**Journal of Childhood, Education & Society**
Volume 6, Issue 2, 2025, 150-163
DOI: 10.37291/2717638X.202562495
ISSN: 2717-638X
Research Article

# Factors affecting first-grade pupils' physical activity during the school day: A pilot study

**Dita Culková[1], Veronika Dušková[2]**

**Abstract**: Physical activity is essential for the healthy development of children, yet many do not achieve the recommended levels. This study investigates the influence of school environments and educational practices on pupils' PA during the school day, emphasizing the importance of supportive school conditions and structured activities. This pilot study involved 43 children from three primary schools in the Olomouc region of the Czech Republic. PA was measured using digital pedometers. Data on school conditions and family lifestyle were collected via two questionnaires. The analysis employed variance inflation factor analysis, principal component analysis (PCA), multiple linear regression, and Spearman's correlation coefficient to identify key predictors of PA. The results show that the most influential factors on PA were passive conditions of the school environment, particularly school size and access to sports facilities. Active conditions, such as organized PA breaks and outdoor learning, also had a positive effect on PA levels. However, family lifestyle did not show a significant direct impact on school-day PA. The findings underscore the crucial role of school environments and educational practice in maintaining children's PA. There is a significant need for policies and initiatives that promote active school environments. Schools should implement comprehensive PA programs to support children's overall health and well-being.

**Article History**
Received: 13 September 2024
Accepted: 07 March 2025

**Keywords**
Physical activity regime; School environment; Active school; Step counts; Family lifestyle

## Introduction

Physical activity (PA) plays a crucial role in children's development, significantly contributing to health-oriented fitness. Studies show that physically fit pupils participate more in both physical education (PE) lessons and school breaks, leading to higher overall PA levels (Gomes et al., 2017; Haug et al., 2010; Poitras et al., 2016). Health recommendations suggest at least 60 minutes of daily moderate-to-vigorous PA (MVPA) (Singh et al., 2012). However, a significant proportion of adolescents (80.3%) fail to meet these guidelines (Gomes et al., 2017). Given these concerning statistics, school-based interventions have been explored as a viable strategy to promote PA among students, highlighting the crucial role of structured school environments. This underscores the need for effective interventions that encourage regular movement throughout the school day. One promising approach is school-based PA programs, which provide structured opportunities for students to engage in PA. Jarnig et al. (2023) demonstrated that implementing daily PA interventions in primary schools significantly enhances children's cardiorespiratory endurance, muscle strength, and flexibility. Recognizing the importance of early intervention, researchers emphasize that structured PA programs should begin as early as preschool to ensure long-term engagement. Higher levels of vigorous physical activity (VPA) in preschool age support the development of healthy body composition and aerobic fitness later in childhood (Sigmund et al., 2007). Li et al. (2023) provide further evidence that school-based PA interventions positively influence academic performance, particularly in mathematics and reading, reinforcing the necessity of integrating PA within school curricula. Costa et al. (2024) further emphasize that multi-component school-based PA programs, including structured exercise sessions and active learning approaches, significantly enhance not only

[1] University of Hradec Králové, Faculty of Education, Department of Physical Education and Sports, Hradec Králové, Czech Republic, e-mail: dita.culkova@uhk.cz, ORCID: https://orcid.org/0000-0002-6227-1442

[2] University of Hradec Králové, Faculty of Education, Department of Physical Education and Sports, Hradec Králové, Czech Republic, e-mail: veronika.duskova99@seznam.cz, ORCID: https://orcid.org/0009-0002-6432-5448

Corresponding author: Dita Culková

students' physical fitness but also their motivation and engagement in daily movement activities. Contardo Ayala et al. (2024) expand on this by demonstrating that well-structured PA interventions lead to sustained behavioral changes, helping students maintain an active lifestyle beyond school settings.

Recognizing the importance of PA in childhood development, many countries have incorporated PA into their national education policies as a preventive approach to declining activity levels. In the Czech Republic, PA is an integral part of the national education system, with PE being a compulsory subject in both primary and secondary schools (Gába et al., 2022). On average, students attend two PE lessons per week, with some schools incorporating additional movement breaks or extracurricular sports activities. The national curriculum emphasizes a holistic approach, promoting not only sports skills but also general motor development, health education, and the importance of an active lifestyle (Kovář et al., 2023). However, despite these structured efforts, differences in PA engagement persist across socio-economic groups and genders, requiring further attention to equity in school-based PA opportunities. Research indicates that boys generally engage in more structured PA activities than girls, with boys more frequently meeting MVPA recommendations (14.6%–40.5%) compared to girls (7.5%–25.2%) (Kantanista et al., 2021). Additionally, disparities in PA participation are also evident across socio-economic groups, with children from lower socioeconomic status backgrounds exhibiting lower overall PA levels and higher obesity prevalence compared to their higher socioeconomic status peers (Richard et al., 2023). Li et al. (2023) further highlight that structured PA initiatives should be adapted to address disparities in participation, as engagement levels may vary based on student demographics, school policies, and available resources. Various national initiatives, such as the "Active school" program (Kovář et al., 2023), have been introduced to encourage more physical movement throughout the school day. Nevertheless, research suggests that existing policies may not fully counteract the rise in sedentary behaviors, particularly among older students, stressing the need for continuous policy revisions. Reis et al. (2024) emphasize that without consistent reinforcement and policy adjustments, many school-based PA initiatives fail to achieve long-term behavioral changes in students, emphasizing the necessity of a sustained commitment at the institutional level. This underscores the necessity of sustained efforts in PA policy adaptations and intervention strategies to ensure that PA remains a priority throughout childhood and adolescence.

Beyond physical health, PA has significant implications for cognitive and academic outcomes. Sufficient PA positively impacts mental health and the educational process, enhancing various dimensions of school engagement, including behavior (e.g., time-on-task), emotions (e.g., lesson enjoyment), cognition (e.g., self-regulated learning, executive function), and academic performance (e.g., grades, test scores) (Singh et al., 2012; Van Dijk et al., 2014). Some authors question the direct link between PA and academic achievements. Taras (2005) notes that PA improves short-term concentration but has limited long-term academic benefits. While certain studies suggest a strong connection between PA and academic performance, others indicate only minor improvements in cognitive outcomes. Li et al. (2023) provide additional insights, emphasizing that the extent of PA's impact on academic outcomes depends on its frequency, duration, and integration within school curricula. Their meta-analysis highlights that PA interventions with consistent implementation and adequate support from educators yield the most substantial academic benefits. Observation measures show a strong positive association with school engagement, while subjective measures show a smaller positive association. Overall, PA has a small positive impact on school engagement but no effect on disengagement (Trudeau & Shephard, 2008). Moreover, regular physical activity has been associated with improved mental health outcomes in children, including reductions in anxiety and depression, as well as enhancements in self-esteem and cognitive function (Hale et al., 2023; Rodriguez-Ayllon et al., 2019). This discrepancy may stem from variations in PA intensity, duration, and its integration within the school curriculum, highlighting the need for more standardized approaches. Nonetheless, PA is positively linked with school engagement, as physically active pupils exhibit better classroom focus and reduced off-task behavior (Watson et al., 2017).

