Compliance with 24-Hour Movement Patterns in Schoolchildren: Infant Versus Primary Stage

Cumplimiento de las Pautas de Movimiento de 24 Horas en Escolares: Etapa Infantil Versus Etapa Primaria

Daniel García-Martínez
Gema Díaz-Quesada
Gema Torres-Luque

Department of Musical, Plastic and Corporal Expression Didactics, Faculty of Humanities and Educational Sciences, University of Jaén, Spain

Correspondence:
Gema Díaz-Quesada
gmdiaz@ujaen.es

Short title:
Compliance With Movement Patterns inSchoolchildren: Infant vs Primary

How to cite this article:
García-Martínez, D., Díaz-Quesada, G., & Torres-Luque, G. (2024). Compliance with 24-hour movement patterns in schoolchildren: infant versus primary stage. *Cultura, Ciencia y Deporte, 19*(62), 2154. https://doi.org/10.12800/ccd.v19i62.2154

Received: 11 December 2023 / **Accepted:** 15 September 2024

Abstract

Physical activity, sedentary behavior and sleep are the three main behaviors that interact during the day. The objective of the present study was, on the hand, to analyze the level of compliance with the 24 hours of movement in schoolchildren (pre-school versus primary school) and, on the other hand, to determine the differences between different times of the week. The sample consisted of 260 schoolchildren (93 from the infant stage and 167 from the primary stage). The 24 hours movement assessment was carried out including; physical activity, sedentary behavior and sleep. Physical activity time was determined by means of a questionnaire (Leisure Time Sedentary Behavior Questionnaire) throughout the week, as well as the hours of sleep by means of a weekly diary. From the results, compliance with the recommendations of 24 hours of movement was over 75%. In addition, the Primary stage performs more physical activity, experiences higher levels of sedentary behavior and gets more hours of sleep compared to the Infant stage. The conclusion is to increase physical activity levels from an early age and to keep a stricter control of daily sedentary behavior and sleep hours.

Keywords: Physical activity, sedentarism, sleep, recommendations, schoolchildren.

Resumen

Tanto la actividad física, como la conducta sedentaria y el sueño, son los tres principales comportamientos que interactúan durante el día. El objetivo del presente estudio fue, por un lado, analizar el nivel de cumplimiento de las 24 horas de movimiento en escolares (Infantil versus Primaria) y por otro determinar las diferencias entre diferentes momentos de la semana. La muestra estaba formada por 260 escolares (93 de la etapa Infantil y 167 de la etapa Primaria). Se llevó a cabo la evaluación de las 24 horas de movimiento que incluye; la actividad física, conducta sedentaria y sueño. El tiempo de actividad física se determinó por medio de una pulsera de actividad física durante 7 días; el tiempo de conducta sedentaria por medio de cuestionario (Cuestionario de conducta sedentaria en el tiempo libre) a lo largo de la semana, al igual que las horas de sueño por medio de diario semanal. De los resultados destaca el cumplimiento de las recomendaciones de 24 horas de movimiento por encima del 75%. Además, la etapa Primaria realiza más actividad física, experimenta mayores valores de conducta sedentaria y consume más horas de sueño respecto a la etapa Infantil. Se concluye incrementar los niveles de actividad física desde edades tempranas y llevar un control más estricto de la conducta sedentaria diaria y de las horas de sueño.

Palabras clave: Actividad física, sedentarismo, sueño, recomendaciones, escolares.

Introduction

The benefits of performing physical activity in the prevention or reduction of disease have been recognized by the scientific literature in the adolescent stage, especially at moderate (e.g., walking at a brisk pace) or vigorous (e.g., playing a game of basketball) intensities (Bull et al., 2020; Poitras et al., 2016).

According to the most recognized health recommendations, for ages 6 to 17 years, 60 min of moderate to vigorous physical activity (MVPA) is recommended, according to the Center for Disease Control and Prevention and the guidelines of the U.S. On the other hand, the guidelines set by the United Kingdom and the E.U. Physical Activity Guidelines established that, for ages under five years, it is recommended that a child perform 60 min of MVPA per day (Department of Health, Physical Activity, Health Improvement and Protection, 2011; Education and Culture of European Commission. EU Physical Activity Guidelines, 2008) and 180 min of total physical activity per day, according to the World Health Organization (WHO, 2019). In this regard, according to Miraflores et al. (2016), in children aged 3 to 6 years, it has been determined that they should perform 3 hours of physical activity per day, of any intensity and in different settings. Measuring physical activity in step volume is considered as an alternative, with recommendations around 13,000 steps per day for these ages (Cardon & De Bourdeaudhuij, 2007; Tanaka & Tanaka, 2009).

The adoption of a healthy lifestyle characterized by high levels of physical activity, low screen time, and optimal sleep duration has been found to provide more health benefits than the adoption of just one of these behaviors (Carson et al., 2017; Chaput et al., 2014). These health patterns have typically been studied in isolation, but, however, there is compelling evidence that these movement-related behaviors, interact throughout the day (24 hours) (Janssen et al., 2017; Poitras et al., 2016; Saunders et al., 2016). Time spent in physical activity inevitably and excludably interacts with sedentary and sleep time (Chaput et al., 2014). Consequently, both physical activity, sedentary behavior and sleep are the main behaviors that interact during the day. In this line, taking into account the time contained in a day and attending to scientific veracity, authors such as Tremblay et al. (2016) elaborated, for a healthy use of the 24 hours a day, the following recommendations regarding sedentary behavior and sleep: recreational screen time (< 2 hours) and sleep duration (9-11 hours in children between 5 and 13 years). In contrast, for the 3-6 years stage, according to Ramos Berzosa (2021), sedentary behavior time should be less than 1 hour per day. Furthermore, according to the American Academy of Pediatrics (A.A.P, 2016), the daily amount of sleep for children aged 3 to 5 years is 10 to 13 hours. Thus, attending to a holistic view of behavior throughout the 24 h can be employed as health indicators (Rollo et al., 2020; Tremblay et al., 2016), mainly associated with benefits at the physical, psychological and cognitive levels in children and adolescents (Carson et al., 2016; Chaput et al., 2016; Lissak, 2018; Poitras et al., 2016; Rollo et al., 2020; Tarokh et al., 2016; Wu et al., 2017). More specifically, a joint adherence to 24-hour movement recommendations (physical activity, sedentary behavior, and sleep duration) have been associated with additional health benefits, especially improved quality of life, diet, fitness, adiposity, and mental and social health (Carson et al., 2017; Janssen et al., 2017; Lee et al., 2018; Rollo et al., 2020; Walsh et al., 2018).

