Received: 22 November 2021 | Revised: 24 March 2022 | Accepted: 13 April 2022

DOI: 10.1111/ijpo.12923

ORIGINAL RESEARCH

Pediatric OBESITY WILEY

Relationship between parents' and children's objectively assessed movement behaviours prior to and during the COVID-19 pandemic

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Funding information
Department of Education of the Government of Navarra (Spain), Grant/Award Number: CENEDUCA1/2019; Instituto de Salud Carlos III

Summary

Background: The coronavirus disease 2019 (COVID-19) pandemic could have provoked undesirable harmful effects on movement behaviours among children.

Objective: To compare levels of physical activity (PA), sedentary behaviour (SB), and sleep time in children prior to and during the COVID-19 pandemic (after the lockdown) and to determine the association between changes in moderate-to-vigorous PA (MVPA), total PA (TPA), SB, and sleep time between mothers and fathers with their children.

Methods: A total of 110 children (aged 4–7 years) and their parents (63 mothers and 52 fathers) wore GENEActiv accelerometers for 6 days (4 weekdays and 2 weekend days) prior to the pandemic and 1 year into the pandemic to assess SB, MVPA, TPA, and sleep time.

Results: Children performed more MVPA on weekdays ($p = 0.002$), had higher SB ($p = 0.001$), and slept fewer hours during the pandemic than before ($p < 0.001$). Likewise, children performed more weekend day MVPA and TPA ($p < 0.001$) during the pandemic, and slept less than prior to the pandemic ($p = 0.002$). On weekdays, an increase in mother's MVPA and TPA (categorized as tertiles) was associated with higher increased on MVPA ($p = 0.030$) and TPA in their children ($p = 0.023$), respectively. On weekends, an increase in mother's MVPA was also associated with higher increases in MVPA ($p = 0.011$) in their children.

Conclusion: During the pandemic, children got more MVPA, more SB, and slept fewer hours than before. Changes in PA seem to be associated with mother's behaviours, especially during weekdays.

KEYWORDS
accelerometer, activity, coronavirus, family research, moderate to vigorous physical, sedentary behaviour

1 | INTRODUCTION

Coronavirus disease 2019 (COVID-19) caused by the novel severe acute respiratory coronavirus 2 (SARS-CoV-2) emerged in China at

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the end of 2019, before quickly spreading worldwide.[1] The crisis was declared a pandemic by WHO on March 11th, 2020, and Spain instigated a mandatory home "lockdown" from March 14th to April 26th 2020, which resulted in mass destruction of civil life and relationships. All non-essential businesses were closed (including bars, restaurants, and leisure centres), and it was forbidden to gather in houses. Opportunities for movement were greatly affected because of local curfews and perimeter closures, and social relationships were limited to people living together. For schoolchildren, the lockdown measures were especially disruptive because schools, sports centres, and playgrounds were closed, and they were quarantined at home with their parents. During year 2021, school time is less flexible because of physical distancing measures; for example, children must spend most of their time in the same place, with the same partners, and they cannot mix with children from other classes.

Overall, the COVID-19 pandemic is related to changes in the quantity and nature of physical activity (PA), sedentary behaviour (SB), and sleep among children and youth.[2] Specifically, there is a growing body of evidence demonstrating the significant impact of the COVID-19 lockdown on these movement behaviours in Spanish preschoolers.[3,4] For example, López-Bueno et al.[3] showed, by self-reported questionnaire, that preschoolers (3–5 years old) reduced their total physical activity (TPA) by 92 min per day (from 223 to 131 min) and increased their recreational screen time exposure by 2.2 h per day (from 1.7 to 3.9 hours) during the lockdown. These findings are consistent with another study showing the negative effects of the COVID-19 lockdown on PA levels, SB and sleep quality,[4] as measured objectively with accelerometers. By contrast and in another European country, Swedish preschooler's weekday and weekend day PA and time spent outside increased during the pandemic (parental reported), but screen time also increased.[5] In the same way, Fillon et al.[6] analysed 348 French children and showed that a total of 25.0% of the children to decrease, 24.7% maintained, and 50.3% increase their PA during the lockdown.