Given the complexity of PA's effects, further examination of environmental and social determinants is necessary to understand and optimize intervention strategies. The Report Card on Physical Activity for Children and Youth in the Czech Republic highlights that a notable percentage of Czech children and

adolescents fail to meet PA guidelines and exhibit high levels of sedentary behavior (Gába et al., 2022). Effective improvements in PA require understanding the factors that influence it. Hu et al. (2021) identified support from friends, parents, teachers, and the availability of facilities and safe environments as key predictors.

Among these determinants, family and school environments play a crucial role in shaping PA habits. Family and parental influence on children's PA presents a mixed picture. Petersen (2020) highlights the impact of parental behavior, while Trost and Loprinzi (2011), Bauman et al. (2012), and a meta-analysis by Pugliese and Tinsley (2007) found no correlation. Yao and Rhodes (2015) identified a moderate effect. The impact of family on a child's PA changes with age, with parental support playing a key role in preschool age but decreasing as peer influence increases. Overall, parents' support is related to the level of PA and the perception of this support by children (Pugliese & Tinsley, 2007; Wilk et al., 2018; Yao & Rhodes, 2015).

Environmental predictors such as school opportunities, access to PA facilities, and weather influence children's time spent on PA and the types of activities they engage in (Tay et al., 2021). Studies consistently show a positive correlation between children's outdoor time and overall PA (Ferreira et al., 2007; Sterdt et al., 2014; Vanderloo et al., 2013). By fostering a supportive school environment with sufficient PA opportunities, educators and policymakers can play a key role in mitigating the decline in PA levels seen during adolescence.

Schools play a crucial role in shaping children's PA habits, as their daily structure significantly influences activity levels. The organization of the school day significantly impacts PA levels. Children in activity-permissive school environments exhibit higher levels of movement compared to those in traditional settings (Culková et al., 2020; Lanningham-Foster et al., 2008.). The availability and use of sports facilities and equipment during school hours, such as game equipment during recess, enhance children's MVPA levels (Lanningham-Foster et al., 2008; Sterdt et al., 2014; Verstraete et al., 2006). Increasing PA time at school through additional PE lessons positively affects children's body mass (Ługowska et al., 2022; Reisberg et al., 2020). Allocating up to an additional hour per day for PA programs does not negatively impact academic performance, despite reducing time for other subjects (Hatfield & Chomitz, 2015; Singh et al., 2012). By fostering a supportive environment that encourages regular movement, schools can help mitigate the decline in PA levels observed in later childhood and adolescence, reinforcing the long-term benefits of school-based PA interventions. Creating opportunities for PA within and outside of lessons, providing access to adequate facilities, and incorporating movement-based learning strategies are essential components of a comprehensive approach to promoting PA among pupils.

In the Czech Republic, notable changes in children's PA levels occur after transitioning from preschool to primary school, a period that requires targeted intervention strategies (Sigmund et al., 2009). School-aged children tend to be more active on school days, whereas preschool children reach their highest activity levels on weekdays (Brazendale et al., 2021; Roscoe et al., 2019). Duncan et al. (2007) found that children engage in more PA on weekdays than on weekends, with lunchtime serving as a crucial source of daily PA. This suggests limited support for PA during school hours, except for lunchtime, highlighting the need for structured PA integration throughout the school day. Other studies highlight that preschool children generally exhibit higher PA levels than adolescents and young adults (Sigmund et al., 2007). As children get older, their natural need for movement decreases, so they need more support to maintain their PA levels (Martin et al., 2014; Vale et al., 2010).

A document by the Czech School Inspectorate titled "Active School" (Kovář et al., 2023) provides methodological recommendations divided into four pillars to support PA in schools: quality of PE lessons, non-formal learning opportunities, regular sports events, and the physical regime of pupils in the school environment. This study focuses on the fourth pillar, presenting examples of good practices and analyzing predictors and factors of pupils' PA at school. The alternative hypothesis is stated as follows: “School environment and conditions have a significant effect on children’s level of physical activity.” The follow-up research question is: “Which factors and practices within the fourth pillar of the "Active School" program most influence the level of physical activity among pupils during the school day?”

## Method

### Survey Design, Participants, Measures and Procedures

To deliver the goals of the pilot study, quantitative measurement was applied using inSPORTline Strippy digital pedometers and two questionnaire surveys. The total number of the children was 52. The measurement was completed by 43 pupils (21 girls and 22 boys) and the measuring period covered 5 days in October 2022. The measurement took place within school time range from 7:30 AM till 2:00 PM. Pedometers were attached to children's ankles, as per the manufacturer's guidelines.

Three primary schools were selected based on a teacher survey focusing on the conditions for physical activity. Primary schools in the Olomouc region were contacted, and 30 schools out of 104 were randomly selected. These schools received a questionnaire addressed to first-grade teachers through the school management. As part of the questionnaire, they agreed to cooperate in further research, which included a questionnaire survey for parents of first-grade pupils and the measurement of children's activity levels using digital pedometers. Fourteen school representatives completed the questionnaire, and nine agreed to further cooperation. From these nine, three schools were selected based on their varying conditions for the implementation of physical activity during the school day, ensuring a diverse representation of school environments.

All selected school facilities were located in the Olomouc region of the Czech Republic, in areas with similar geographical and urban characteristics. The questionnaire was self-constructed, focusing on both passive and active school conditions for PA as outlined in the fourth pillar of the document "Active School"(Kovář et al., 2023). Among the passive conditions, the questionnaire examined school size, number of floors, sports facilities and equipment, their availability to pupils, and the duration of the long recess. Regarding active conditions, we investigated the frequency of lessons conducted outside the school building, the integration of movement-based learning, and the organization of physically active breaks. Based on the questionnaire results, three public primary schools with varying PA conditions were selected. The specific differences between these schools are presented in Table 1.

