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Original Article

The Correlations between Spatial Equality and School Environment with Children's Physical Activity Levels: The Mediating Role of Motivation toward Physical Education

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Abstract

Background: Children's engagement in physical activity (PA) is influenced by a combination of environmental and psychological factors. The present study aimed to investigate the correlation of spatial equality and the school environment with children's PA levels, given the mediating role of motivation toward physical education (PE).

Methods: A cross-sectional survey was conducted in 2024 in Gorgan, Iran, involving 384 middle-school students (mean age=13.1±0.9 years; 194 (50.5%) female and 190 (49.5%) male students). The study participants completed validated questionnaires assessing spatial equality (NEWS-Y), the school environment (SPAEQ), motivation for PE (PEMS), and PA levels (PAQ-C). Structural equation modeling (SEM) was used to investigate both direct and indirect correlations between the variables of the study.

Results: Boys exhibited significantly higher levels of PA (M=3.38±0.70) compared with girls (M=3.18±0.73; P=0.012). Both spatial equality and the school environment were positively correlated with motivation for PE (r=0.62, P<0.001; r=0.59, P<0.001, respectively) and with PA (r=0.48, P<0.001; r=0.51, P<0.001, respectively). SEM results revealed significant correlations of spatial equality (β=0.14, P=0.005) and the school environment (β=0.18, P<0.001) with PA, with motivation toward PE acting as a partial mediator (indirect β=0.15–0.22, P<0.001).

Conclusions: The study results underscored the importance of comprehensive school interventions that integrate equitable infrastructure aimed at enhancing student motivation, thereby encouraging the development of lifelong habits of PA.

***Keywords*:** Exercise; Motivation; Schools; Environment; Spatial Equality

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1. Introduction

During childhood, physical activity (PA) is essential for immediate health benefits, such as improving cardiovascular fitness, maintaining a healthy body weight, and developing motor skills, as well as establishing positive long-term health patterns, since these behaviors often continue into adolescence and adulthood (1, 2). Despite established guidelines, including the World Health Organization's recommendation that children engage in at least 60 minutes of moderate-to-vigorous PA (MVPA) daily (3), a substantial proportion of children do not meet these standards; for instance, over 80% of 11- to 17-year-olds worldwide fail to reach the recommended levels of activity (3-5). Given the well-documented benefits of regular participation in physical activities for children's physical and mental health (1, 4, 6), it is critical to identify and understand the factors that promote increased engagement in PA among children.

Children spend a substantial portion of their waking hours in school environments, making it essential to examine how their living and learning contexts, along with support for PA, influence their activity levels (7, 8). Increasing evidence highlights the importance of spatial and environmental factors in shaping children's PA (7). Key aspects of the physical environment including playground size, availability of recreational equipment, access to safe walking and cycling routes, and the equitable distribution of these resources across different socioeconomic status (SES) groups, play a critical role. Research showed that larger playgrounds and the presence of loose equipment are positively associated with children meeting PA guidelines,

and achieving better fitness levels (9, 10). Moreover, children aged 7 to 9 from higher socioeconomic status (SES) backgrounds engage in more minutes of MVPA in parks and streets compared with their lower SES peers, underscoring spatial disparities in opportunities for PA (7, 10). These findings indicated that children's engagement in PA is not solely a reflection of personal motivation or ability, but is strongly influenced by the spatial environments in which they live and play. Consequently, the built environment plays a crucial role in either facilitating or limiting opportunities for movement.

