se asoció a una disminución de la actividad física, un mayor tiempo de consumo con pantallas y una peor calidad del sueño. La peor calidad del sueño persistió al acabar ese periodo, confirmando las tendencias previas a la pandemia.

Palabras clave:

Calidad de sueño. Pantallas. Actividad física. Alimentación. Confinamiento. Proyecto SENDO.

INTRODUCTION

The COVID-19 pandemic profoundly altered people's lives worldwide, producing long-term consequences for public health, the economy, and social interactions (1).

The lockdown measures implemented due to COVID-19 significantly changed children's routines. They experienced changes in nutrition, physical activity, television/screen use, social activity, schoolwork schedules, and attendance (2). Moreover, several studies have associated the COVID-19 lockdown with higher levels of anxiety and depression in children (3).

The confinement condition can lead to forced inactivity and increased sedentary behavior, which are known to increase the risk for psycho-physical adverse conditions such as obesity, muscle atrophy, and cardiovascular vulnerability (4), as well as symptoms of anxiety and depression (5).

Another critical aspect of children's lifestyles that has changed during the COVID-19 pandemic is nutrition. Feeding patterns have also changed during the pandemic, especially during the lockdown (6,7). Social distancing measures may have contributed to worsening food patterns, such as increased consumption of unhealthy snacks and sugar-containing foods (8).

This confinement could have adverse effects on children's physical and mental health as they did not get to play with their friends, participate in sports groups, or have regular exercise in school physical education classes (9). This is especially concerning as previous studies have shown that most children and adolescents did not reach the recommended 60 minutes of moderate to vigorous physical activity per day set by the World Heart Association and the World Health Organization even before the pandemic (10). A further reduction of physical activity during the pandemic could have harmful effects as physical activity during youth is an essential determinant for future physical activity (11), is an antecedent for mental health (12), and helps prevent future health challenges such as obesity and cardiovascular diseases (13).

The social isolation caused by the COVID-19 pandemic greatly reduced physical activity levels in both male and female students (14,15). Physical activity is crucial in promoting positive mood (16), maintaining a healthy weight, and fostering self-esteem in children and adolescents (17). Vigorous physical activity has been shown to substantially reduce adolescents' stress, anxiety, and depression (18), providing protection against metabolic syndrome (19).

In addition to food and physical exercise, screen usage changed drastically due to the COVID-19 lockdown (20). Studies suggest a widespread, immediate, and potentially adverse impact on children's screen time due to the COVID-19 lockdown (21-23). The two crucial negative impacts of screen time on the physical health of children and adolescents are sleep problems (24,25) and an increased risk of myopia (26). Excessive screen exposure has been linked to physical health symptoms like eye strain, sleep disturbances, carpal tunnel syndrome, and neck pain. Psychologically, excess screen time is linked to impaired concentration, obsession, and even diagnosable mental illnesses such as anxiety, depression, and attention-deficit hyperactivity disorder (27-31).

Furthermore, the dramatic lifestyle changes and stressors associated with this pandemic pose a threat to mental health and have the potential to exacerbate risk factors for suicide (32).

A previous report focused on assessing the changes in sleep quality in Spanish children during the lockdown (33). This study aimed to determine changes in nutrition patterns, physical activity, screen time, and sleep quality in Spanish children during the lockdown between March and June 2020.

MATERIALS AND METHODS

STUDY AIM, DESIGN, AND SETTING

The SENDO project (*S*eguimiento de *E*scolares *N*avarros para un *D*esarrollo *Ó*ptimo) evaluates the impact of diet and lifestyle on the health of children and adolescents. It is a prospective, dynamic, multipurpose pediatric cohort that started in 2015. The study collects self-reported data through online questionnaires completed by parents and children. The inclusion criteria for the SENDO project were children aged 4-5 years living in Spain. The participants were aged 4-11 years at the time of questionnaire

completion in May 2021, depending on when they joined the study. More details on this cohort study design have been published elsewhere (34).

PARTICIPANTS

Until September 2020, 832 participants were recruited. Of these, 485 completed an additional questionnaire to report various lifestyle changes during the lockdown period. However, 14 participants with incomplete information —meaning they needed more information on four or more questions regarding sleeping quality, physical activity, or screen time— were excluded from the analysis. The remaining participants who had missed only a few items were contacted to complete the information. After excluding the ineligible participants, the final sample comprised 471 participants.