A second self-constructed questionnaire was distributed to the parents of the children and aimed to assess the family's lifestyle, the pupil's exercise habits, and personal characteristics potentially linked to the pupil's PA. The questionnaire items were developed based on current research in the field of children's PA and included questions regarding the child's temperament, tendency toward spontaneous PA, leisure-time interests, participation in sports clubs, sports skills, and other regular physical activities. Additionally, it assessed whether the family practiced active transportation to school, engaged in seasonal sports activities, and whether there was a competitive athlete in the family.

The study included 52 first-grade children from the Olomouc region, selected from three primary schools with different conditions for physical activity implementation. The children were first-grade students, typically aged 6 to 7 years old. Regarding socio-economic status (SES), the Olomouc region is a diverse area encompassing both urban and rural communities, ensuring that participants come from a range of socio-economic backgrounds. The schools selected for this study included children from various socio-economic classes, as the region itself reflects a mix of middle-class, working-class, and lower-income households. While no direct SES data were collected, the selected schools represent typical public primary education institutions, which accommodate children from different socio-economic environments. Family characteristics were assessed indirectly through a parent questionnaire, which included items on family lifestyle, physical activity habits, and home environment factors influencing children's PA engagement. This allows for an understanding of parental involvement in PA and potential socio-economic influences.

The following validated questionnaires served as references for constructing survey items: Physical Activity Questionnaire for Children (PAQ-C) (Cuberek et al., 2021) and International Physical Activity Questionnaire (IPAQ) – Short Form (Lee et al., 2011).

**Table 1**
*Structure of the Questionnaires: Number of Items Taken from Validated Questionnaires and Newly Created Ones*

| Questionnaire | Total items (excluding demographics) | Borrowed items | Newly created items |
|---|---|---|---|
| Teacher Questionnaire | 15 | 6 | 9 |
| Parent Questionnaire | 13 | 7 | 6 |

Examples of questions:

- Borrowed item - Teacher Questionnaire: How often is first-grade teaching conducted outside the school building? (Inspired by PAQ-C)
- Newly created item - Teacher Questionnaire: What types of sports equipment are available at school?
- Borrowed item - Parent Questionnaire: How many hours does your child spend on screens on an average weekday? (Inspired by IPAQ-SF)
- Newly created item - Parent Questionnaire: Does your child take advantage of opportunities for spontaneous movement?

**Table 2**
*Overview of the Factors and Components of the Teacher Questionnaire*

| Component | Factor | Number of Items | Question Example | Measurement Scale |
|---|---|---|---|---|
| School size | Passive conditions | 4 | How many floors does the school where you teach have? | Numerical response (number of floors) |
| Availability of outdoor and indoor spaces for PA | Passive conditions | 1 | The school where I teach has access to (garden, courtyard, gym, etc.) | List of options + open response |
| Length of the long break | Passive conditions | 1 | How long is the longest break during the school day? | Numerical response (minutes) |
| Possibility of active break participation | Passive conditions | 1 | Do first-grade students have the opportunity to spend breaks actively outside the classroom? | 4-point Likert scale |
| Availability of physical activities during breaks | Passive conditions | 1 | What physical activities can students engage in during breaks? | List of options + open response |
| Stability of the learning environment (classroom movement) | Passive conditions | 1 | Do first-grade students stay in the same classroom all day? | Multiple-choice (yes/no, frequency of movement) |
| Frequency of outdoor lessons | Active conditions | 1 | How often does first-grade teaching take place outside the school building? | Numerical response (days per week) |
| Integration of movement breaks into lessons | Active conditions | 1 | How often do teachers incorporate movement breaks in lessons? | 5-point Likert scale |
| Organization of movement-recreational breaks | Active conditions | 1 | Do you organize movement-recreational breaks with first-grade students? | Multiple-choice (yes/no) |
| Utilization of school spaces by students | Student behavior | 1 | How often do first-grade students use these spaces? | List of options + usage frequency |
| Most frequent student activities during breaks | Student behavior | 1 | Select the 3 most common activities first-grade students do during breaks. | List of options + selection of the most frequent |

**Table 3**
*Overview of the Factors and Components of the Parent Questionnaire*

| Component | Factor | Items | Question Example | Measurement Scale |
|---|---|---|---|---|
| Gender | Respondent factors | 1 | What is your child's gender? | Multiple-choice (Male/Female/Other) |
| Age | Respondent factors | 1 | How old is your child? | Numerical response (years) |
| Temperament | Respondent factors | 2 | How would you describe your child's temperament? | 4-point Likert scale |
| Sports skills | Family influence | 1 | Which sports skills does your child possess at an intermediate level? | Multiple-choice |
| Extracurricular activities | Family influence | 2 | Does your child regularly participate in any sports training? | Multiple-choice |

| | | | | |
|---|---|---|---|---|
| Screen time | Family influence | 1 | How many hours does your child spend on screens on an average weekday? (TV, mobile, tablet, etc.) | Numerical response (hours) |
| School transport | Family factor | 1 | What is the most common way your child travels to and from school? | Multiple-choice |
| Athlete in the family | Family factor | 1 | Is there an athlete in your family who participates in competitions or matches? | Yes/No |
| Family activities | Family factor | 2 | Select the winter activities you regularly engage in with your child (several times per month). | Multiple-choice |

**Content Validity and Pilot Testing**

Content validity was assessed by gathering input from subject matter experts in the relevant field. For content validity, three experts with expertise in educational research, psychology, and physical activity reviewed the questionnaire items in a two-round process. In the first round, they individually assessed the clarity, relevance, and alignment of each item with the research objectives. Based on their feedback, necessary revisions were made. In the second round, the revised questionnaire was re-evaluated by the same experts to ensure that the modifications addressed their concerns and improved the overall validity of the instrument. Following the expert validation process, the questionnaire was pilot-tested on three potential respondents representative of the target population. Their feedback focused on the clarity of instructions, comprehensibility of items, and ease of completion. Minor wording adjustments were made to enhance the user-friendliness of the questionnaire, ensuring that it was well understood by participants.

Furthermore, Principal Component Analysis (PCA) was applied to address multicollinearity issues before performing multiple linear regression. While PCA primarily served as a dimensionality reduction technique, it also provided insight into the underlying structure of the questionnaire variables, helping to confirm their meaningful grouping into principal components. This approach strengthened the interpretability and robustness of the statistical analysis.

Informed consent was obtained from participants at all stages of the research. Consent was provided by school management and parents, while children gave their verbal assent. All research was conducted in accordance with the standards of the Declaration of Helsinki.