However, despite the independent and combined benefits of these three behaviors interacting 24 hours a day, a large percentage of young people do not meet the daily recommendations (Tremblay et al., 2016). Recently, a study conducted in more than 140 countries, showed that more than 75% of adolescents aged 11-17 years do not meet the international recommendations for physical activity, i.e., only 1 in 4 young people (Guthold et al., 2020).

The percentage of non-compliance can increase notably when the three 24h movement recommendations are examined together (Tapia-Serrano et al., 2022), especially in the transition from primary to secondary education (Chong et al., 2022). In this regard, a meta-analysis by authors such as Tapia-Serrano et al. (2022), with a sample of 387,437 young people from 63 studies and 23 countries, showed that only 11% of preschoolers, 10% of children and only 3% of adolescents meet the three recommendations (physical activity, sedentary behavior and sleep). Furthermore, it should be noted that only 9% of preschoolers, 16% of children and 28% of adolescents did not comply with any of the above three recommendations. In this regard, several studies have shown the benefits of physical activity in children, but little research has been conducted in children under three years of age (Díaz-Quesada et al., 2021).

In turn, it would be interesting to know at what times these recommendations are most clearly met. Among other circumstances, because the school has been considered an ideal place to promote the practice of physical activity and thus achieve the daily recommendations from an early age (Martínez-Gómez et al., 2014); even being indicated as the context where half of the daily physical activity time is spent (Pate et al., 2006). And is that, it has been shown that academic performance can be improved through physical activity at school (Carriedo & González, 2019).

Thus, in the scientific literature it has been shown that preschool children who regularly attend school perform the same amount of AFMV as those who do not go to school (Statler et al., 2020). Consequently, children have a higher level of physical activity outside school hours than during school time (Pate et al., 2006). In this line, different studies have also shown that preschool children perform more AFMV on weekdays compared to weekend days (Roscoe et al., 2019).

Another study has reflected that Chinese preschool-aged children spent significantly more time performing vigorous physical activity on weekdays than on weekends (Ji et al., 2018). However, most studies examining the level of physical activity intensity focus on the primary and secondary educational stages, while studies at younger ages remain scarce, despite the health benefits of physical activity in younger children (González-Díaz et al., 2017). On the other hand, less empirical attention has been paid to Spanish children in this context (Díaz-Quesada et al., 2022). In turn, there is a lack of information on what happens according to the educational stage analyzed, not only in terms of physical activity, but also sedentary behavior and sleep.

Therefore, the objectives of the present study are: a) To analyze the level of compliance with the 24-hour movement patterns in schoolchildren (pre-school versus primary school) and, b) To determine the differences between different times of the week.

Method

Sample

A total of 260 schoolchildren were selected, 93 Infant Education (average age = 4 years; height = 1.08 m; mass = 19.30 kg; BMI = 16.29 kg/ m^2) and 167 Primary Education (average age = 9.15 years; height = 1.40 m; mass = 37.06 kg; and BMI = 18.76 kg/ m^2). The sample selection was performed through a purposive sampling method according to the criteria of accessibility and proximity (Otzen & Manterola, 2017). The guardians signed a written consent to participate in the study and this study is approved by the ethics committee of the local entity.

Procedure

Assessment of 24-hour movement patterns including physical activity, sedentary behavior and sleep duration was conducted.

Physical Activity

Minutes of daily physical activity were determined using Garmin vivofit® jr. fitness wristbands (Garmin Ltd., Schaffhausen, Switzerland) for students aged 3 to 5 years and Xiaomi mi Band 4 Anhui Huami Information Technology Co., Ltd., China) for students aged 6 to 12 years. Both physical activity wristbands are wearable and designed for ages from 3 years old (Müller-Riemenschneider et al., 2017; Wang et al., 2017). The design of this wristband is comfortable, durable, and waterproof. The wearable device is paired with its app via a cell phone or tablet (APP Vivofit Jr. Ltd., Schaffhausen, Switzerland; and, Mi Fit, Anhui Huami Information Technology Co., Ltd., China; respectively). Both devices have been shown to be accurate in assessing physical activity in minutes or steps (Alsubheen et al., 2016; El-Amrawy & Nounou, 2015; Wang et al., 2017), being previously employed with early age populations (Gorny et al., 2017; Diaz-Quesada et al., 2021).

The participants wore the physical activity bracelet for seven consecutive days of a week of school routine, not taking it off either to sleep or to take a shower. Subsequently, the data from the application were consulted to obtain the average number of daily steps throughout the week. Students were considered to meet the physical activity recommendations when they performed a minimum of 13,000 steps (Cardon & De Bourdeaudhuij, 2007; Tanaka & Tanaka, 2009) (NASPE, 2014; Tremblay et al., 2016; Tremblay et al., 2017).