Overall, since the beginning of the pandemic, preschoolers performed fewer organized physical activities, and spent more time indoors.[2,7] For instance, a longitudinal survey of 14 countries reporting the effects of COVID-19 on these behaviours among 3–5-year-olds found that sedentary screen time increased during the pandemic and there were small changes in PA.[8] Likewise, a study in Dutch youths aged 4–18 years investigated the effect of COVID-19 measures on screen time and PA prior and post-school closures, finding that children were less physically active, and screen time was higher following the school closures.[9] This finding is contrary to that of Hurter et al.[10] who found that PA levels of upper primary school children aged 4–6 years increased immediately upon return to school.

The COVID-19 pandemic has made children spend more time with their families, especially on weekdays, and the influence of parents on children's PA could be stronger than usual on weekends due to the above-mentioned restrictions. Along this line, several studies have looked for associations of PA between preschoolers and their parents, prior to the pandemic.[11,12] One study indicated that most mothers reported infrequent co-participation in PA with their children.[12] By contrast, Xu et al.[11] found that SB and PA levels of parents can strongly influence those of their preschool children, with maternal influence stronger during the weekdays and paternal influence stronger on the weekends. Although this information is currently not available for the current pandemic, the aforementioned longitudinal survey by Okely et al.[8] highlights the important role parents play in supporting their children to participate in healthy levels of movement behaviours during the pandemic.

Accordingly, the purpose of the present study was two-fold: to analyse PA, SB, and sleep time in Spanish children's pre- and during the COVID-19 pandemic; and to determine the association between changes in MVPA, TPA, SB, and sleep time between mothers and fathers with their children's movement behaviours. We hypothesized that children would have less PA and sleep time during the pandemic and that parents would influence their movement behaviour.

2 | MATERIAL AND METHODS

2.1 | Study design and participants

Using a longitudinal study design from the "Observatorio de Actividad Física en escolares de 3 a 9 años, https://observatorioactividadfisica.es," we enrolled 110 children (54 boys and 56 girls) 4–7 years old (mean age 5.77) and 115 parents (63 mothers and 52 fathers). Participants were enrolled from two different schools: a private school, *Santa María la Real-Maristas*, and a state school, *San Juan de la Cadena*, via non-probabilistic sampling from Pamplona, Spain. In September of 2019, the principal investigator had a meeting with the school heads to explain the goals of the project. In October of 2019, parents/guardians of children were informed of the study objectives during parent/guardian meetings at participating schools and were invited to review the study protocol. Recruitment 1 was carried out from January to March of 2020. After summer holidays, the investigator team had another meeting with the school heads and the parent/guardian to perform a second measurement 1 year later (January to March 2021, recruitment 2) as shown in Figure 1. The protocol was approved prior to COVID-19, however, investigators adjusted the protocol to follow the safety guidelines following the requirements set-out by the government of Spain and each school.

Exclusion criteria included injury/surgery in the last month, and/or any medical limitation/restrictions on physical ability testing. Parent/guardian informed consent and children informed assent were obtained. The study protocol was completed in accordance with the Helsinki Declaration and was approved by the Ethics Committee of the Universidad Pública de Navarra (CENEDUCA1/2019).

2.2 | Measures and procedures

Anthropometric measures (height, weight, and body mass index [BMI]) were evaluated according to the CDC-NHANES Survey protocol by