**Data Cleaning and Statistical Analysis**

To analyze the collected data, a publicly accessible statistical software, Jeffrey's Amazing Statistics Program (JASP), version 0.17.3, was used. Multiple linear regression was conducted to identify significant predictors of PA. Prior to implementing the regression model, the data were standardized, and a variance inflation factor (VIF) analysis was performed to detect and address multicollinearity issues among variables. Variables with a VIF value exceeding 10 were considered problematic. As a result of high VIF values, Principal Component Analysis (PCA) was applied to reduce data dimensionality and create principal components that represented the original dataset while eliminating multicollinearity.

After conducting PCA, multiple linear regression was reapplied to identify significant predictors of PA, measured by the number of steps. In this analysis, principal components served as independent variables, while step count functioned as the dependent variable. Additionally, Spearman's correlation coefficient was computed to assess monotonic relationships between variables.

This study analyzes children's PA through advanced statistical modeling, which involves mitigating multicollinearity using PCA and subsequently incorporating principal components into a regression model. This approach provides a more comprehensive understanding of the relationships between the school environment, daily activities, and children's PA.

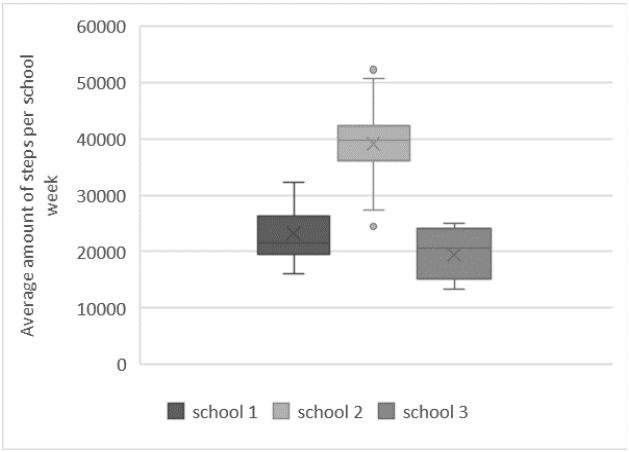
## Findings

The specific differences between chosen schools are in Table 4.

**Table 4**
*Passive and Active Conditions for Physical Activity in the Schools Surveyed*

| | School 1 | School 2 | School 3 |
|---|---|---|---|
| Number of pupils in the school | 180 | 146 | 90 |
| Gymnasium part of the school | ✔ | ✔ | Small gymnasium |
| Multifunctional sports pitch | ✔ | ✔ | × |
| Garden or park nearby | ✔ | ✔ | ✔ |
| Outdoor classroom (space for teaching outside the school) | ✔ | × | × |
| Change of classrooms during the day | × | ✔ | × |
| Possibility to spend recess outside | × | ✔ | ✔ |
| Possibility of free movement along school corridors | ✔ | ✔ | ✔ |
| Possibility of free movement in a garden/at sports pitch | × | ✔ | ✔ |
| Regular outdoor lessons | once per 2 weeks | twice per week | × |
| Availability of facilities and equipment for PA | × | ✔ | × |
| Organised physical recreation breaks | × | ✔ | × |
| Learning in motion or physical exercise moments during lessons | ✔ | ✔ | × |
| Duration of the "long" break | 15 minutes | 20 minutes | 15 minutes |
| Toilets available on another floor of the school | × | ✔ | × |

**Figure 1**
*Differences in the Number of Steps Between the Respective Primary Schools*




To evaluate the alternative hypothesis H2: "The school environment and conditions significantly affect children's level of physical activity," PCA was applied to analyze the effects of key variables. PCA was conducted on standardized variables to generate principal components, which were then used as independent variables in the regression model. The analysis identified four principal components that together explained approximately 98% of the total variability in the data. The first principal component alone accounted for 61.34% of the variability and was found to have the strongest contributions from variables related to active breaks (0.45), equipment uses during breaks (0.45), classroom transitions (0.45), outdoor breaks (0.45), and overall passive school conditions (0.421).

The primary purpose of PCA was to address multicollinearity issues before conducting multiple linear regression. Additionally, PCA provided insight into the underlying structure of questionnaire variables, confirming their meaningful grouping into principal components. PCA was chosen over Partial Least Squares (PLS) regression because the goal was to reduce data dimensionality rather than to build a predictive model with highly correlated variables. Unlike PLS, PCA creates uncorrelated principal components, making it a more suitable technique for subsequent regression analysis. After applying PCA, multiple linear regression was performed to identify significant predictors of PA, represented by the number of steps (Table 5).

**Table 5**
*Multiple Linear Regression Analysis of Factors Affecting Children's Physical Activity*

| Factor | Coefficient(β) | Std. error | T-value | P-value | Significance |
|---|---|---|---|---|---|
| Active breaks | **341.30** | 119.24 | **2.862** | **0.008** | **Yes** |
| Facilities availability during breaks | **467.72** | 189.46 | **2.469** | **0.020** | **Yes** |
| Classroom size | **556.18** | 210.41 | **2.643** | **0.014** | **Yes** |
| Temperament | **6801.08** | 1571.56 | **4.328** | **<0.001** | **Yes** |
| Family lifestyle | 241.25 | 634.52 | 0.380 | 0.706 | No |
| Athlete in family | 3592.21 | 2513.09 | 1.429 | 0.161 | No |

The dependent variable in this analysis is the step count. The regression coefficients (β) indicate the change in step count resulting from a one-unit change in the predictor variable, while holding all other variables constant. The interpretation of data analyzed by the Multiple Linear Regression Analysis is as follows.

Passive Conditions: structural aspects of schools, such as the number of floors and class size, were found to have a positive and statistically significant impact on PA. This suggests that schools with more floors and larger class sizes provide greater opportunities for pupils to move throughout the school day.

Active Conditions: Organized active recess and outdoor learning opportunities were positively correlated with higher step counts. This result suggests that school programs and policies promoting active recess and outdoor learning can make a substantial contribution to increasing children's PA.

The Role of Child Temperament: The analysis revealed that in addition to the school environment, a child's temperament plays a significant role in their PA. Children who exhibit higher levels of extroversion or a stronger tendency toward spontaneous activity showed increased step counts, highlighting the importance of considering individual differences when designing interventions aimed at enhancing PA.

Influence of Family Lifestyle: The analysis did not identify a significant direct relationship between family lifestyle and children's PA, suggesting that the home environment influences may be mediated by other factors or that the school environment exerts a more dominant influence on children's PA during the school day.

Comprehensive Analysis: Integrating the results from the regression analysis with findings from the Spearman correlation coefficient calculation provides a more holistic perspective on the factors influencing PA. While the regression analysis quantifies the impact of individual factors, the Spearman coefficient complements this by indicating the strength and direction of monotonic relationships between variables.