Sedentary Behavior

Sedentary behavior was assessed by means of the Health Behaviour in School-aged Children (HBSC) questionnaire validated in Spanish children and adolescents (Moreno et al., 2008). Participants had to respond to six items indicating the number of hours per day they spent watching television or Tablet, using a computer or cell phone and doing homework, both on weekends and during the week. This questionnaire was completed by the parent or guardian in the case of children between 3 and 6 years of age. The mean daily time spent in each sedentary behavior was calculated using a ratio of 5:2; that is: (daily time in sedentary behavior on weekdays (5 days) + (daily time in sedentary behavior on weekends (2 days) / 7 days). The daily sedentary behavior time was measured by summing the different daily sedentary time behaviors (Tapia-Serrano et al., 2022). Students were considered to meet the sedentary behavior recommendations when students aged 3 and 4 years spent less than 1 hour/day (Tremblay et al., 2017) and, students aged 5 to 12 years spent less than 2 hours/day (Tapia-Serrano et al., 2022; Tremblay et al., 2016).

Sleep Duration

The participants in the physical activity diary recorded the hours of sleep on each day of the week. In the case of children aged 3 to 6 years, these were completed by parents or guardians. The daily hours of sleep were calculated based on the ratio 5:2; that is: (hours of sleep during the week (5 days) + (hours of sleep at the weekend (2 days) / 7 days). Students were considered to meet the sleep recommendations when students aged 3 and 4 years accumulated between 10 and 13 hours

of sleep each day (Tremblay et al., 2017) and students aged 5 to 12 years accumulated between 9 and 11 hours of sleep each day (Tremblay et al., 2016).

Compliance With Recommendations

Participants were classified into one of eight possibilities based on their compliance with the 24h guidelines: 1) they did not meet any of the three guidelines; 2) they met only one guideline (physical activity, screen time or sleep duration); 3) they met two guidelines (physical activity + screen time; physical activity + sleep duration; screen time + sleep duration) or 4) they met all three 24 h guidelines assessed (physical activity screen time + sleep duration) based on previous studies (Tapia-Serrano et al., 2022).

Statistical Analysis

A descriptive analysis of the data was performed in the form of mean and standard deviation. Next, a Shapiro-Wilk normality test was performed which confirmed the non-normal distribution of the data. Next, a frequency analysis was performed to find out which participants met the individual 24-hour movement guidelines (met only sleep duration, met only physical activity, met only screen time, or met no recommendation) and in combination (met sleep duration + physical activity, met only sleep duration + screen time, met only physical activity + screen time, met only physical activity + screen time, or met all three recommendations). Subsequently, the variables were analyzed using the nonparametric Mann-Whitney U test, where the results are shown as mean and standard deviation, as well as the significance value *p*. The Mann-Whitney U test was used to observe the differences in the distribution of 24 h of movement between different times (all week, weekdays versus weekends and school hours versus after-school hours) between the Infant versus Primary stage, where physical activity, sedentary behavior and hours of sleep were evaluated. A confidence level of 95% was used for all analyses. The statistical program IBM SPSS Statistics 27.0 for Windows IBM Software (Group, Chicago, Illinois, United States) and the Jamovi program version 2.3.24 were used.

Results

Table 1 shows the compliance with the recommendations of 24 h of movement in terms of the eight possibilities of physical activity, sedentary behavior and hours of sleep.

Table 1
Compliance with the recommendations of 24h of movement for each of the eight situations (Infant versus Primary)

	Total (n = 260)	Infant (n = 93)	Primary (n = 167)	Difference Infant vs Primary (%)
Don't meet any of the 3 guidelines	0.40%	0.80%	0.00%	+ 0.80
They meet only 1 guideline	11.40%	11.40%	11.37%	+ 0.03
PA	78.46%	78.49%	78.44%	+ 0.05
Sedentary Behavior	79.60%	79.56%	79.64%	- 0.80
Sleep Duration	83.85%	83.87%	83.83%	+ 0.04
They meet only 2 guidelines	34.40%	34.50%	34.24%	+ 0.26
PA + SD	63.10%	63.44%	62.87%	+ 0.57
PA + SB	62.30%	62.36%	62.24%	+ 0.12
SD + SB	70.45%	69.90%	71.00%	- 1.1
Meet the 3 guidelines PA + SB + SD	53.83%	53.76%	53.90%	- 0.14

Note: PA: Physical Activity; SB: Sedentary Behavior; SD: Sleep Duration.

Compliance with the established recommendations is above 75%. Likewise, compliance with the three guidelines is above 50%. The compliance with the recommendations regarding the hours of sleep between the Infant and Primary stages stands out, with 83.8%. It is also observed that the Primary stage always shows a higher percentage than the Infant stage.

Table 2 shows the differences in the distribution of 24 hours of movement between the Early Childhood Education stage versus the Primary Education stage.

Table 2
Differences in the distribution of 24h of movement Infant stage versus Primary stage

Variable	Total (n = 260)	Infant (n = 93)	Primary (n = 167)	Value of *p*
Physical Activity				
The whole week (steps/day)	10947.20 ± 3780.99	9204.26 ± 2656.27	11917.8 ± 3967.97	< .001
Weekdays (M-F) (steps/day)	11235.65 ± 3948.41	9470.22 ± 3116.26	12218.79 ± 4027.85	< .001
Weekend (S-S) (steps/day)	10226.09 ± 4684.68	8539.34 ± 2985.94	11165.42 ± 5178.64	< .001
School hours (steps/day)	5120.77 ± 1473.62	4511.06 ± 960.09	5460.30 ± 1597.83	< .001
After school hours (steps/day)	6114.88 ± 3123.23	4959.16 ± 2788.70	6758.49 ± 3121.59	< .001
Sedentary Behavior				
The whole week (hours/day)	9.55 ± 5.26	7.45 ± 5.20	10.71 ± 4.93	< .001
Weekdays (M-F) (hours/day)	4.02 ± 3.16	3.34 ± 3.70	4.40 ± 2.76	< .001
Weekend (S-S) (hours/day)	5.52 ± 3.02	4.11 ± 2.76	6.31 ± 2.88	< .001
Sleep Hours				
The whole week (hours/day)	9.50 ± 0.75	9.30 ± 0.81	9.62 ± 0.70	.005
Weekdays (M-F) (hours/day)	9.47 ± 0.75	9.26 ± 0.82	9.58 ± 0.69	.057
Weekend (S-S) (hours/day)	9.59 ± 1.07	9.33 ± 1.07	9.74 ± 1.04	.004

In general, the Primary stage performs more physical activity, experiences higher values of sedentary behavior and consumes more hours of sleep compared to the Infant stage.

