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Physical activity in kindergarten, fundamental movement skills, and screen time in Spanish preschool children

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Abstract

Schools have been postulated as ideal environments to encourage physical activity (PA). This study aimed to assess the relationship between PA in school hours, motor competence, and screen time in a sample of Spanish preschool children. Fifty-seven 4–5-year-old preschoolers ($n = 32$ girls) participated. The Garmin Vivofit wristband was used to measure the PA levels during school hours in a week. Sedentary behavior was estimated through screen-time hours reported by preschoolers' families and motor competence was assessed by the Athletic Skills Track. The anthropometry (weight/height) and demographic data were also collected. We found that motor competence was significantly associated with PA both in minutes and in steps. Therefore, increased motor competence was related to higher engagement in PA during school hours. No association was found between screen time and PA or proficiency of motor competence. No gender differences were found in any variable assessed. Based on the relationship between motor competence proficiency and the amount of PA in preschool children, our findings support the need for specific strategies to promote fundamental movement skills and increase PA practice from early childhood.

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KEYWORDS
motor development, preschool children, school health, sedentary time

1 | INTRODUCTION

Preschool children (between 3 and 5 years) are at a critical period for establishing healthy behaviors impacting physical, mental, and social development (Herrmann et al., 2021). In this regard, being physically active during the early years is associated with multiple health benefits and may contribute to or compromise a physically active lifestyle in youth and adulthood (Herrmann et al., 2021). The World Health Organization (WHO) recommends that preschool children spend at least 180 min per day doing physical activity (PA), of which at least 60 min are moderate-to-vigorous intensity, and that the time of sedentary screen time is less than 1 h (WHO, 2019). However, previous studies have reported that most preschool children do not reach the recommended levels of PA (Chaput et al., 2017; Lahuerta-Contell et al., 2021; Tucker, 2008) and spend excessively sedentary behavior, mainly devoted to screen time (Chen et al., 2022; Hinkley et al., 2012).

Fundamental movement skills (FMS) are basic patterns of movements (e.g., running, jumping, or caching) considered the "building blocks" that lead to more specialized and complex movements (Gallahue & Ozmun, 2006). In this respect, early childhood is considered an important stage for developing FMS, not only necessary for more advanced movements but also for the general development of children. In this sense, emerging evidence suggests that childhood motor competence is an important contributor to the amount of PA during early years (Robinson et al., 2012), adolescence (Barnett et al., 2009), and adulthood (Jaakkola et al., 2016). For instance, the conceptual models of Stodden et al. (2008) and Robinson et al. (2015) focus on the reciprocal and dynamic impact that the competency of FMS and PA play on children's health. Greater FMS competency leads to higher PA levels, health-related fitness, perceived motor competence, and healthier weight status. As well, the WHO (2019) suggests the optimal combination of sedentary time and PA (less sedentary time and more PA) as one of the main determinants of motor development. On the contrary, low actual motor competence leads to a low perception of competence, low self-esteem, and insecurity in motor activities (Estevan et al., 2019; Fort-Vanmeerhaeghe et al., 2017) that may influence motivation toward sports and PA, leading to the gradual cessation of PA during adolescence (Barnett et al., 2009; Owen et al., 2014). That is, some children and adolescents may not feel competent or skilled enough to be physically active (Owen et al., 2014). In this respect, Self-Determination Theory has been widely used to explain the relationship between motivation and PA in children and adolescents. This theory suggests that competence, together with relationships and autonomy, is one of the three basic psychological needs that individuals must satisfy to obtain optimal motivation (Deci & Ryan, 2000). Beyond the umbrella of Self-Determination Theory, previous studies demonstrated that, of all forms of motivation, only intrinsic motivation significantly and positively predicts PA among adolescents (Kalajas-Tilga et al., 2020).