Correlations between PA and School Environment Factors shows Table 6.

**Table 6**
*Spearman's Correlations of Passive and Active School Conditions and Step Counts*

| Variable | Steps | Variable | Steps |
|---|---|---|---|
| School corridor size | 0.50*** | Distance to toilets | 0.05 |
| Number of floors | 0.77*** | Long break duration | -0.28 |
| Changes of classroom | 0.76*** | Breaks outdoor | 0.76*** |
| Classroom size | 0.77*** | Facilities availability during breaks | 0.56*** |
| Usage of sports equipment | 0.76*** | Sports facilities existence | 0.50*** |
| Active conditions | 0.56*** | Active breaks | 0.76*** |
| Learning outdoor | 0.56*** | Playing pe games during breaks | 0.56*** |

$p < .05$, ** $p < .01$, *** $p < .001$

To address the research question "Which factors and practices within the fourth pillar of the "Active School" program most influence the level of physical activity among pupils during the school day?" we conclude that the most influential factor affecting children's PA is the passive conditions of the school environment, particularly school size and access to sports facilities, which were statistically significantly correlated with higher PA in children, as evidenced by Spearman's correlation coefficient of 0.77. Closely

following this are active conditions, including organized PA breaks and outdoor learning, both of which also positively influence children's PA. This finding underscores the crucial role of the school environment and its structural elements in supporting children's PA during the school day. Based on the results we fail to reject the alternative hypothesis: "The school environment and conditions significantly affect children's level of physical activity."

## Discussion

The findings of this study underscore the significant impact of school environment and educational practices on pupils' PA during the school day. The results indicate that both passive and active conditions within the school environment play a crucial role in determining the level of PA among pupils. Specifically, schools that provide opportunities for movement through structural features and organized activities demonstrate higher levels of student PA, as evidenced by step counts.

Structural aspects of schools, such as the number of floors and classroom size, were found to have a positive and statistically significant effect on PA. This aligns with previous research suggesting that larger and more complex school layouts encourage more movement among pupils (Gibson et al., 2008). The positive correlation between the number of floors and step counts (0.77) suggests that schools with more floors provide more opportunities for incidental PA as pupils move between classes. However, some studies indicate that while school infrastructure plays a role, other factors such as school policies and teacher-led movement initiatives may also significantly impact PA levels (Poitras et al., 2016; Sterdt et al., 2014). This suggests that a holistic approach, integrating both structural and programmatic interventions, is necessary to maximize PA levels among students. Moreover, studies such as Poitras et al. (2016) and Verstraete et al. (2006) emphasize that school-based interventions should not only focus on providing movement opportunities but also consider the overall educational setting, including how PA is embedded into the curriculum and supported by school culture. Additionally, Rodrigo-Sanjoaquin et al. (2022) highlight that schools incorporating movement-based learning strategies show significant improvements not only in PA levels but also in academic performance and student engagement, suggesting that PA interventions can have broader educational benefits.

The availability of facilities for PA during breaks also showed a significant positive impact on PA levels. Schools with accessible sports equipment and designated areas for physical activities during recess were associated with higher step counts. This finding is supported by studies that highlight the importance of providing adequate resources and infrastructure to promote PA in school settings (Lanningham-Foster et al., 2008; Poitras et al., 2016; Sterdt et al., 2014; Verstraete et al., 2006). However, Sterdt et al. (2014) also suggest that simply providing facilities is not enough; active supervision and engagement strategies are necessary to maximize their impact on PA levels. Additionally, Lanningham-Foster et al. (2008) indicate that movement-friendly environments, when combined with teacher encouragement and structured PA programs, yield the most significant increases in daily step counts.

Organized active breaks and outdoor learning opportunities were strongly associated with increased PA levels. The significant coefficients for active breaks ($\beta = 341.30$, $p = 0.008$) and facilities availability during breaks ($\beta = 467.72$, $p = 0.020$) indicate that these strategies effectively increase student PA. These results align with previous research showing that structured school-based PA interventions lead to higher MVPA levels and reduced sedentary behavior (Poitras et al., 2016; Verstraete et al., 2006). Similar to Verstraete et al. (2006), who found that implementing structured PA during school hours contributed to increased PA levels, our study highlights the role of structured school activities in shaping daily movement behaviors. Moreover, the observed correlation between PA and outdoor learning supports findings by Culková et al. (2020), who reported that children in activity-permissive schools exhibit significantly higher movement levels than those in traditional school environments. Furthermore, Reisberg et al. (2020) emphasized that frequent structured PA breaks within the school setting promote both engagement and overall PA levels, reinforcing the importance of integrating PA into daily academic routines. Additionally, Sterdt et al. (2014) suggest that while structured PA opportunities in schools play a key role in promoting movement behaviors, their effectiveness depends on contextual factors such as teacher facilitation, school-

wide policies, and student motivation. This highlights the necessity of a multi-layered approach in PA interventions, ensuring that environmental, social, and educational factors align to support children's movement engagement.

To provide more specific examples based on the schools surveyed, we see that in many aspects of its conditions, primary school 2 differed from the other two schools, specifically in the following nuances: the pupils can spend their breaks outside; outdoor learning takes place twice per week; there are organized physical recreation breaks (playing PE games); pupils have access to sports equipment (for breaks and lunch break); exercise moments are included in lessons, the school practices so-called learning in motion; the so-called "long" break is 20 minutes and the pupils have to walk to another floor to use toilets. This observed school meets the requirements in accordance with other research results (Culková et al., 2020; Lanningham-Foster et al., 2008) pointing out that children from schools with activity-permissive school environment with high level of supervision and improvements move significantly more compared to the amount that they move in the traditional school environments (Sallis, 2000). Similarly, Poitras et al. (2016) (2016) and Sterdt et al. (2014) indicate that the effectiveness of PA-supportive school environments is often determined by the consistency of implementation and whether movement is perceived as a natural part of the school culture rather than an isolated initiative.

The study also highlighted the role of individual differences, such as a child's temperament, in influencing PA levels. Children with higher levels of extroversion or a greater tendency towards spontaneous activity showed higher step counts ($\beta = 6801.08$, $p < 0.001$). This underscores the need to consider individual characteristics when designing PA interventions. These findings align with previous studies that emphasize the role of personality traits in PA engagement, highlighting that extroverted children may be more inclined to participate in group-based PA, whereas more introverted children may require alternative strategies to encourage movement (Sigmund et al., 2007). Furthermore, Culková et al. (2020) - found that children in environments with flexible and child-centered PA policies were more likely to engage in spontaneous movement, reinforcing the importance of tailoring interventions to different personality types. Rodrigo-Sanjoaquin et al. (2022) also report that individualized PA strategies tailored to student personality and motivation levels can enhance both PA engagement and long-term adherence to active lifestyles.