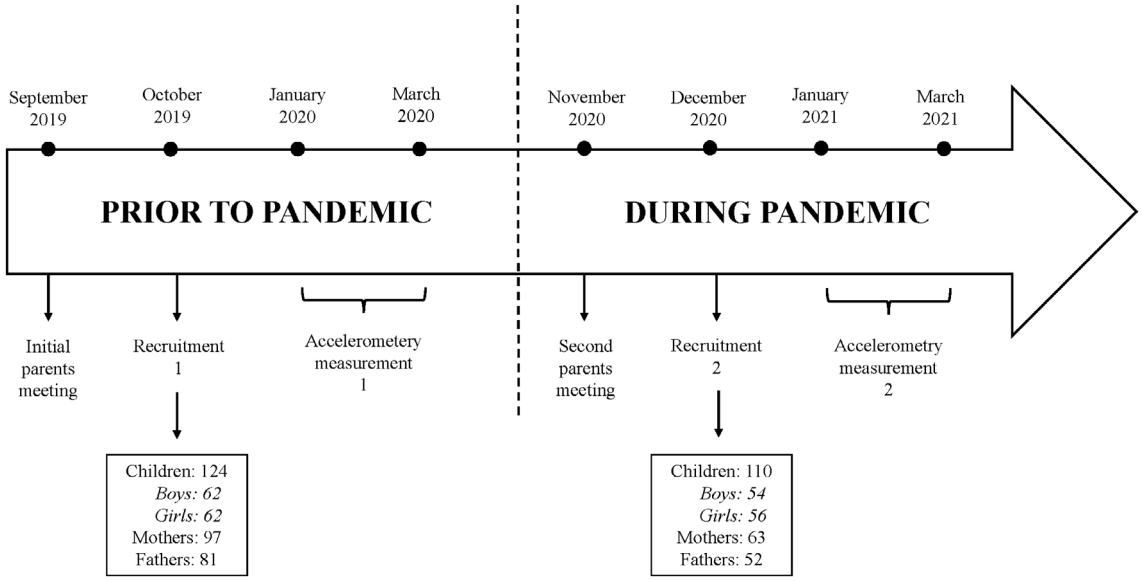

FIGURE 1 Timeline and participants in the longitudinal study

trained evaluators.[13] Height was measured in the Frankfurt position using a SECA 213® stadiometer with 1-mm precision and weight was measured using a Tanita DC-430MAS scale with 100 g precision, in light clothing and bare feet. BMI was calculated in kg/m^2 using measured weight and height.

Maternal education level was obtained by asking mothers about the highest level of education, which was dichotomized as university education and below. Maternal education is a key predictor of other resources within the family that strongly predicts childrens' well-being.[14]

Socioeconomic status (SES) was measured according to the level of average income per family unit. Socioeconomic factors have been reported as lifestyle determinants during the COVID-19 lockdown in children and adolescents.[15]

Accelerometry measures were computed with a tri-axial *GENEActiv Original* accelerometer during 6 consecutive days (4 weekdays and 2 weekend days) days (full time) at a frequency of 87.5 Hz,[16] worn on the non-dominant hand. Accelerometer data were extracted using the *GENEActiv* PC Software (version 3.3) and processed and analysed using the R-package GGIR.[17] Children must have worn the monitor for ≥600 min during wake time and an average sleep time ≥ 200 min, in each of the 6 days recorded. Specific cut-points for children and adults were applied to determine sedentary time, and light, moderate, and vigorous PA (i.e., TPA). For children, we used the following cut-offs: <56.3 (sedentary time),[18] 56.3 mg (light physical activity), 191.6 mg (moderate physical activity), and ≥ 695.8 mg (vigorous physical activity).[19] For adults, we used the following cut-offs: <45.8 (sedentary time),[18] 45.8 mg (light physical activity), 93.2 mg (moderate physical activity), and ≥ 418.3 mg (vigorous physical activity).[19] According to van Hees et al.,[20] a sleep algorithm was used to detect sleep and wake between self-reported bedtime and get uptime.

2.3 | Data analysis

Data are presented as means (SD or SE) or absolute and relative prevalence (*n* [%]). Normality was tested using one-sample Kolmogorov–Smirnov. The PA variables were found not to be normally distributed.

An analysis of covariance was employed to evaluate differences in changes in PA (TPA and MVPA), SB, and sleep time on weekdays and on weekends in children and their parents prior to and during the COVID-19 pandemic. In addition, changes on MVPA, TPA, SB, and sleep time of mothers and fathers during this period were categorized into tertiles to determine associations with changes in their children's movement behaviour on weekdays and weekends. We performed our analysis separately because there are findings showing different associations between mothers and fathers with their children.[21] Finally, a post-hoc analysis of Kruskal–Wallis test results was performed using the Dunn test and was adjusted by age, sex (only in children), and SES.