Specifically, in preschool-aged children, recent systematic reviews found a strong level of evidence to support a low to moderate positive association between FMS competence (specifically total FMS and object-control skills) (Dobell et al., 2020; Jones et al., 2020); however, these associations can likely be influenced by differences in the measurement of PA (subjective vs. objective) and FMS (product-oriented vs. process-oriented assessment) (Xin et al., 2020). Product-oriented assessment tools, that quantitatively evaluate the outcome of the FMS (i.e., how high can a child jump?), are less time-consuming in educational settings (Rey et al., 2020) and require less training compared to process-oriented assessment (Hulteen et al., 2020). However, studies using product-oriented assessment tools of FMS were notably lacking, and process-oriented tools seem to get more attention and have greater use by researchers (Xin et al., 2020). To date, only six previous studies have examined potential relationships between preschoolers' PA and FMS using product-oriented tools (Fisher et al., 2005; Iivonen

et al., 2013, 2016; Kambas et al., 2012; Laukkanen et al., 2014; Matarma et al., 2018), and inconsistent associations have been reported (Xin et al., 2020). On this matter, Athletic Skills Track (AST) is a novel and promising product-oriented assessment tool (Hoeboer et al., 2016) that has been only used in a previous study with primary school children to analyze associations between sedentary behavior, PA, and motor competence (Adank et al., 2018). AST is a dynamic method to assess motor competence using a sequence of different motor tasks. The advantages of this circuit-based assessment lie primarily in its low cost, high reliability, and feasibility, and ease of administration, especially in educational settings (Hoeboer et al., 2018). However, we are not aware of any published studies that have considered novel product-oriented tests like AST in preschooler children (Hoeboer et al., 2018).

The school environment has been postulated as the ideal place to enhance the development of motor competence and to foster in general, the development of healthy behaviors (Leis et al., 2020). In this regard, evidence indicates that most preschool children's PA occurs during preschool hours (Tucker, 2008), however, at the same time, it has been reported that children spend sitting >60% of class time (Minges et al., 2016) and consequently, preschoolers engage in very little PA during school hours (Lahuerta-Contell et al., 2021). The increase in physical inactivity, sedentary behaviors, and reduced motor competence (WHO, 2019) makes it essential to increase research in this field from early childhood. It has been shown that these behaviors can already be detected in the early years and studying the association between them may allow intervention early and before detrimental health effects occur (Webster et al., 2019).

The present study aimed to assess the relationship between objectively measured PA in school hours, product-oriented FMS proficiency, and screen time in Spanish preschool children. The main hypothesis tested was that preschoolers with higher levels of FMS proficiency would exhibit higher values of PA.

2 | METHODS

2.1 | Participants

A prospective observational study was carried out with a convenience sample of 57 Spanish preschool (4.62 ± 1.03 years of age) children (girls $n = 32$, boys $n = 25$) aimed to assess the relationship between children's PA, FMS, and screen time during a week. All children were to the same public school located in the northwest of Spain. No children had medical contraindications that could affect their PA or motor competence. All children were given verbal information and verbal assent before the test. Written informed consent was obtained from parents or legal representatives after an explanation of the experimental protocol and its potential benefits and harms. Ethical approval for this study was obtained from the local Research Ethics Committee.

2.2 | Design, procedures, and measures

The children's body mass was measured to the nearest 0.1 kg using a portable digital scale (Tanita 800s). Stature was measured to the nearest 0.1 cm using a portable stadiometer (Seca). Two measurements were taken for both body mass and stature and averaged for body mass index (BMI) calculation. BMI was calculated and expressed as $kg\,m^{-2}$.

Regarding FMS, the AST was used to assess children's motor competence. The AST is a robust, reliable, valid, and feasible product-oriented assessment that uses time as the only outcome to evaluate FMS performance (Hoeboer et al., 2018). The AST consists of an obstacle track of a series of 5–7 FMS with the aim to be completed as fast as possible. There are three age-related specific versions of the AST (AST-1, AST-2, and AST-3). The AST-1 used in the present study has been designed for the youngest children (4.6 years). AST-1 consists of the following FMS: walking, traveling jumps, alligator crawling, slaloming, and clambering. All children were shown an example by

the teacher before they performed three try-out trials of the AST-1 track (Figure 1). During the three try-out trials, the children received feedback from the research assistant and teacher about how the skills should be performed to help children in understanding the obstacle course. Then, all children performed two trials as quickly as possible with 4–5 min of rest before the second trial. A research assistant measured the time to complete the two trials with a stopwatch. According to Hoeboer et al. (2018) and to ease the interpretation of the outcomes of the AST, AST times have been converted into motor quotient (MQ) values with the formula MQ = (50th percentile AST-1/time AST-1) × 100, based on the age and gender of the child.