The importance of school-based PA strategies is undeniable, but the role of family remains debated. Our findings indicate that while family lifestyle may not directly affect PA levels during school hours, it significantly influences children's engagement in PA outside of school (Bauman et al., 2012; Pugliese & Tinsley, 2007). Petersen et al. (2020) further emphasize that children in highly active families are more likely to engage in PA outside structured settings.

Additionally, successful PA implementation in schools depends on teacher awareness and institutional support. Many teachers lack formal training on incorporating PA into daily lessons (Dinkel et al., 2017), and while they generally express positive attitudes toward PA in classrooms, time constraints and competing academic demands present obstacles (McMullen et al., 2014). Programs such as 'PaV' (Havel et al., 2016) and 'Active School' (Kovář et al., 2023), aim to address these barriers, but long-term effectiveness depends on sustained institutional backing (Hatfield & Chomitz, 2015). Without continuous policy reinforcement and teacher engagement, PA initiatives may struggle to achieve lasting impact.

The results of this study highlight the importance of school-based interventions in promoting PA. Schools that implement structured PA programs, provide adequate facilities, and create an environment that encourages movement can significantly enhance pupils' PA levels. However, as emphasized by Verstraete et al. (2006) and Poitras et al. (2016), the sustainability of such programs is highly dependent on long-term institutional support and integration into daily school practices. Without continuous reinforcement from school policies and staff engagement, the effectiveness of PA interventions may decline over time.

## Limitations and Future Research

We acknowledge that due to the small sample size the generalizability of the results is not possible. The selection of 52 children was influenced by limited resources and the study's focus on a particular educational setting. This smaller sample allowed for more detailed follow-up of each participant. Another limitation was our access to questionnaires. As the questionnaires were designed for the purposes of this study, it is possible that they contained social desirability bias. Although we tried to ensure the relevance and clarity of the questionnaires, future studies could benefit from using already validated questionnaires or conducting pilot testing for newly developed instruments. Another limitation is the geographical location of the research, which may affect the transferability of the results to other areas. Additionally, the study relied on self-reported measures of PA, which may be subject to reporting bias. Future research should consider larger sample sizes and objective measures of PA to validate these findings.

## Conclusion

This study confirms that school structural features, such as the number of floors and class size, directly impact children's physical activity (PA). More floors and larger class sizes create natural movement opportunities throughout the school day. Organized active breaks and outdoor learning are among the most effective strategies for boosting PA levels, with schools implementing these measures seeing significantly higher pupil step counts. Temperament also plays a crucial role—extroverted and naturally active children engage more in PA, underscoring the need for tailored interventions that cater to different personality types. The absence of a direct link between family lifestyle and PA during school hours reinforces the dominant role of the school environment in shaping children's activity levels. Initiatives like 'Active Schools' prove highly effective in fostering movement-friendly environments, emphasizing the importance of deliberate, well-structured PA programs in schools. To maximize the benefits, schools must prioritize systematic PA integration, ensuring long-term improvements in children's health and well-being.

## Declarations

### *Authors' Declarations*

***Acknowledgements:*** Not applicable.

***Authors' contributions:*** Study design, D.C., V.D.; data collection, V.D.; statistical analysis, D.C.; data interpretation, D.C., V.D.; manuscript preparation, D.C., V.D.; literature search, D.C.; funding acquisition, D.C.

***Competing interests:*** The authors declare that they have no competing interests.

***Funding:*** This research was funded by the Specific Research (16/I_22) at the Faculty of Education, University of Hradec Kralove.

***Ethics approval and consent to participate:*** The ethical recommendations approved in the Declaration of Helsinki (2013) were followed. The research project was approved by the Ethics Committee for Research of the University of Hradec Králové with a positive assessment number 1/2024. Informed consent was obtained from all subjects involved in the study.

### *Publisher's Declarations*

***Editorial Acknowledgement:*** The editorial process of this article was completed under the editorship of Dr. Mesut Saçkes through a double-blind peer review with external reviewers.

***Publisher's Note:*** Journal of Childhood, Education & Society remains neutral with regard to jurisdictional claims in published maps and institutional affiliation.

## References

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J., & Martin, B. W. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Brazendale, K., Beets, M. W., Armstrong, B., Weaver, R. G., Hunt, E. T., Pate, R. R., Brusseau, T. A., Bohnert, A. M., Olds, T., & Tassitano, R. M. (2021). Children's moderate-to-vigorous physical activity on weekdays versus weekend days: A multi-country analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *18*, 1–13. https://doi.org/10.1186/s12966-021-01095-x

Contardo Ayala, A. M., Parker, K., Mazzoli, E., Lander, N., Ridgers, N. D., Timperio, A., Lubans, D. R., Abbott, G., Koorts, H., &

Salmon, J. (2024). Effectiveness of intervention strategies to increase adolescents' physical activity and reduce sedentary time in secondary school settings, including factors related to implementation: A systematic review and meta-analysis. *Sports Medicine - Open*, *10*(1), 25. https://doi.org/10.1186/s40798-024-00688-7

Costa, J. A., Vale, S., Cordovil, R., Rodrigues, L. P., Cardoso, V., Proença, R., Costa, M., Neto, C., Brito, J., Guilherme, J., & Seabra, A. (2024). A school-based physical activity intervention in primary school: Effects on physical activity, sleep, aerobic fitness, and motor competence. *Frontiers in Public Health*, *12*, 1365782. https://doi.org/10.3389/fpubh.2024.1365782

Cuberek, R., Janíková, M., & Dygrýn, J. (2021). Adaptation and validation of the physical activity questionnaire for older children (PAQ-C) among Czech children. *PloS One*, *16*(1), e0245256. https://doi.org/10.1371/journal.pone.0245256

Culková, D., Procházková, V., & Suk, J. (2020). Physical activity of elementary school pupils at a traditional state school and a jena plan school. *E-Pedagogium*, *20*(2), 47-58. https://doi.org/10.5507/epd.2020.007

Dinkel, D., Schaffer, C., Snyder, K., & Lee, J. M. (2017). They just need to move: Teachers' perception of classroom physical activity breaks. *Teaching and Teacher Education*, *63*, 186–195. https://doi.org/10.1016/j.tate.2016.12.020

Duncan, M. J., Al-Nakeeb, Y., Woodfield, L., & Lyons, M. (2007). Pedometer determined physical activity levels in primary school children from central England. *Preventive Medicine*, *44*(5), 416–420. https://doi.org/10.1016/j.ypmed.2006.11.019