A *p*-value ≤0.05 was defined as statistically significant using *p Holm* adjustment. Cohen's *d* effect size was used to assess the magnitude of differences within groups and between groups (Cohen's *d*) and classified as small ($d = 0.20–0.49$), moderate ($d = 0.50–0.79$), and large ($d \geq 0.80$).[22] All statistical analysis was performed using JASP software (JASP Team, 2018).

3 | RESULTS

Table 1 shows the sample characteristics of participating children by sex prior to and during the COVID-19 pandemic. Significant differences were observed only in monthly family income ($p = 0.025$) (Table 1).

Table 2 shows the differences between PA, SB, and sleep time prior to and during COVID-19 pandemic. On weekdays, children

TABLE 1 Sample characteristics of children prior to and during the COVID-19 pandemic

	Prior to pandemic ($n = 124$)			During pandemic ($n = 110$)		
	Boys ($n = 62$)	Girls ($n = 62$)	p	Boys ($n = 54$)	Girls ($n = 56$)	p
Years (age)	5.70	5.83	0.179	6.70	6.83	0.179
Height (cm)	109.40	110.48	0.696	121.26	120.77	0.622
Weight (kg)	23.67	21.83	0.481	25.20	24.03	0.160
Body mass index (kg/m^2)	16.35	18.29	0.362	18.46	16.37	0.170
Maternal education *, *n* (%)	36 (57.45)	35 (56.86)	0.953			
Monthly family income#, *n* (%)	20 (32.65)	34 (55.32)	0.025			

*Mother with university studies.
#More or equal than 3000 euros (€).

showed an increase in MVPA (mean difference 10.70 min per day; $p = 0.002$; $d = 0.352$) and SB (mean difference 31.59 min per day; $p = 0.001$; $d = 0.366$) duration, and a decrease in sleep time (mean difference − 0.60 h per day; $p < 0.001$; $d = 0.620$). On weekends, children showed an increase in MVPA (mean difference 22.48 min per day; $p < 0.001$; $d = 0.624$) and TPA (mean difference 29.87 min per day; $p < 0.001$; $d = 0.406$) and a decrease their sleep time (mean difference − 0.52 h; $p = 0.002$; $d = -0.344$).

Mothers did not change their PA and sleep time (both weekdays and weekends) but decreased SB on weekends (mean difference − 47.24 min per day; $p = 0.049$; $d = 0.326$). Fathers also showed higher sleep time (mean difference 0.49 h per day; $p = 0.045$; $d = 0.364$) on weekdays. In addition, fathers showed lower SB (mean difference − 56.45 min per day; $p = 0.005$; $d = 0.523$), and higher sleep time (mean difference 0.62 h per day; $p = 0.031$; $d = 0.393$) on weekends (Table 2).

Figure 2 shows the association between changes in MVPA, TPA, and SB in both parents (categorized as tertiles) and their children PA levels on weekdays. Specifically, an increase in mother's MVPA (T1 < T3; $d = 1.279$; $p = 0.030$) and TPA (categorized as tertiles) was associated with higher increases in MVPA and TPA in their children (T1 < T3; $d = 0.880$; $p = 0.023$). On weekends, an increase in mother's MVPA was associated with higher increases in MVPA in their children (T1 < T2, $d = -0.904$, $p = 0.011$). However, contrary to expectations, there was also a difference between tertiles (T2 < T3, $d = 0.686$, $p = 0.035$) (Figure 3).

4 | DISCUSSION

We compared the levels of PA, SB, and sleep time in children aged 4–7 years prior to and during the pandemic, and we examined for relationships between these behaviours and those of their parents. Our main results are that, during the pandemic, the levels of MVPA and SB increased in children during weekdays, and sleep time decreased. Much the same was true at the weekend. Interestingly, an increase in mother's MVPA during this period was positively related with higher increases in MVPA in their children for both weekdays and weekends.