Similar to previous studies (Webster et al., 2019), parents reported each child's screen time in hours and minutes per day during weekdays (Monday to Friday) and weekends. Screen time included the sum of the time spent each day watching television, using a computer, a smartphone, and/or iPad/Tablet, and/or playing video games.

PA levels were measured with the Garmin Vivofit® jr PA wristband (Garmin). Garmin Vivofit® jr PA wristband is an objective measurement device and has been validated for PA assessment in children aged 4–10 years (Müller et al., 2018). Children wore the bracelet for 5 consecutive days (Monday to Friday) during school hours. The participating school had a schedule from 9:00 a.m. to 2:00 p.m., so children carried the bracelet for 5 h/day. The teachers oversaw placing the activity bracelets on the children's wrists on arrival at the school and removing them before going out. Garmin Vivofit® jr measured PA in terms of steps and moderate-to-vigorous PA (MVPA) in minutes per day. These data were recorded as the sum of the 5 days of steps and MVPA.

It is important to mention that during these 5 days, the children carried out the structured psychomotricity sessions that are part of the preschool curriculum wearing the wristband. The sessions took place once a week and lasted 60 min approximately.

2.3 | Statistical analysis

All analyses were performed using the SPSS statistical package version 23 (SPSS Inc.). A significance level of $p < .05$ was considered. Gender differences in anthropometry, FMS, PA, and screen time were assessed with unpaired t tests. Standard multiple regression models were employed to analyze the associations of PA with FMS and screen time. Previous evidence suggested that gender, age, and BMI are determinants of motor competence (AST) and PA,

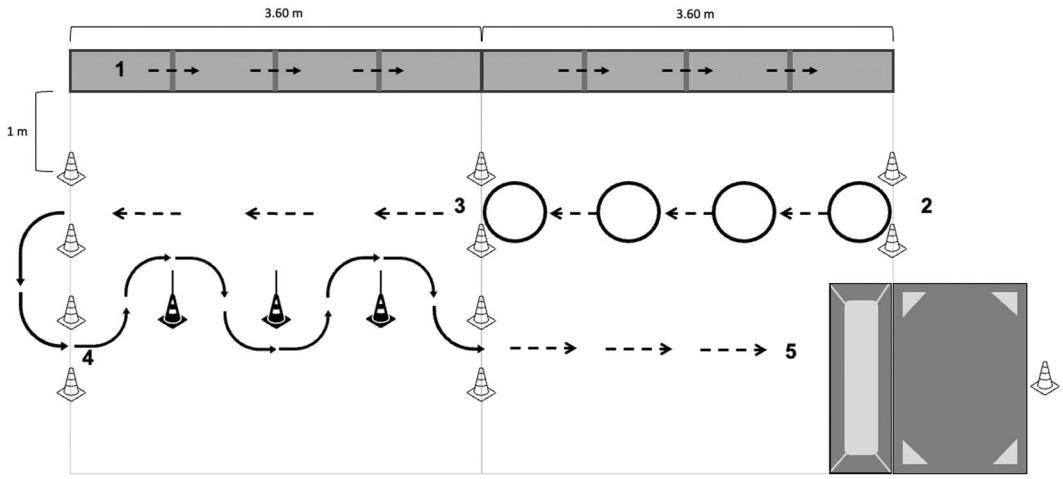

FIGURE 1 AST-1 schematically displayed. (1) Walking, (2) traveling jumps, (3) alligator crawling, (4) slaloming, and (5) clambering. AST, Athletic Skills Track.