Ferreira, I., Van Der Horst, K., Wendel-Vos, W., Kremers, S., Van Lenthe, F. J., & Brug, J. (2007). Environmental correlates of physical activity in youth–a review and update. *Obesity Reviews*, *8*(2), 129–154. https://doi.org/10.1111/j.1467-789X.2006.00264.x

Gába, A., Baďura, P., Vorlíček, M., Dygrýn, J., Hamřík, Z., Kudláček, M., Rubín, L., Sigmund, E., Sigmundová, D., & Vašíčková, J. (2022). The Czech Republic's 2022 report card on physical activity for children and youth: A rationale and comprehensive analysis. *Journal of Exercise Science & Fitness*, *20*(4), 340–348. https://doi.org/10.1016/j.jesf.2022.08.002

Gibson, C. A., Smith, B. K., DuBose, K. D., Greene, J. L., Bailey, B. W., Williams, S. L., Ryan, J. J., Schmelzle, K. H., Washburn, R. A., & Sullivan, D. K. (2008). Physical activity across the curriculum: Year one process evaluation results. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 1–11. https://doi.org/10.1186/1479-5868-5-36

Gomes, T. N., Katzmarzyk, P. T., Hedeker, D., Fogelholm, M., Standage, M., Onywera, V., Lambert, E. V., Tremblay, M. S., Chaput, J.-P., & Tudor-Locke, C. (2017). Correlates of compliance with recommended levels of physical activity in children. *Scientific Reports*, *7*(1), 16507. https://doi.org/10.1038/s41598-017-16525-9

Hale, G. E., Colquhoun, L., Lancastle, D., Lewis, N., & Tyson, P. J. (2023). Physical activity interventions for the mental health of children: A systematic review. *Child: Care, Health and Development*, *49*(2), 211–229. https://doi.org/10.1111/cch.13048

Hatfield, D. P., & Chomitz, V. R. (2015). Increasing children's physical activity during the school day. *Current Obesity Reports*, *4*(2), 147–156. https://doi.org/10.1007/s13679-015-0159-6

Haug, E., Torsheim, T., Sallis, J. F., & Samdal, O. (2010). The characteristics of the outdoor school environment associated with physical activity. *Health Education Research*, *25*(2), 248–256. https://doi.org/10.1093/her/cyn050

Havel, J., Janíková, M., Mužík, V., & Mužíková, L. (2016). *Analýza a perspektivy utváření pohybového a výživového režimu žáků na prvním stupni základní školy*. Masarykova univerzita.

Hu, D., Zhou, S., Crowley-McHattan, Z. J., & Liu, Z. (2021). Factors that influence participation in physical activity in school-aged children and adolescents: A systematic review from the social ecological model perspective. *International Journal of Environmental Research and Public Health*, *18*(6), 3147. https://doi.org/10.3390/ijerph18063147

Jarnig, G., Kerbl, R., Jaunig, J., & Van Poppel, M. N. M. (2023). Effects of a daily physical activity intervention on the health-related fitness status of primary school children: A cluster randomized controlled trial. *Journal of Sports Sciences*, *41*(11), 1073–1082. https://doi.org/10.1080/02640414.2023.2259210

Kantanista, A., Tarnas, J., Borowiec, J., Elegańczyk-Kot, H., Lubowiecki-Vikuk, A., Marciniak, M., & Król-Zielińska, M. (2021). Physical activity of children and adolescents from the Czech Republic, Hungary, Poland, and Slovakia: A systematic review. *Annals of Agricultural and Environmental Medicine*, *28*(3), 385–390. https://doi.org/10.26444/aaem/125557

Kovář, K., Zatloukal, T., Andrys, O., Suchomel, P., Kovářová, L., Cuberek, R., Zvonař, M., Vokounová, Š., Cacek, J., Čepička, L., Flemr, L., Chrudimský, J., Janíková, M., Musálek, M., Rubín, L., Suchomel, A., Vobr, R., Zahradník, D., Ságnerová, S., … Hamřík, Z. (2023). *Aktivní škola: Inspirace pro podporu pohybových aktivit žáků: Metodické doporučení* (1. vydání). Česká školní inspekce. https://www.csicr.cz/CSICR/media/Elektronicke-publikace/2023/MD_Aktivni_skola_pohybove_aktivity_a/html5/index.html?pn=1

Lanningham-Foster, L., Foster, R. C., McCrady, S. K., Manohar, C. U., Jensen, T. B., Mitre, N. G., Hill, J. O., & Levine, J. A. (2008). Changing the school environment to increase physical activity in children. *Obesity*, *16*(8), 1849–1853. https://doi.org/10.1038/oby.2008.282

Lee, P. H., Macfarlane, D. J., Lam, T. H., & Stewart, S. M. (2011). Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 1–11. https://doi.org/10.1186/1479-5868-8-115

Li, D., Wang, D., Zou, J., Li, C., Qian, H., Yan, J., & He, Y. (2023). Effect of physical activity interventions on children's academic performance: A systematic review and meta-analysis. *European Journal of Pediatrics*, *182*(8), 3587–3601. https://doi.org/10.1007/s00431-023-05009-w

Ługowska, K., Kolanowski, W., & Trafialek, J. (2022). The impact of physical activity at school on children's body mass during 2 years of observation. *International Journal of Environmental Research and Public Health*, *19*(6), 3287. https://doi.org/10.3390/ijerph19063287

Martin, A., Saunders, D. H., Shenkin, S. D., & Sproule, J. (2014). Lifestyle intervention for improving school achievement in overweight or obese children and adolescents. *Cochrane Database of Systematic Reviews*, *3*, CD009728. https://doi.org/10.1002/14651858.CD009728.pub2

McMullen, J., Kulinna, P., & Cothran, D. (2014). Physical activity opportunities during the school day: Classroom teachers' perceptions of using activity breaks in the classroom. *Journal of Teaching in Physical Education*, *33*(4), 511–527. https://doi.org/10.1123/jtpe.2014-0062

Petersen, T. L., Møller, L. B., Brønd, J. C., Jepsen, R., & Grøntved, A. (2020). Association between parent and child physical activity: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *17*(1), 1–16. https://doi.org/10.1186/s12966-020-00966-z

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* (Suppl. 3), S197–S239. https://doi.org/10.1139/apnm-2015-0663

Pugliese, J., & Tinsley, B. (2007). Parental socialization of child and adolescent physical activity: A meta-analysis. *Journal of Family Psychology*, *21*(3), 331. https://doi.org/10.1037/0893-3200.21.3.331