It was observed that, in terms of physical activity, in general, students in the infant stage performed less physical activity in steps/day compared to students in the primary stage throughout the week, with highly significant differences ($p < .001$) between the two stages. Regarding the steps taken in the variable's weekdays (M-F) (steps/day) and weekends (S-D) (steps/day), significant differences ($p < .001$) were observed between the different stages, where the Primary stage showed more steps taken at both times compared to the Infant stage. In the analysis of the variables school time (steps/day) and out-of-school time (steps/day), significant differences were also observed ($p < .001$), with students in the Primary stage performing more physical activity in steps/day both at school and out-of-school time compared to the Infant stage.

The results regarding sedentary behavior showed that students in primary school had higher values than those in infant school ($p < .001$). When analyzing the variables between weekdays (M-F) (hours/day) and weekends (S-D) (hours/day), significant differences were observed, where the Primary stage had more sedentary behavior in relation to the Infant stage, at both times.

The analysis of the hours of sleep showed significant differences between the different stages. In general, the primary school subjects obtained more hours of sleep during the week compared to the infant stage. The results showed significant differences in the analysis of the variable weekend (S-D) (hours/day) ($p = .004$), where the Primary stage slept more compared to the Infant stage. No significant differences in hours of sleep were found in the analysis of the midweek variable (M-F) (hours/day).

Discussion

The objectives of the present study were to analyze the level of compliance with the 24-hour movement patterns in schoolchildren (infant versus primary) and to determine the differences between different times of the week. The results indicate that compliance with the three movement patterns is above 53%, with physical activity, sedentary behavior and sleep individually above 75%. Relatively speaking, the infant stage has a lower volume of steps, but also less sedentary behavior than the participants in the primary stage, an aspect that can be seen both throughout the week and at the different times evaluated.

Knowing the behavior with respect to movement patterns can generate strategies that involve healthy lifestyle habits in the future. The results of this study are very interesting if it is established that they are Spanish population. Regarding the infant stage, 78.4%, 79.5% and 83.8% comply with the recommendations for physical activity, sedentary behavior and sleep, respectively (Table 1). Regarding physical activity, different studies indicate that physical activity compliance is around 30-90% (Berglind et al., 2018; Chaput et al., 2017; Cliff et al., 2017; Kracht et al., 2019). This range is very wide, mainly due to the country (Berglind et al., 2018; Chaput et al., 2017) or the measurement instrument (accelerometer or questionnaire) (Cliff et al., 2017; Walsh et al., 2018), so the results of this study are above 50-60% (Chaput et al., 2017; Chia et al., 2020) in children from Canada or Singapore and below that determined in countries such as the USA or Australia (Cliff et al., 2017; Kracht et al., 2019). In the same way, it happens with sedentary behavior, where most researches mark around 17-31% (Carson et al., 2017; Chaput et al., 2017; Chia et al., 2020; Cliff et al., 2017), the present results being in line with those found by Berling et al. (2018) and Roberts et al. (2017) between 63 and 70%. The importance of compliance with sleep recommendations is currently one of the most discussed issues, due to its implication in lifestyle habits acquired from an early age (Rollo et al., 2020; Tremblay et al., 2016). The results of 83% are in line with research conducted by other investigators, who place sleep compliance at around 70-98% (Berling et al., 2018; Chaput et al., 2017; Chia et al., 2020; Cliff et al., 2017). To highlight that sleep is an essential activity that interacts and modulates a psychic and physiological balance in the individual (Fabres & Moya, 2021) and, in children, its lack, can cause low cognitive functioning (Hirshkowitz et al., 2015). Regarding the primary school stage, the results of the present study obtained percentage values similar to those of children, both in physical activity (78.4%), sedentary behavior (79.9%) and sleep (83.8%), respectively. Here there are differences to those found in other studies in the population aged 8-11 years. Physical activity is around 20-44% in studies even attending to twelve different countries, while sedentary behavior compliance is reduced at these ages around 20-30% and sleep around 30-40% (Dumuid et al., 2018; Laurson et al., 2014; Sampasa-Kanyinga et al., 2017; Thiyel et al., 2019). It is obvious that the reasons for these differences can be very varied as discussed above, what is certain is that, although there are fewer longitudinal studies, it seems that as age advances, compliance with 24 h movement recommendations tends to decrease (Chong et al., 2022). In turn, for example, in terms of physical activity values, percentages to those found are around 78% closer to 89% analyzed by Manyanga et al. (2019) in a total of 683 children aged 9 to 11 years in Mozambique; highlighting those differences in terms of the geographical area of the world and sociocultural variability may be important factors to consider when observing the causes and generating future intervention strategies (Sampasa-Kanyinga et al., 2017).

It is true that, from a more global approach, 53% of the total sample of this study complied with the three movement patterns (Table 1). This fact is very relevant, since scientific evidence indicates, on the one hand, differential values between ages 3-4 years and 9-11 years, ranging from 13-30% (Chaput et al., 2017; Chia et al., 2020; Cliff et al., 2017) and 5-10% (Dumuid et al., 2018; Guerrero et al., 2019; Laurson et al., 2014; Sampasa-Kanyinga et al., 2017; Thivel et al., 2019), respectively. In the present study, the data are substantially above and also without age being a determinant. As highlighted above, it may be due to social, cultural, economic or geographical factors, which may have a determining influence on the child population, where although they have not been taken into account in the present research, they are a possibility for future analysis. But it is a value to highlight, because what is evidenced is that compliance with the 3 24h guidelines is associated with a better quality of life (Sampasa-Kanyinga et al., 2017), less impulsivity (Guerrero et al., 2019), as well as the high use of screens can lead to psychosocial problems (Chong et al., 2022).