VARIABLES

The SENDO project collects data on various sociodemographic, lifestyle, and diet-related factors through baseline and annual questionnaires (Q0, Q1, Q2, etc.). In May 2021, a new questionnaire focused on emotional, nutritional, physical activity, screen time, sleeping habits, and other lifestyle factors was introduced.

To assess sleeping habits in children, we used the BEAR questionnaire, a widely used screening tool to identify sleep problems. The BEAR questionnaire has already been validated in Spain and includes questions related to bedtime reluctance, difficulty falling asleep, awakening during the night, and regularity and duration of sleep (35,36). Points were assigned to each answer based on their frequency of occurrence. A score was calculated for each participant by adding the points for the four questions.

Each participant completed the BEAR questionnaire before the lockdown (using the last annual questionnaire they finished) and twice in May 2021 (covering periods during and after the lockdown). We calculated the total score for each participant before, during, and after the lockdown. The final scores ranged from 0 to 12, with higher scores indicating more sleeping problems.

Dietary information was collected through a previously validated semi-quantitative FFQ, which included 149 food items (37). For each food item, a portion size was specified. Parents reported how often their child consumed each food item over the previous year by choosing one of nine consumption frequencies ranging from "never or rarely" to "6 or more times/d". For dietary changes during lockdown, we present a descriptive analysis of the consumption of food groups.

Diet quality was assessed with the KIDMED index, an *a priori*-defined dietary index to evaluate adherence to the MedDiet pattern in children and adolescents (38). The KIDMED index consists of 16 items: 12 scored 0 or 1; 4 scored −1 or 0. Thus, the score in the KIDMED index ranges from −4 to 12 points. Participants' adherence to the MedDiet was classified as poor (≤ 3 points), medium (4-7 points), or high (≥ 8 points) according to their score.

The study gathered data about physical activity through a questionnaire that included 17 different types of activities and 10 response options, ranging from never to over 10 hours per week. The Spanish version of the questionnaire was validated in the "Seguimiento Universidad de Navarra" study (39). The variable was defined as moderate or intense activity, measured hours per day. Physical activities can be classified according to their intensity. Moderate-intensity activities require 3 to 6 METs, whereas vigorous-intensity activities require more than 6 METs. The target heart rate for moderate exercise intensity is 50 %-70 % of your maximum heart rate, while for vigorous exercise intensity, it is 70 %-85 % (40). The guidelines defined moderate activity as brisk walking and other moderate-intensity activities, such as dancing. In contrast, vigorous intensity was defined as activities that require high-intensity exercise, such as jogging, running, fast cycling, fast swimming, and team sports (41).

In addition, screen time was assessed by averaging the daily hours spent watching TV, using a computer, playing video games, or similar.

STATISTICAL ANALYSIS

Participant characteristics were analyzed by sex. Mean values and standard deviations (SD) were used for quantitative variables, while percentages were used for categorical ones. The Student t-test was applied for quantitative variables and χ^2 tests for qualitative ones to compare between-group differences.

BEAR questionnaire scores were compared across the three periods (before, during, and after lockdown) using repeated measures for each participant. Similarly, physical activity and screen time were also compared, but only with two periods (before and during lockdown) due to the lack of information after lockdown.

Hierarchical models with two levels of clustering were used to account for the intra-cluster correlation between siblings. The interaction between time and *a priori* selected variables, such as sex, number of siblings, number of cohabitants, parental education, having a pet, having a mobile phone, physical activity (METS), BMI (kg/m^2), moderate or intense activity (hours/week), and adherence to the Mediterranean diet, was assessed by introducing the interaction term into the model and calculating a likelihood ratio test.

The regression of differences method was employed to study the association between changes in screen consumption and sleep quality and between changes in physical activity and sleep quality. Participants were divided into tertiles, and multiple linear regression was used to study the relationship between tertiles of screen consumption, physical activity, and sleep quality.