thus, regression analysis has been conducted previously indicating that age (F [1,33] = 25.61, $p < .001$) and BMI (F [1,33] = 18.40, $p = .028$) were significant predictors of PA, but not gender (F [1,33] = 1.70, $p = .201$). Similarly, for AST, age (F [1,33] = 24.48, $p < .001$) and BMI (F [1,33] = 6.39, $p = .016$) were significant predictors, but not gender (F [1,33] = 0.40, $p = .530$). Consequently, age and BMI were introduced into the regression equation to control the effect of those variables.

3 | RESULTS

Table 1 shows descriptive statistics and gender comparisons for the study sample. There were no gender differences in any variable ($p > .05$). Children were 4.62 ± 1.03 years of age and engaged in 1.81 ± 1.28 h day^{-1} and 2.95 ± 1.94 h day^{-1} of screen time during in-week and weekend, respectively. In addition, preschoolers spent an average of 181.28 min on MVPA and took 19,846.68 steps per week.

Regression models controlled by age and BMI indicated significant positive associations between MVPA (total minutes) (Table 2) and PA (total steps) (Table 3) with AST, that is, higher AST MQ were associated with more steps per day and minutes of moderate PA. These models explained 73% and 74% of the variance in MVPA and steps,

TABLE 1 Participants' descriptive values by gender.

	All (n = 57)	Males (n = 25)	Females (n = 32)	p value
Age (years)	4.62 ± 1.03	4.62 ± 1.04	4.62 ± 1.06	.986
AST (s)	48.44 ± 26.80	50.95 ± 27.48	45.09 ± 26.43	.530
BMI (kg m^{-2})	17.88 ± 2.24	17.63 ± 2.10	18.21 ± 2.46	.456
MVPA (min week^{-1})	181.28 ± 78.80	166.35 ± 58.42	201.20 ± 98.52	.236
Steps (steps week^{-1})	19,846.68 ± 9049.42	18,135.85 ± 6811.03	22,127.80 ± 11,232.39	.236
In-week screen time (h day^{-1})	1.81 ± 1.28	1.86 ± 1.10	1.75 ± 1.52	.810
Weekend screen time (h day^{-1})	2.95 ± 1.94	3.22 ± 2.02	2.60 ± 1.85	.356

Abbreviations: AST, Athletic Skills Track; BMI, body mass index; MVPA, moderate-to-vigorous physical activity.

TABLE 2 Regression model predicting moderate-to-vigorous physical activity in preschool children.

Total physical activity (min)					
	B	SE	β	t	p
Constant	−260.66	72.59		−3.59	.001
Age	20.58	16.39	0.17	1.25	.219
BMI	12.02	3.89	0.34	3.08	.004
AST MQ	1.45	0.31	0.53	4.55	<.001
In-week screen time	−0.15	9.75	−0.01	−0.01	.987
Weekend screen time	1.56	6.59	0.1	0.60	.549
R^2	0.73				
Adjusted R^2	0.68				

Abbreviations: AST, Athletic Skills Track; BMI, body mass index; MQ, motor quotient.

TABLE 3 Regression model predicting physical activity (total steps) in preschool children.

Physical activity (steps)					
	B	SE	*β*	*t*	*p*
Constant	−30747.44	8081.76		−3.80	.001
Age	2295.95	1824.98	0.17	1.25	.218
BMI	1365.59	433.70	0.33	3.15	.004
AST MQ	172.23	35.46	0.547	4.856	<.001
In-week screen time	−53.54	1086.09	-0.01	-0.05	.961
Weekend screen time	498.56	733.70	0.11	0.68	.502
R^2	0.74				
Adjusted R^2	0.70				

Abbreviations: AST, Athletic Skills Track; BMI, body mass index; MQ, motor quotient.

respectively. However, there were no associations between MVPA (Table 2) or PA (Table 3) with in-week or weekend screentime. In addition, children's in-week (β (SE) = 2.85 (3.87), p = .467) and weekend (β (SE) = 0.94 (2.56), p = .715) screen time was not associated with AST scores.