Another important question to consider is to know what this behavior is like at different times of the week. In this sense, when contrasting the absolute values, the differences between educational stages are more evident (Table 2). Thus, it can be seen that the primary school stage obtains a greater volume of steps (about 12,000 steps per day compared to approximately 9,500 steps in the infant stage), the difference being statistically significant, not only throughout the week but also at the different times evaluated (Table 2). It is true that the steps developed by the Infant Stage, are in accordance with other studies that mark a value of 10,000 steps/day during the week, although with lower values of 8,000 steps/day at the weekend (De Craemer et al., 2018), being the trend at ages of approximately two years lower (Díaz-Quesada et al., 2021). Independent of this casuistry, both in physical activity and sedentary behavior, it is shown how at the weekend compliance with the recommendations tends to fall (Chong et al., 2022; De Craemer et al., 2018; Leppanen et al., 2019). Regarding sleep, no such clear differences are shown, with both groups having a duration between 9 and 11 hours at the different times evaluated. It is interesting to note that, normally, the hours of sleep at the weekend tend to be longer than during the week (Chong et al., 2022; Leppanen et al., 2019), although no such trend was observed in this sample. Although it is necessary to further delve into the behavior of movement patterns at different times, these results may contribute to generate strategies involving a healthier daily habit.

Finally, this study is not without some limitations. The small size and difficulty of accessing the child sample would be one of the limitations. Also, due to the nature of the study itself, as it is a cross-sectional study, causal relationships cannot be established.

Conclusions

It is concluded that compliance with the recommendations of 24 h of movement in terms of physical activity, sedentary behavior and sleep in the schoolchildren analyzed are above 75% in both stages. In addition, the Primary stage performs more physical activity, experiences higher values of sedentary behavior; being the hours of sleep similar to those of the Infant stage. This study can contribute to future intervention policies to promote behaviors according to the 24h movement guidelines from early ages, from an integrated and holistic approach.

Practical Applications

The findings obtained in this study may provide useful information that will contribute to raise awareness of the importance of achieving a balance between physical activity, control of sedentary behavior, and hours of sleep. Likewise, at the school level, this study serves as a reference point to encourage the creation of strategies and educational programs to increase the levels of physical activity in the different educational stages and to reduce sedentary behavior. Finally, this study reflects a current framework of the behavior of children at an early age throughout the week and serves as a reference for future action points in this regard.

Ethics Committee Statement

The study was performed following the ethical standards of the Declaration of Helsinki (1975) and was approved by the Ethics Committee of the University of Jaén (JUN.22/1.PRY, 7/7/2022).

Conflict of Interest Statement

The funding bodies or institutions had no influence on the design of the study, the analysis of the data or the interpretation of the results.

Funding

This research was funded by University of Jaén, as part of the Plan de Innovación y Mejora Docente (PIMED-UJA 2022) project, PIMED31_202224.

Authors' Contribution

Conceptualization D.G.M., G.D.Q. & G.T.L.; Methodology G.D.Q. & G.T.L.; Software D.G.M., G.D.Q. & G.T.L.; Validation D.G.M. & G.D.Q.; Formal Analysis D.G.M. & G.D.Q.; Investigation D.G.M., G.D.Q. & G.T.L.; Resources D.G.M., G.D.Q. & G.T.L.; Data Curation D.G.M., G.D.Q. & G.T.L.; Writing – Original Draft D.G.M. & G.D.Q.; Writing – Review & Editing G.T.L.; Visualization G.T.L.; Supervision D.G.M., G.D.Q. & G.T.L.; Project Administration D.G.M., G.D.Q. & G.T.L.; Funding Acquisition G.T.L. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author (gmdiaz@ujaen.es).

References

Alsubheen, S.A.A., George, A.M., Baker, A., Rohr, L.E., & Basset, F.A. (2016). Accuracy of the vivofit activity tracker. *Journal of Medical Engineering & Technology*, *40*(6), 298-306. https://doi.org/10.1080/03091902.2016.1193238

American Academy of Pediatrics. (2016). *Los buenos hábitos del sueño: ¿Cuántas horas de sueño necesita su niño?* HealthyChildren.org. https://doi.org/10.1542/9781610020794-part02-ch35

Berglind, D., Ljung, R., Tynelius, P., & Brooke, H.L. (2018). Cross-sectional and prospective associations of meeting 24-h movement guidelines with overweight and obesity in preschool children. *Pediatric Obesity*, *13*(7), 442-449. https://doi.org/10.1111/ijpo.12265

Bull, F.C., Al-Ansari, S.S., Biddle, S., Borodulin, K., Buman, M.P., Cardon, G., Carty, C., Chaput, J.P., Chastin, S., Chou, R., Dempsey, P.C., DiPietro, L., Ekelund, U., Firth, J., Friedenreich, C.M., Garcia, L., Gichu, M., Jago, R., Katzmarzyk, P.T., Lambert, E., & Willumsen, J.F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British Journal of Sports Medicine*, *54*(24), 1451- 1462. https://doi.org/10.1136/bjsports-2020-102955

Cardon, G., & De Bourdeaudhuij, I. (2007). Comparison of pedometer and accelerometer measures of physical activity in preschool children. *Pediatric Exercise Science*, *19*(2), 205-214. https://doi.org/10.1123/pes.19.2.205

Carriedo, A., & González, C. (2019). Rendimiento Académico en Educación Física: Aspectos Académicos versus Físico-Deportivos. (Academic Achievement in Physical Education: Academic versus Physical Activity aspects). *Cultura, Ciencia y Deporte*, *14*(42), 225–232. https://doi.org/10.12800/ccd.v14i42.1335