The analysis was conducted using the software STATA 15.0 (Stata Corporation, College Station, TX, USA). All *p*-values were two-tailed, and statistical significance was determined at the conventional cut-off point of $p < 0.05$.

ETHICAL CONSIDERATIONS

The SENDO project adheres to the ethical principles for medical research in human beings, as stated in the Declaration of Helsinki. This study has been approved by the Ethics Committee for Clinical Research of Navarra (Pyto 2016/122). Informed consent was obtained from the parents of all participants during recruitment.

RESULTS

This study involved 471 participants, 223 females and 248 males, with an average age of 7.5 years (SD: 1.8). Table I provides relevant information regarding the participants' baseline characteristics. There were no significant differences between the groups regarding the sociodemographic and lifestyle characteristics of the children or the family characteristics.

During the lockdown, the consumption of most food groups remained relatively unchanged, except for snacks and homemade bakery items. 32 % of participants reported consuming more or much more snacks and 62 % of them reported consuming more or much more homemade baked goods during lockdown (Table II).

Children spent an average of 1.27 hours (SD 0.99) on moderate to vigorous physical activity daily before lockdown. However, this value decreased significantly during confinement to 0.79 (SD 0.96) ($p < 0.001$).

Before lockdown, the average daily screen time spent on leisure activities was 1.13 hours (SD: 0.81). During confinement, it increased significantly to 2.65 hours (SD: 1.69) ($p < 0.001$).

The BEAR scale was used to examine children's sleep quality before, during, and after confinement. The results showed that the mean score of the BEAR scale was 0.52 (SD 1.25), 1.43 (SD 1.99), and 1.07 (SD: 1.55) for before, during, and after confinement, respectively. All comparisons indicated a statistically significant worsening of sleep quality during confinement with little recovery afterward.

The study also investigated the relationship between sleep quality during confinement, measured by the BEAR score, and physical activity levels in tertiles. However, no statistically significant differences were found (Table III).

Regarding screen time, children who spent the most leisure time on screens during confinement (upper tertile) had significantly higher BEAR scale scores (indicating worse sleep quality) compared to children who spent less time on screens (lower tertile) ($p = 0.005$), as shown in table III.

Also, a significant association was found between increased screen time for leisure and worsened sleep quality in confined children ($p = 0.04$).

Table I. SENDO project participants' baseline characteristics. Numbers are expressed as % or mean (± SD)

	Boys	Girls	*p* value
n	**248**	**223**	
Age (years)	7.45 ± 1.73	7.49 ± 1.95	0.832
Number of siblings	1.27 ± 1.23	1.40 ± 0.95	0.191
Numbers of cohabitants	3.48 ± 1.35	3.79 ± 3.00	0.137
BMI (kg/m^2)	16.08 ± 1.78	16.18 ± 2.06	0.544
z-BMI	-0.03 ± 0.92	0.02 ± 1.07	0.545
Physical activity (METS-hours/week)	48.90 ± 33.90	41.13 ± 28.11	0.007
Moderate or intense activity (hours/week)	9.64 ± 7.99	8.10 ± 5.45	0.016
Screen time (hours/day)	1.14 ± 0.80	1.12 ± 0.82	0.835
Punctuation KIDMED[1]	5.85 ± 1.94	6.10 ± 1.82	0.154
BEAR score[2]	0.52 ± 1.26	0,52 ± 1.19	0.997
Maternal age (years)	42.43 ± 4.06	42.19 ± 4.37	0.436
Paternal age (years)	43.42 ± 5.37	43.26 ± 5.31	0.958
Smoking (% exposed to secondhand smoke)	5.62	8.00	0.544
Pet ownership (% of children with pets)	23.39	26.46	0.441
Mobile phone (% of children with a mobile phone)	0.4	1.79	0.142
Parents´ education (% of children with mother or father with at least a college education)[3]	87.50	85.20	0.467

[1]Adherence to the Mediterranean diet. [2]Sleep quality. [3]University alone or university plus master or doctorate.