Few studies have examined how the exit from the COVID-19 lockdown has affected movement behaviours in children. A longitudinal study in Japanese preschoolers pre- and during COVID-19 found that PA and adherence to WHO-recommended guidelines decreased significantly, and also that children engaged in less weekday MVPA and weekday and weekend light PA.[7] This Japanese study also reported that both weekday and weekend SB increased during the COVID-19 pandemic.[7] These results reflect those of Ten Velde et al.[9] in Dutch children, who also showed that PA levels in children decreased during the COVID-19 pandemic, while recreational screen time increased. Contrary to expectations and the aforementioned findings, our study shows that children increased their PA and SB and decreased their sleep time during the pandemic. This finding is consistent with that of Hurter et al.[10] who showed that PA levels increased significantly upon return to school and after the COVID-19 lockdown.

There are several possible explanations for our changes. One explanation might be due to information about healthy habits received by the families after the first assessments through the web https://observatorioactividadfisica.es/ as well as individual reports of the results. Specifically, the 68.1% of the families report that after the first evaluation they did or tried to do more PA with their children. Furthermore, restrictions and social distancing made children spend more time with their families, which could have resulted in higher PA levels. In fact, young children are less likely to go out independently since they rely on parents or caretakers to accompany them.[23] In addition, perimeter closures reduced mobility to interprovincial movements and, consequently, families could have made many excursions around Navarre to nature sites. Second, we hypothesize that the increase of SB in our sample may be due to the change in school stage from early childhood education to primary education, which involves a change in school routines and increased sedentary activities at desks. Regarding sleep time, and in accordance with our findings, it was recently reported that the wake-up- and bedtime of preschoolers aged 2–5 years was delayed after lockdown and sleep quality deteriorated.[24]

Regarding the relationships between parents and children's movement behaviour during the pandemic, our results indicate that the PA of children is related to their mother's behaviour, mainly MVPA. Although it has been hypothesized that this relationship may vary

TABLE 2 Comparison between physical activity, sedentary behaviour, and sleep time in children and their parents on weekdays and weekends prior to and during the COVID-19 pandemic (after the lockdown)

	Weekdays								Weekends							
	Prior to pandemic			Difference between prior and during the COVID-19 pandemic					Prior to pandemic			Difference between prior and during the COVID-19 pandemic				
		95% CI			95% CI					95% CI			95% CI			
	Mean	Lower	Upper	Mean difference	Lower	Upper	*d*	*p*	Mean	Lower	Upper	Mean difference	Lower	Upper	*d*	*p*
Children[a]																
MVPA (minutes/day)	91.95	85.53	98.37	10.70	4.18	17.22	0.352	0.002	77.93	72.15	83.72	22.48	14.75	30.21	0.624	<0.001
TPA (minutes/day)	386.19	372.99	399.40	4.27	−10.17	18.71	0.063	0.558	298.83	286.06	311.60	29.87	14.07	45.66	0.406	<0.001
SB (minutes/day)	492.39	473.32	511.05	31.59	13.08	50.10	0.366	0.001	577.98	559.56	596.41	1.12	−23.38	25.61	0.010	0.928
Sleep time (hours/day)	9.44	9.31	9.57	−0.60	−0.80	−0.39	−0.620	<0.001	9.43	9.24	9.61	−0.52	−0.84	−0.20	−0.344	0.002
Mothers[b]																
MVPA (minutes/day)	23.99	20.95	27.04	2.41	−1.43	6.25	0.201	0.212	39.42	21.17	57.66	−10.37	−42.72	21.97	0.104	0.520
TPA (minutes/day)	361.66	341.89	381.43	9.20	−14.55	32.96	0.124	0.438	334.68	309.84	359.52	0.03	−43.25	43.30	0.010	0.999
SB (minutes/day)	664.48	637.62	691.34	−26.53	−59.49	6.43	0.258	0.111	672.99	654.26	691.72	−47.24	−94.26	−0.22	0.326	0.049
Sleep time (hours/day)	6.98	6.73	7.22	0.30	−0.10	0.70	0.234	0.138	7.44	7.16	7.72	0.57	−0.07	1.21	0.283	0.078
Fathers[b]																
MVPA (minutes/day)	30.00	25.86	36.13	1.58	−8.16	11.33	0.057	0.742	37.00	26.98	47.02	−8.77	−33.09	15.55	0.128	0.467
TPA (minutes/day)	355.10	332.58	377.62	−7.49	−32.82	17.84	0.100	0.551	320.85	302.30	339.40	4.00	−25.45	33.44	0.048	0.783
SB (minutes/day)	701.64	670.09	733.19	−37.49	−81.88	6.89	0.295	0.095	704.27	677.54	731.01	−56.45	−94.83	−18.08	0.523	0.005
Sleep time (hours/day)	6.47	6.19	6.75	0.49	0.012	0.97	0.364	0.045	7.08	6.77	7.39	0.62	0.06	1.20	0.393	0.031