Carson, V., Chaput, J.P., Janssen, I., & Tremblay, M.S. (2017). Health associations with meeting new 24-hour movement guidelines for Canadian children and youth. *Preventive Medicine*, *95*, 7-13. https://doi.org/10.1016/j.ypmed.2016.12.005

Carson, V., Tremblay, M.S., Chaput, J.P., & Chastin, S.F. (2017). Associations between sleep duration, sedentary time, physical activity, and health indicators among Canadian children and youth using compositional analyses. *Applied Physiology, Nutrition, and Metabolism*, *41*(6), S294-S302. https://doi.org/10.1139/apnm- 2016-0026

Chaput, J.P., Carson, V., Gray, C.E., & Tremblay, M.S. (2014). Importance of all movement behaviors in a 24 hour period for overall health. *International Journal of Environmental Research and Public Health*, *11*(12), 12575-12581. https://doi.org/10.3390/ijerph111212575

Chaput, J.P., Colley, R.C., Aubert, S., Carson, V., Janssen, I., Roberts, K.C., & Tremblay, M.S. (2017). Proportion of preschool-aged children meeting the Canadian 24-Hour Movement Guidelines and associations with adiposity: results from the Canadian Health Measures Survey. *BMC Public Health, 17*(5), 147-154. https://doi.org/10.1186/s12889-017-4854-y

Chaput, J.P., Gray, C.E., Poitras, V.J., Carson, V., Gruber, R., Olds, T., Weiss, S.K., Connor Gorber, S., Kho, M.E., Sampson, M., Belanger, K., Eryuzlu, S., Callender, L., & Tremblay, M.S. (2016). Systematic review of the relationships between sleep duration and health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism*, *41*(6), S266-S282. https://doi.org/10.1139/apnm-2015-0627

Chia, M.Y.H., Tay, L.Y., & Chua, T.B.K. (2020). Quality of life and meeting 24-h WHO guidelines among preschool children in Singapore. *Early Childhood Education Journal*, *48*, 313-323. https://doi.org/10.1007/s10643-019-00987-9

Chong, K.H., Parrish, A.M., Cliff, D.P., Dumuid, D., & Okely, A.D. (2022). Changes in 24-hour movement behaviours during the transition from primary to secondary school among Australian children. *European Journal of Sport Science*, *22*(8), 1276-1286. https://doi.org/10.1080/17461391.2021.1903562

Cliff, D.P., McNeill, J., Vella, S.A., Howard, S.J., Santos, R., Batterham, M., Melhuish, E., Okely, A.D., & de Rosnay, M. (2017). Adherence to 24-h movement Guidelines for the early years and associations with social-cognitive development among Australian preschool children. *BMC Public Health, 17*, 207-215. https://doi.org/10.1186/s12889-017-4858-7

De Craemer, M., McGregor, D., Androutsos, O., Manios, Y., & Cardon, G. (2018). Compliance with 24-h movement behaviour guidelines among Belgian pre-school children: the ToyBox-study. *International Journal of Environmental Research and Public Health*, *15*(10), 2171. https://doi.org/10.3390/ijerph15102171

Department of Health, Physical Activity, Health Improvement and Protection (2011). *Start Active, Stay Active a Report on Physical Activity for Health from the Four Home Countries, Chief Medical Officers.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/830943/withdrawn_dh_128210.pdf

Díaz-Quesada, G., Bahamonde-Pérez, C., Giménez-Egido, J.M., & Torres-Luque, G. (2021). Use of wearable devices to study physical activity in early childhood education. *Sustainability*, *13*(24), 13998. https://doi.org/10.3390/su132413998

Díaz-Quesada, G., Gálvez-Calabria, M.D.L.Á., Connor, J.D., & Torres-Luque, G. (2022). When Are Children Most Physically Active? An Analysis of Preschool Age Children's Physical Activity Levels. *Children*, *9*(7), 1015. https://doi.org/10.3390/children9071015

Dumuid, D., Maher, C., Lewis, L.K., Stanford, T.E., Martín Fernández, J.A., Ratcliffe, J., Katzmarzyk, P.T., Barreira, T.V., Chaput, J.P., Fogelholm, M., Hu, G., Maia, J., Sarmiento, O.L., Standage, M., Tremblay, M.S., Tudor-Locke, C., & Olds, T. (2018). Human development index, children's health-related quality of life and movement behaviors: a compositional data analysis. *Quality of Life Research: an International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation, 27*(6), 1473–1482. https://doi.org/10.1007/s11136-018-1791-x

Education and Culture of European Commission (2008). *EU Physical Activity Guidelines.* https://www.efdn.org/wp-content/uploads/2016/07/eu-physical- activity-guidelines-european commission.pdf

El-Amrawy, F., & Nounou, M.I. (2015). Are currently available wearable devices for activity tracking and heart rate monitoring accurate, precise, and medically beneficial? *Healthcare Informatics Research*, *21*(4), 315-320. https://doi.org/10.4258/hir.2015.21.4.315

Fabres, L., & Moya, P. (2021). Sueño: conceptos generales y su relación con la calidad de vida. *Revista Médica Clínica Las Condes, 32*(5), 527-534. https://doi.org/10.1016/j.rmclc.2021.09.001

Gorny, A.W., Liew, S.J., Tan, C.S., & Müller-Riemenschneider, F. (2017). Fitbit charge HR wireless heart rate monitor: validation study conducted under free-living conditions. *JMIR mHealth and uHealth*, *5*(10), e8233. https://doi.org/10.2196/mhealth.8233

González-Díaz, I.M., Fraguela-Vale, R., & Varela-Garrote, L. (2017). Niveles de actividad física en Educación Infantil y su relación con la salud: implicaciones didácticas. *Sportis*, *3*(2), 358-374. https://doi.org/10.17979/sportis.2017.3.2.1888