Reis, L. N., Reuter, C. P., Burns, R. D., Martins, C. M. D. L., Mota, J., Gaya, A. C. A., Silveira, J. F. D. C., & Gaya, A. R. (2024). Effects of a physical education intervention on children's physical activity and fitness: The PROFIT pilot study. *BMC Pediatrics*, *24*(1), 78. https://doi.org/10.1186/s12887-024-04544-1

Reisberg, K., Riso, E., & Jürimäe, J. (2020). Associations between physical activity, body composition, and physical fitness in the transition from preschool to school. *Scandinavian Journal of Medicine & Science in Sports*, *30*(11), 2251–2263. https://doi.org/10.1111/sms.13784

Richard, V., Piumatti, G., Pullen, N., Lorthe, E., Guessous, I., Cantoreggi, N., & Stringhini, S. (2023). Socioeconomic inequalities in sport participation: Pattern per sport and time trends – a repeated cross-sectional study. *BMC Public Health*, *23*(1), 785. https://doi.org/10.1186/s12889-023-15650-7

Rodrigo-Sanjoaquin, J., Corral-Abós, A., Solana, A. A., Casterad, J. Z., Lhuisset, L., & Bois, J. (2022). Effectiveness of school-based interventions targeting physical activity and sedentary time among children: A systematic review and meta-analysis of accelerometer-assessed controlled trials. *Public Health*, *213*, 147–156. https://doi.org/10.1016/j.puhe.2022.10.004

Rodriguez-Ayllon, M., Cadenas-Sánchez, C., Estévez-López, F., Muñoz, N. E., Mora-Gonzalez, J., Migueles, J. H., Molina-García, P., Henriksson, H., Mena-Molina, A., Martínez-Vizcaíno, V., Catena, A., Löf, M., Erickson, K. I., Lubans, D. R., Ortega, F. B., & Esteban-Cornejo, I. (2019). Role of physical activity and sedentary behavior in the mental health of preschoolers, children and adolescents: A systematic review and meta-analysis. *Sports Medicine*, *49*(9), 1383–1410. https://doi.org/10.1007/s40279-019-01099-5

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

Sallis, J. F. (2000). Age-related decline in physical activity: A synthesis of human and animal studies. *Medicine & Science in Sports & Exercise*, *32*(9), 1598–1600. https://doi.org/10.1097/00005768-200009000-00012

Sigmund, E., De Ste Croix, M., Miklankova, L., & Frömel, K. (2007). Physical activity patterns of kindergarten children in comparison to teenagers and young adults. *European Journal of Public Health*, *17*(6), 646–651. https://doi.org/10.1093/eurpub/ckm033

Sigmund, E., Sigmundová, D., & Ansari, W. E. (2009). Changes in physical activity in pre-schoolers and first-grade children: Longitudinal study in the Czech Republic. *Child: Care, Health and Development*, *35*(3), 376–382. https://doi.org/10.1111/j.1365-2214.2009.00945.x

Singh, A., Uijtdewilligen, L., Twisk, J. W., Van Mechelen, W., & Chinapaw, M. J. (2012). Physical activity and performance at school: A systematic review of the literature including a methodological quality assessment. *Archives of Pediatrics & Adolescent Medicine*, *166*(1), 49–55. 10.1001/archpediatrics.2011.716

Sterdt, E., Liersch, S., & Walter, U. (2014). Correlates of physical activity of children and adolescents: A systematic review of reviews. *Health Education Journal*, *73*(1), 72–89. https://doi.org/10.1177/0017896912469578

Taras, H. (2005). Physical activity and student performance at school. *Journal of School Health*, *75*(6), 214–218.

https://doi.org/10.1111/j.1746-1561.2005.00026.x

Tay, G. W. N., Chan, M. J., Kembhavi, G., Lim, J., Rebello, S. A., Ng, H., Lin, C., Shek, L. P., Lança, C., & Müller-Riemenschneider, F. (2021). Children's perceptions of factors influencing their physical activity: A focus group study on primary school children. *International Journal of Qualitative Studies on Health and Well-Being*, *16*(1), 1980279. https://doi.org/10.1080/17482631.2021.1980279

Trost, S. G., & Loprinzi, P. D. (2011). Parental influences on physical activity behavior in children and adolescents: A brief review. *American Journal of Lifestyle Medicine*, *5*(2), 171–181. https://doi.org/10.1177/1559827610387236

Trudeau, F., & Shephard, R. J. (2008). Physical education, school physical activity, school sports and academic performance. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 1–12. https://doi.org/10.1186/1479-5868-5-10

Vale, S., Silva, P., Santos, R., Soares-Miranda, L., & Mota, J. (2010). Compliance with physical activity guidelines in preschool children. *Journal of Sports Sciences*, *28*(6), 603–608. https://doi.org/10.1080/02640411003702694

Van Dijk, M. L., De Groot, R. H., Savelberg, H. H., Van Acker, F., & Kirschner, P. A. (2014). The association between objectively measured physical activity and academic achievement in Dutch adolescents: Findings from the GOALS study. *Journal of Sport and Exercise Psychology*, *36*(5), 460–473. https://doi.org/10.1123/jsep.2014-0014

Vanderloo, L. M., Tucker, P., Johnson, A. M., & Holmes, J. D. (2013). Physical activity among preschoolers during indoor and outdoor childcare play periods. *Applied Physiology, Nutrition, and Metabolism*, *38*(11), 1173–1175. https://doi.org/10.1139/apnm-2013-0137

Verstraete, S. J., Cardon, G. M., De Clercq, D. L., & De Bourdeaudhuij, I. M. (2006). Increasing children's physical activity levels during recess periods in elementary schools: The effects of providing game equipment. *The European Journal of Public Health*, *16*(4), 415–419. https://doi.org/10.1093/eurpub/ckl008

Watson, A., Timperio, A., Brown, H., Best, K., & Hesketh, K. D. (2017). Effect of classroom-based physical activity interventions on academic and physical activity outcomes: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *14*, 1–24. https://doi.org/10.1186/s12966-017-0569-9

Wilk, P., Clark, A. F., Maltby, A., Tucker, P., & Gilliland, J. A. (2018). Exploring the effect of parental influence on children's physical activity: The mediating role of children's perceptions of parental support. *Preventive Medicine*, *106*, 79–85. https://doi.org/10.1016/j.ypmed.2017.10.018

Yao, C. A., & Rhodes, R. E. (2015). Parental correlates in child and adolescent physical activity: A meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 1–38. https://doi.org/10.1186/s12966-015-0163-y