Note: Values are reported as mean ± SE.

Abbreviations: MVPA, moderate-to-vigorous physical activity; TPA, total physical activity; SB, sedentary behaviour.

[a]Analyses were adjusted for age, sex, and socioeconomic status.

[b]Analyses were adjusted for age and socioeconomic status.

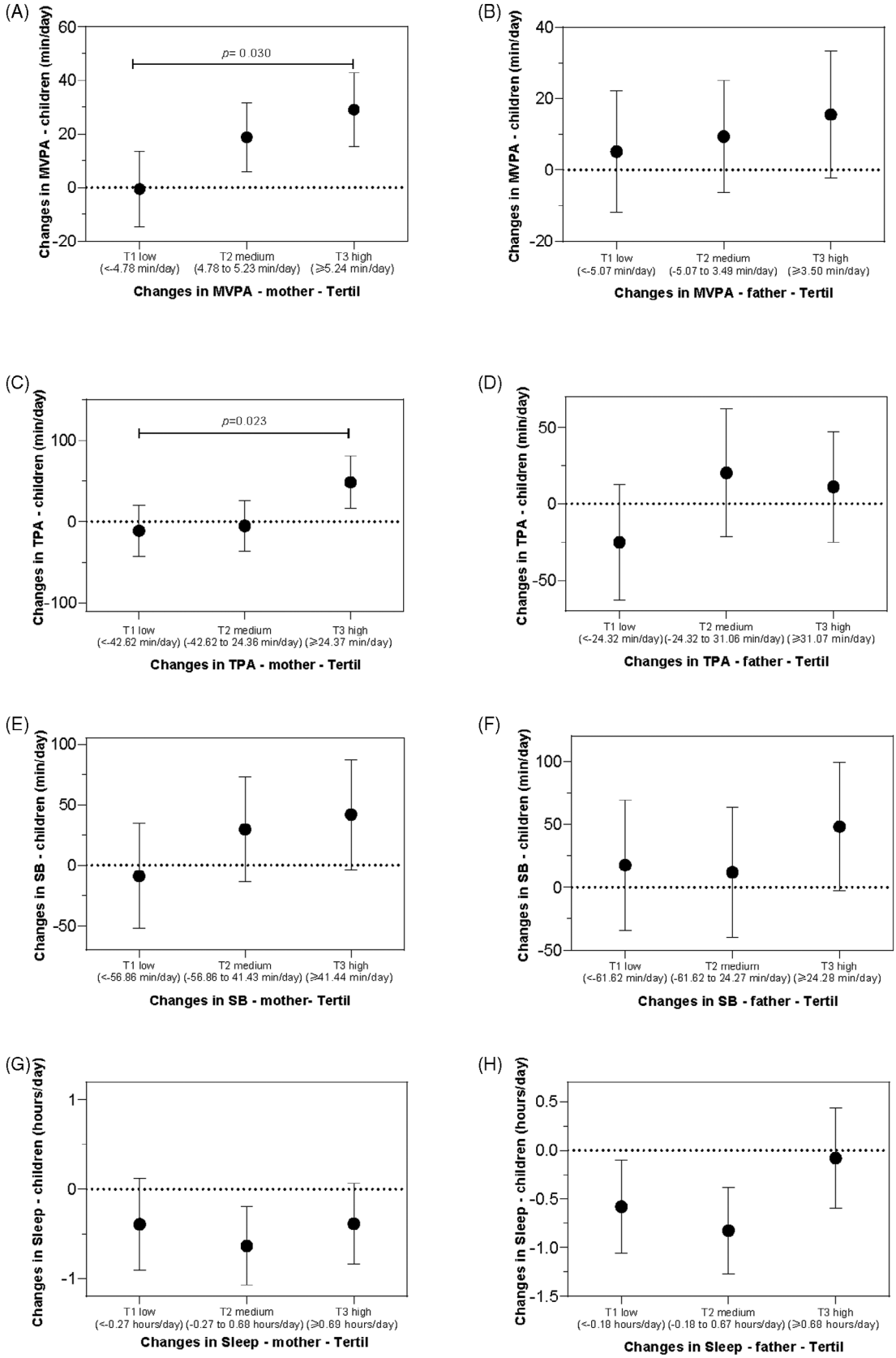

FIGURE 2 Changes in MVPA, TPA, SB, and sleep time of mothers (left) and fathers (right) during this period and its associations with changes in their children's movement behaviour on weekdays. SB, sedentary behaviour; T, tertil; TPA, total physical activity. Data were analysed by Kruskal–Wallis and Dunn's post hoc test and adjusted by sex, age, and SES