Guerrero, M.D., Barnes, J.D., Walsh, J.J., Chaput, J.P., Tremblay, M.S., & Goldfield, G.S. (2019). 24-hour movement behaviors and impulsivity. *Pediatrics, 144*(3). https://doi.org/10.1542/peds.2019-0187

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2020). Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1· 6 million participants. *The Lancet Child & Adolescent Health*, *4*(1), 23-35. https://doi.org/10.1016/s2352-4642(19)30323-2

Hirshkowitz, M., Whiton, K., Albert, S.M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Adams-Hillard, P.J., Katz, E.S., Kheirandish-Gozal, L., Neubauer, D.N., O'Donnell, A.E., Ohayon, M., Peever, J., Rawding, R., Sachdeva, R.C., Setters, B., Vitiello, M.V., & Ware, J.C. (2015). National Sleep Foundation's updated sleep duration recommendations: final report. *Sleep Health, l1*(4), 233-243. https://doi.org/10.1016/j.sleh.2015.10.004

Janssen, I., Roberts, K.C., & Thompson, W. (2017). Is adherence to the Canadian 24- Hour Movement Behaviour Guidelines for Children and Youth associated with improved indicators of physical, mental, and social health? *Applied Physiology, Nutrition, and Metabolism*, *42*(7), 725-731. https://doi.org/10.1139/apnm-2016-0681

Ji, M., Tang, A., Zhang, Y., Zou, J., Zhou, G., Deng, J., Yang, L., Li, M., Chen, J., Qin, H., & Lin, Q. (2018). The relationship between obesity, sleep and physical activity in Chinese preschool children. *International Journal of Environmental Research and Public Health*, *15*(3), 527. https://doi.org/10.3390/ijerph15030527

Kracht, C.L., Webster, E.K., & Staiano, A.E. (2019). Sociodemographic differences in young children meeting 24-hour movement. *Journal of Physical Activity and Health, 16*(10), 908-915. https://doi.org/10.1123/jpah.2019-0018

Laurson, K.R., Lee, J.A., Gentile, D.A., Walsh, D.A., & Eisenmann, J.C. (2014). Concurrent Associations between Physical Activity, Screen Time, and Sleep Duration with Childhood Obesity. *International Scholarly Research Notices, 2014*(1), 204540. https://doi.org/10.1155/2014/204540

Leppänen, M.H., Ray, C., Wennman, H., Alexandrou, C., Sääksjärvi, K., Koivusilta, L., Erkkola, M., & Roos, E. (2019). Compliance with the 24-h movement guidelines and the relationship with anthropometry in Finnish preschoolers: the DAGIS study. *BMC Public Health, 19*, 1-8. https://doi.org/10.1186/s12889-019-7967-7

Lissak, G. (2018). Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study. *Environmental Research*, *164*, 149-157. https://doi.org/10.1016/j.envres.2018.01.015

Manyanga, T., Barnes, J.D., Chaput, J.P., Katzmarzyk, P.T., Prista, A., & Tremblay, M.S. (2019). Prevalence and correlates of adherence to movement guidelines among urban and rural children in Mozambique: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity, 16*, 1-12. https://doi.org/10.1186/s12966-019-0861-y

Martinez-Gomez, D., Veiga, O. L., Zapatera, B., Gomez-Martinez, S., Martínez, D., & Marcos, A. (2014). Physical activity during high school recess in Spanish adolescents: the AFINOS study. *Journal of Physical Activity and Health*, *11*(6), 1194-1201. https://doi.org/10.1123/jpah.2012-0345

Miraflores, E., Cañada, D., & Abad, B. (2016). Actividad Física y Salud de 3 a 6 años. *Guía para docentes de Educación Infantil.* Gobierno de España. https://www.observatoriodelainfancia.es/oia/esp/descargar.aspx?id=5126&tipo=documento

Moreno, L.A., De Henauw, S., González-Gross, M., Kersting, M., Molnar, D., Gottrand, F., Barrios, L., Sjöström, M., Manios, Y., Gilbert, C.C., Leclercq, C., Widhalm, K., Kafatos, A., & Marcos, A. (2008). Design and implementation of the healthy lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study. *International Journal of Obesity, 32*(5), S4-S11. https://doi.org/10.1038/ijo.2008.177

National Association for Sport and Physical Education. (2014). *Active start: A statement of physical activity guidelines for children from birth to age 5* (2nd ed.). Reston. https://doi.org/10.1080/00971170.1977.10621114

Otzen, T., & Manterola, C. (2017). Técnicas de muestreo en un estudio de población. *Revista Internacional de Morfología, 31*(1), 227-232. https://doi.org/10.4067/S0717-95022017000100037

Pate, R.R., Davis, M.G., Robinson, T.N., Stone, E.J., McKenzie, T.L., & Young, J.C. (2006). Promoting physical activity in children and youth: a leadership role for schools: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Physical Activity Committee) in collaboration with the Councils on

Cardiovascular Disease in the Young and Cardiovascular Nursing. *Circulation*, *114*(11), 1214-1224. https://doi.org/10.1161/circulationaha.106.177052

Poitras, V.J., Gray, C.E., Borghese, M.M., Carson, V., Chaput, J.P., Janssen, I., Katzmarzyk, P.T., Pate, R.R., Connor Gorber, S., Kho, M.E., Sampson, M., & Tremblay, M.S. (2016). Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism*, *41*(6), S197- S239. https://doi.org/10.1139/apnm-2015-0663

Ramos-Berzosa, P. (2021). La actividad física y el sueño en la etapa de 3 a 6 años. [Tesis doctoral, Universidad de Valladolid]. Repositorio del campus de la UVA. https://uvadoc.uva.es/handle/10324/49070