4 | DISCUSSION

This study aimed to observe the relationship existent between PA, FMS competency, and screen time. Motor competence (assessed with AST MQ test) was significantly associated with MVPA (minutes) and steps without significant differences between girls and boys. However, screen time (sedentary behavior) was not associated with PA (MVPA and steps). The analysis was controlled by children's age and BMI which allowed study only the interactions between PA, FMS proficiency, and screen time.

The sum of time engaged by participants in MVPA during school hours in 1 week (Monday to Friday) was 181 min, of which 60 were from the structured physical education session. Considering that the WHO recommends that preschool children spend at least 180 min per day doing PA (WHO, 2019) and given that previous studies have reported that most of the PA of preschool children take place during school hours (Tucker, 2008), the children in our study may not achieve the levels of PA that have been shown to be beneficial to health. These results highlight the importance of schools in promoting more structured movement opportunities, to be promoted for preschoolers during school hours.

It is also important to note that all of the children spent more than the recommended (60 min per day) on screen time, with an average of 108 min during in-week and 177 min during the weekend. In this sense, previous studies in the American (Pate et al., 2008), British (Roscoe et al., 2019), and Spanish (Lahuerta-Contell et al., 2021) populations also found that most preschool children did not reach the recommended PA time for health benefits. In terms of screen time, our findings are also in line with previous studies reporting preschool children's screen times above recommendations (Hinkley et al., 2012; Li et al., 2022).

Although previous evidence supports the reciprocal relationship between motor competence and PA, research about this association in preschool children is scarce (Clark et al., 2020). Thus, the primary aim of this study was to examine the association between PA and FMS competency in Spanish preschoolers. Present results showed a positive association between PA and FMS competence. That is, we found that preschoolers with higher scores obtained in AST MQ were more likely to engage in higher amounts of MVPA and steps. It is important to note that most previous evidence about the relationship between PA and FMS used process-oriented tests for motor

competence assessment (Xin et al., 2020). Thus, it is not possible to directly compare our results with earlier studies. However, present findings are consistent with the conceptual models of Stodden et al. (2008) and Robinson et al. (2015), and in line with previous studies which observed that preschool children with greater FMS competence tend to engage in higher amounts of PA (Iivonen et al., 2013; Jones et al., 2020; Li et al., 2022; Robinson et al., 2012) and MVPA (Jones et al., 2020; Webster et al., 2019). Furthermore, this reciprocal relationship (Stodden et al., 2008), which starts at an early age, could be the pathway to a lifetime of engaging in PA (Hulteen et al., 2018; Jones et al., 2020; Martínez-Bello & Estevan, 2021).

Previous studies also found that in childhood, locomotor skills proficiency (Lloyd et al., 2014) and motor coordination (Lopes et al., 2011) may be predictors of subsequent engagement in PA in later years. This is an important fact because it could mean that the implementation of interventions targeted at the development of FMS in the early years could increase later PA. On this matter, educational environments are the ideal place to do it because children spend most of their weekday waking hours there (Reilly, 2010). In fact, Engel et al. (2018) observed that following teacher-led intervention training preschool children at least three times a week in FMS improves proficiency and increases PA levels. These data would also support the known positive effect of motor competence and PA in promoting children's health (Robinson et al., 2015; Stodden et al., 2008).

In terms of sex differences, previous research showed that preschool boys and girls generally do not differ in terms of FMS proficiency (Dobell et al., 2020; Wasenius et al., 2018) and present results are consistent with this, as no significant differences in AST values between boys and girls were observed. However, in contrast to current findings, Webster et al. (2019) have reported lower FMS scores and less moderate-to-vigorous and vigorous PA in girls. This discrepancy is likely to be due to the small number of participants in our study ($n = 57$) compared to Webster et al. (2019) ($n = 126$) as a previous study with small samples also found no differences between boys and girls (Iivonen et al., 2013).