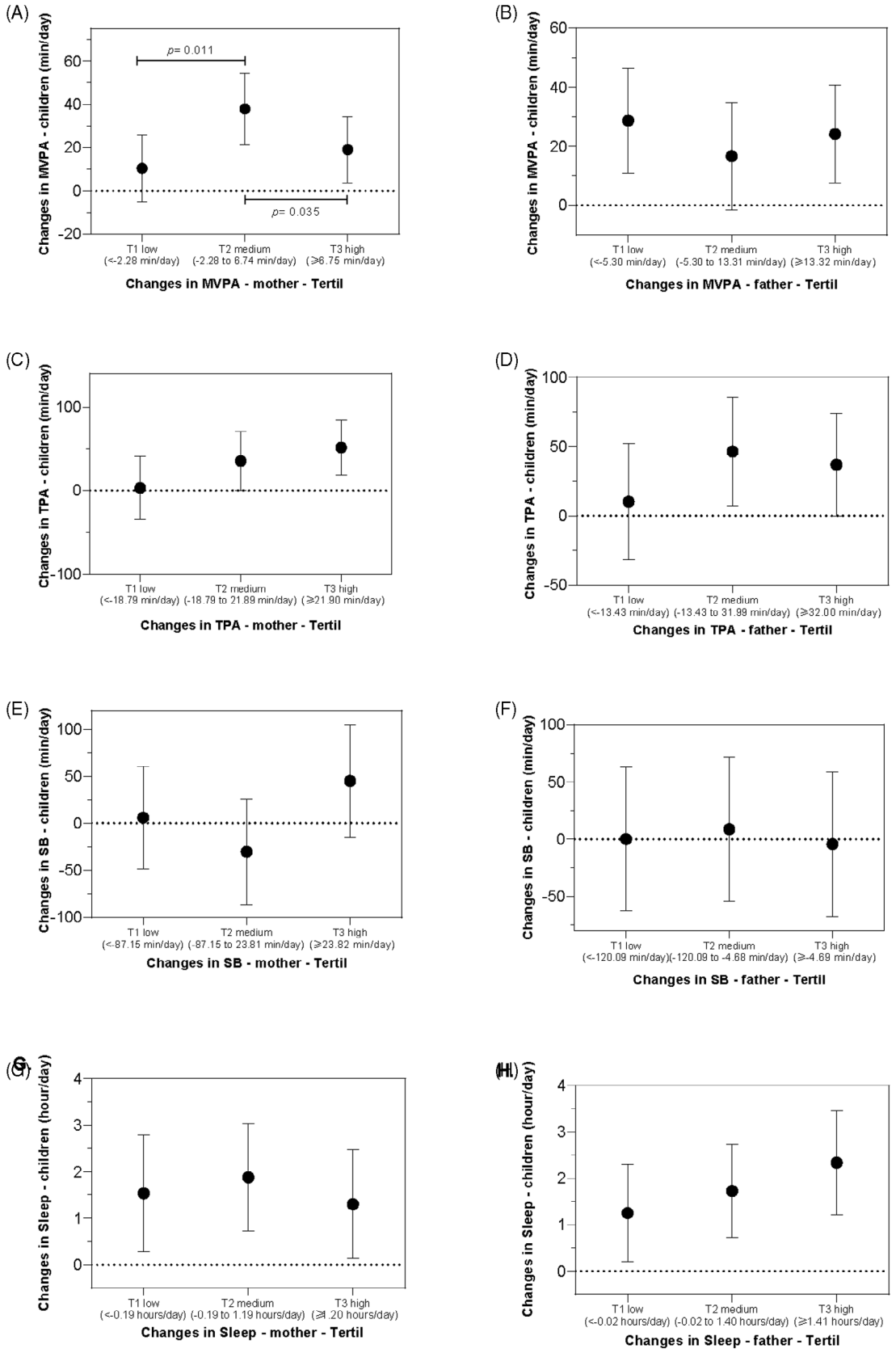

FIGURE 3 Changes in MVPA, TPA, SB, and sleep time of mothers (left) and fathers (right) during this period and its associations with changes in their children's movement behaviour on weekends. SB, sedentary behaviour; T, tertil; TPA, total physical activity. Data were analysed by Kruskal–Wallis and Dunn's post hoc test and adjusted by sex, age, and SES

with environmental conditions,[6] and that some young children are naturally physically active without parental intervention,[25] our results have been reported in recent studies. Specifically, our findings show that an increase in mother's TPA was positively related with higher increases in TPA in their children on weekdays. A possible explanation for this might be that the majority of mothers were walking or cycling together with their child as the main form of transport to the school, as suggested by Hnatiuk et al[12] This above-mentioned study also suggested that walking or cycling together in their free time was associated with higher MVPA in both parties on weekends. Active travel has previously been associated with greater PA in children aged 4 years.[26] Xu et al.[11] showed that children's PA levels on weekends were influenced more by the father's PA than by the mother's PA. This differs from the findings presented in our study. Therefore, the relationships observed between PA of children and their mothers might reflect the changes in behaviour before and during the COVID-19 pandemic observed in the present study.

Some limitations need to be considered in the interpretation of the findings of this study. First, the population might not be fully representative of the general Spanish population, based on the distribution of sex, age, school environment, and socioeconomic status. Another limitation is that the study design was cross-sectional and so we cannot establish the direction of