Table II. Changes in food consumption frequency before and during lockdown (% of participants)

	Much more	More	Similar	Fewer	Much fewer
Fruits	4 %	17 %	67 %	10 %	2 %
Vegetables	3 %	16 %	72 %	8 %	1 %
Fast food	1 %	11 %	58 %	21 %	10 %
Homemade baked goods	5 %	57 %	31 %	4 %	3 %
Industrial bakery	1 %	7 %	53 %	24 %	15 %
Sugary drinks	1 %	6 %	67 %	11 %	15 %
Snacks	3 %	29 %	52 %	9 %	7 %

Table III. Mean (SD) BEAR questionnaire scores during lockdown by terciles of physical activity and screen time

Physical activity	Low (1st tertile)	Medium (2nd tertile)	High (3rd tertile)
BEAR questionnaire score (mean)	1.48 (2.07)	1.48 (2.01)[a]	1.26 (1.81)[b]
Screen time	**Low (1st tertile)**	**Medium (2nd tertile)**	**High (3rd tertile)**
BEAR questionnaire score (mean)	1.35 (1.87)	1.39 (1.83)[c]	2.02 (2.37)[d]

[a]Medium vs. low: p = *0.971; [b]High vs. low:* p = *0.433; [c]Medium vs. low:* p = *0.785; [d]High vs. low:* p = *0.005.*

DISCUSSION

In this study of 471 children from the SENDO project, we discovered that the lockdown enforced in Spain between March and June 2020 due to the COVID-19 pandemic resulted in a significant increase in screen time and a marked decrease in moderate and vigorous physical activity. Additionally, we observed a considerable decline in sleep quality that persisted after the end of the lockdown. Our analysis revealed that the greater the increase in screen time, the more pronounced the worsening of sleep quality, highlighting a potential link between screen time and poor sleep quality. However, we did not find any significant association between the decrease in physical activity and the deterioration of sleep quality. This may be because the quality of physical exercise could have been better, as outdoor activities were restricted during the lockdown.

Our findings underscore the importance of evaluating sleep quality in children and implementing preventive measures anticipating potential future lockdowns. It also highlights the risks of increased screen time and decreased physical activity. However, we do not have to wait for another lockdown to consider this issue. Rapid technological advancements have increased screen time in recent years, resulting in sedentary lifestyles and greater inactivity in children (42,43). The lockdown has only exacerbated this growing trend, making it necessary to establish public health policies to combat this critical issue, particularly during the childhood obesity pandemic.

Prior studies also reported measurable reductions in physical activity among children and adolescents during the COVID-19 lockdown (16,17), which may have contributed to poor sleep quality. Therefore, it is essential to enhance access to resources that promote physical activity to ensure good health and social functioning among children and adolescents during pandemic recovery efforts (44). The use of electronic devices has increased during the lockdown (24,45), and its excessive use has been linked to poor sleep quality (22,23). Hence, targeted health promotion interventions are required to encourage the judicious use of screens for education and entertainment and emphasize the adverse health effects of excess screen time.

Most food groups remained the same regarding dietary habits, except for increased beverages and homemade bakery consumption. Some studies have also reported higher caloric intake during confinement, increased alcohol consumption, and a generally unhealthier diet with more snacking (46,47). This data highlights the need for dietary guidelines to prevent or mitigate potential weight gain during the period of self-isolation, especially for individuals with overweight and obesity.

Our results should be considered alongside specific study limitations. First, the cross-sectional design precludes the determination of causality. The use of self-reported information is susceptible to misclassification bias. However, since the SENDO project information is updated annually through online questionnaires, families are used to this data collection method, which may reduce the risk of systematic error in the reported data.

Another limitation is the demographic composition of SENDO. SENDO project participants are mostly white children from families with higher educational attainment. While this may limit the generalizability of our results, it increases the validity of the responses and reduces potential confounding by socioeconomic status. Due to the observational design, we cannot rule out the possibility of residual confounding by uncontrolled variables. When interpreting the results or generalizing findings to broader populations, these limitations should be considered.

In conclusion, many studies have associated the COVID-19 pandemic and ensuing lockdown with psychological and lifestyle changes. Our study contributes to this body of knowledge by revealing reduced physical activity and worsened sleep quality associated with increased screen time. Helping children to maintain healthy habits despite challenging circumstances and providing early psychological support is important for preventing negative (and potentially persistent) psycho-physical symptoms resulting from lockdown.

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