Interestingly, no relationship was found between the amount of in-week or weekend screen time children participated in and the level of PA practice. These findings are consistent with those of Webster et al. (2019), who observed no associations between preschool children's screen time and any intensity or amount of PA. In addition, Bingham et al. (2016), in their systematic review, found no relationship between screen time and MVPA. In line with this, the systematic review of Maitland et al. (2013) reported that the presence of screens at home is not associated with PA behaviors. They suggest that this may be because children with fewer screens at home may substitute this sedentary behavior for another, with no difference in total sedentary time. However, emerging evidence indicates that an increase in television viewing is associated with adiposity and less psychosocial health, cognitive, and motor skill development (LeBlanc et al., 2012).

In this sense, the association between PA and screen time is influenced by different factors such as location, context, or type of screen activity. Especially whether or not screen time substitutes for active play (Webster et al., 2019). In this regard, a study carried out with 104 children attending 10 preschools in the United States found that in centers that supervised/limited screen time, children were more physically active and less sedentary (Staiano et al., 2018). This difference between our study and those previously mentioned could be due to the fact that screen time in preschool is now being used as a sedentary indoor pastime (Staiano et al., 2018), while outside the preschool, children's screen time has become more widespread. The variety of electronic devices, outdoor screen time, physically active screen time, or, for example, screen time while the child is traveling which coincides with a time when the child would not be physically active, are some examples of this diversification (Webster et al., 2019).

Regarding the last association studied, no relationship was found between FMS competence and screen time. This is not surprising because the WHO (2019) has already suggested that there was no association between sedentary time and motor development. In contrast, it also highlights the benefits of less screen-based sedentary behavior in motor and cognitive development, adiposity, and psychosocial health. However, controversy exists around this association, Cadoret et al. (2018) in their study found that children aged 4–5 years who spent more time with sedentary behaviors had lower FMS proficiency at the age of 7. On the other hand, Barnett et al. (2012) found that preschool children with higher object control proficiency tend to play interactive electronic games more time.

In our study and according to previous research (Webster et al., 2019) screen time included all forms (TV, computer, tablet, and smartphones) and it is possible that the use of any of the screens, in particular, had a more detrimental impact on FMS.

4.1 | Study strengths and limitations

This study is the first to explore the associations between Spanish preschoolers' PA and FMS. The main strengths of this study include the objective assessment of preschoolers' PA and the use of product-oriented assessment of FMS, the AST battery. However, several limitations should be noted. This study was conducted in the north-west region of Spain with a small sample; thus, the findings cannot be generalized. Second, this initial cross-sectional study can only explain the associations between PA, locomotor FMS, and screen time, but no causality conclusions may be drawn. Future research should be carried out in longitudinal studies or factorial experimental designs with bigger samples to further study this relationship and causality. Moreover, suggested mediators of the association between FMS and PA such as perceived motor competence and health-related fitness should be considered in future studies. In addition, studies where the impact of geographical location (e.g., rural vs. urban), family environment and socioeconomic status, or PA level of parents as influencing variables could also be completed. Finally, PA only was assessed during school hours; therefore, children's PA outside the centers was not taken into account. Accordingly, future studies should also examine whether families counterbalance the low level of PA those children engage in at the early childhood center.

5 | CONCLUSIONS

The current study observed that preschool children engaged in very little MVPA during school hours, failing to comply with international recommendations for PA practice. In addition, they spent almost twice as much time per day using screens as recommended. At this time, examining the associations between PA, FMS, and screen time, this study provided scientific evidence supporting a relationship between motor competence proficiency and the amount of PA in preschool children. This direct association means that children with higher FMS competence scores performed more PA both measured in MVPA (minutes) and steps. No relationships were found between screen time and PA practice or FMS competence. Our findings support the need for specific strategies to promote FMS and increase PA practice from early childhood as this will have an immediate impact on children's health and will also have an impact on health in the coming years.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ETHICS STATEMENT

Ethical approval for this study was obtained from the local Research Ethics Committee.

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