the relationships. Finally, another bias is the use of accelerometers, as these devices do not capture certain types of activity well, such as cycling, climbing stairs, or swimming. Also, because our results depend on the cut-off points used to determine each PA intensities, findings should be interpreted with caution.

5 | CONCLUSION

We conclude that during the pandemic after the COVID-19 lockdown, children got more MVPA, more SB, and slept fewer hours than before, which indicates that children's movement behaviours were slightly affected by the COVID-19 pandemic. Increases in the PA levels of children could be associated with their mother' PA levels in this period, especially on weekdays. Future studies are needed to confirm whether these movement behaviours are maintained over time, without social restrictions.

ACKNOWLEDGEMENTS

This study was funded by grant CENEDUCA1/2019 from the Department of Education of the Government of Navarra (Spain). Dr. Antonio García-Hermoso is a Miguel Servet Fellow (Instituto de Salud Carlos III – CP18/0150).

CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

AUTHOR CONTRIBUTIONS

Antonio García-Hermoso and Alicia M. Alonso-Martínez conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript. Alicia M. Alonso-Martínez, Yesenia García-Alonso, and Gaizka Legarra-Gorgoñon designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript. Alicia M. Alonso-Martínez and Robinson Ramírez-Vélez conceptualized and designed the study, coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

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How to cite this article: García-Alonso Y, García-Hermoso A, Izquierdo M, Legarra-Gorgoñon G, Ramírez-Vélez R, Alonso-Martínez AM. Relationship between parents' and children's objectively assessed movement behaviours prior to and during the COVID-19 pandemic. *Pediatric Obesity*. 2022; e12923. doi:10.1111/ijpo.12923