Roberts, K.C., Yao, X., Carson, V., Chaput, J.P., Janssen, I., & Tremblay, M.S. (2017). Meeting the Canadian 24-Hour Movement Guidelines for Children and Youth. *Health reports, 28*(10), 3-7. https://www.researchgate.net/profile/Ian-Janssen/publication/322295003_Meeting_the_Canadian_24Hour_Movement_Guidelines_for_Children_and_Youth/links/5a5f5af2458515b43779639d/Meeting-the-Canadian-24-Hour-Movement-Guidelines-for-Children-and-Youth.pdf

Rollo, S., Antsygina, O., & Tremblay, M.S. (2020). The whole day matters: understanding 24-hour movement guideline adherence and relationships with health indicators across the lifespan. *Journal of Sport and Health Science*, *9*(6), 493-510. https://doi.org/10.1016/j.jshs.2020.07.004

Roscoe, C.M., James, R.S., & Duncan, M.J. (2019). Accelerometer-based physical activity levels differ between week and weekend days in British preschool children. *Journal of Functional Morphology and Kinesiology*, *4*(3), 65. https://doi.org/10.3390/jfmk4030065

Sampasa-Kanyinga, H., Standage, M., Tremblay, M.S., Katzmarzyk, P.T., Hu, G., Kuriyan, R., Maher, C., Maia, J., Viejos, T., Sarmiento, O.L., Tudor-Locke, C., & Chaput, J.P. (2017). Associations between meeting combinations of 24-h movement guidelines and health-related quality of life in children from 12 countries. *Public Health*, *153*, 16-24. https://doi.org/10.1016/j.puhe.2017.07.010

Saunders, T.J., Gray, C.E., Poitras, V.J., Chaput, J.P., Janssen, I., Katzmarzyk, P.T., Olds, T., Gorber, S.C., Kho, M.E., Sampson, M., Tremblay, M.S., & Carson, V. (2016). Combinations of physical activity, sedentary behaviour and sleep: relationships with health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism*, *41*(6), S283-S293. https://doi.org/10.1139/apnm-2015-0626

Statler, J., Wilk, P., Timmons, B.W., Colley, R., & Tucker, P. (2020). Habitual physical activity levels and sedentary time of children in different childcare arrangements from a nationally representative sample of Canadian preschoolers. *Journal of Sport and Health Science*, *9*(6), 657-663. https://doi.org/10.1016/j.jshs.2019.03.009

Tanaka, C., & Tanaka, S. (2009). Daily physical activity in Japanese preschool children evaluated by triaxial accelerometry: the relationship between period of engagement in moderate-to-vigorous physical activity and daily step counts. *Journal of Physiological Anthropology*, *28*(6), 283-288. https://doi.org/10.2114/jpa2.28.283

Tapia-Serrano, M.A., Sevil-Serrano, J., Sánchez-Miguel, P.A., López-Gil, J.F., Tremblay, M.S., & García-Hermoso, A. (2022). Prevalence of meeting 24-Hour Movement Guidelines from pre-school to adolescence: A systematic review and meta-analysis including 387,437 participants and 23 countries. *Journal of Sport and Health Science, 11*(4), 427-437. https://doi.org/10.1016/j.jshs.2022.01.005

Tarokh, L., Saletin, J.M., & Carskadon, M.A. (2016). Sleep in adolescence: Physiology, cognition and mental health. *Neuroscience & Biobehavioral Reviews*, *70*, 182- 188. https://doi.org/10.1016/j.neubiorev.2016.08.008

Thivel, D., Tremblay, M.S., Katzmarzyk, P.T., Fogelholm, M., Hu, G., Maher, C., Maia, J., Olds, T., Sarmiento, O.L., Standage, M., Tudor-Locke, C., Chaput, J.P., & Grupo de investigación ISCOLE (2019). Associations between meeting combinations of 24-hour movement recommendations and dietary patterns of children: A 12-country study. *Preventive Medicine, 118*, 159-165. https://doi.org/10.1016/j.ypmed.2018.10.025

Tremblay, M.S., Carson, V., Chaput, J.P., Connor Gorber, S., Dinh, T., Duggan, M., Faulkner, G., Gray, C.E., Gruber, R., Janson, K., Jansen, I., Katzmarzyk, P.T., Kho, M.E., Latimer-Cheung, A.E., LeBlanc, C., Okely, A.D., Olds, T., Paté, R.R., Phillips, A., … Zehr, L. (2016). Canadian 24-hour movement guidelines for children and youth: an integration of physical activity, sedentary behaviour, and sleep. *Applied Physiology, Nutrition, and Metabolism*, *41*(6), S311-S327. https://doi.org/10.1139/apnm-2016-0151

Walsh, J.J., Barnes, J.D., Cameron, J.D., Goldfield, G.S., Chaput, J.P., Gunnell, K.E., Ledoux, A.A., Zemek, R.L., & Tremblay, M.S. (2018). Associations between 24 hour movement behaviours and global cognition in US children: a cross-sectional observational study. *The Lancet Child & Adolescent Health*, *2*(11), 783-791. https://doi.org/10.1016/s2352-4642(18)30278-5

Wang, L., Liu, T., Wang, Y., Li, Q., Yi, J., & Inoue, Y. (2017). Evaluation on step counting performance of wristband activity monitors in daily living environment. *IEEE Access*, *5*, 13020-13027. https://doi.org/10.1109/access.2017.2721098

World Health Organization. (2019). *Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age*. World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/311664/9789241550536 eng.pdf?sequence= 1&isAllowed=y

Wu, X.Y., Han, L.H., Zhang, J.H., Luo, S., Hu, J.W., & Sun, K. (2017). The influence of physical activity, sedentary behavior on health-related quality of life among the general population of children and adolescents: A systematic review. *PloS One*, *12*(11), e0187668. https://doi.org/10.1371/journal.pone.0187668