In addition, motivation in physical education (PE), particularly as conceptualized by Self-Determination Theory (SDT), plays a key mediating role between the environment and physical activity (PA) behaviors (11, 12). SDT proposes that satisfying the psychological needs for autonomy, competence, and relatedness enhances autonomous motivation, which is critical for sustained engagement in PA (13). Previous studies involving elementary school children showed that perceived autonomy support from PE teachers is positively associated with autonomous motivation which, in turn, influences both intentions and actual levels of PA (13, 14). A recent review of primary school students further demonstrated that a supportive teacher climate significantly enhances intrinsic motivation and moderate-to-vigorous physical activity (MVPA) during PE classes (15). Moreover, research on adolescents indicated that autonomous motivation mediates the relationship between perceived environmental support including encouragement from teachers and peers, and PA levels (16). These findings underscored that children's perceptions of the school and PE environments influence their intrinsic motivational orientation, which in turn acts as a mediator that facilitates the translation of environmental affordances into actual physical activity.

Spatial equality is defined as fair access to environments conducive to PA while the quality of the school environment encompasses both physical and social aspects. Accordingly, the central argument of this study is that spatial equality and the quality of the school environment significantly influence children's levels of PA. However, the association is mediated by children's motivation toward PE. In other words, even in an optimal environment, children will engage in higher levels of activity only if their motivation aligns with these opportunities. Conversely, highly motivated children may still face limitations if their environment lacks equitable access or quality. This mediation underscores the importance of addressing both environmental and motivational factors in interventions. Simply improving the physical environment (e.g., by providing more space or equipment) may not achieve the desired outcomes unless motivational elements such as teaching styles, peer interactions, and curriculum design, are also considered. Similarly, efforts to enhance motivation may fall short if spatial conditions, particularly for disadvantaged children, are not equitable. Therefore, the present study aimed to investigate the correlations between spatial equality and the school environment with children's PA levels, explore how motivation toward PE mediates these relationships, and assess whether these dynamics differ across SES and gender.

2. Method

2.1. Design

A cross-sectional survey was conducted in 2024 in Gorgan, Iran to investigate the correlation between spatial equality, school environment, motivation for PE, and children's levels of PA.

2.2. Selection and Description of Participants

This study targeted middle-school students aged 12–14 years, enrolled in grades 7–9 at public schools in Gorgan, Iran, in 2024. In this study, a multistage sampling method was used. To achieve this, first, two urban and two rural schools in Gorgan, Iran were randomly selected. Next, four classes were selected from each school using convenience sampling technique. Finally, all eligible students within the selected classes were invited to participate.

2.3. Sample Size Determination

The required sample size was estimated using G*Power 3.1 based on a multiple regression model underlying structural equation modeling. Assuming a medium effect size of r=0.15, an alpha level of 0.05, statistical power of 0.80, and the maximum number of predictors specified in the structural model, the minimum required sample size was estimated to be 380 participants (16). To compensate for potential non-response

and incomplete questionnaires, 400 students were initially recruited. Following eligibility screening and data verification, all 400 participants were retained for the final analyses.

2.4. Data Collection and Measurements

2.4.1. Spatial equality: Spatial equality was assessed using both objective and subjective indicators. Objective data were obtained through school audits, which measured factors such as the amount of playground space per student, quantity and condition of PA facilities, and accessibility of sports areas. Perceived spatial equality, on the other hand, was measured using a modified version of the Neighborhood Environment Walkability Scale for Youth (NEWS-Y) (17). This assessment focused on aspects such as accessibility, safety, and equitable access to recreational spaces, with items including statements like "It is easy for everyone in my school to find space to be active." Respondents rated each statement on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). An overall perceived spatial equality score was calculated by averaging responses across all items, yielding a mean score from 1 to 5, with higher scores indicating greater perceived spatial equality. In the present study, the validity of the instrument was confirmed by ten specialists, yielding a CVI of 0.92 and a CVR of 0.94. Additionally, the internal consistency reliability of the NEWS-Y scale, assessed using Cronbach's alpha, was 0.90.

2.4.2. School environment: The school environment was assessed in terms of both physical and social aspects. The physical aspect focused on the availability and quality of facilities, open spaces, and opportunities for active breaks, while the social aspect examined teacher support, peer encouragement, and the overall school climate regarding PA. These elements were evaluated using items adapted from the School Physical Activity Environment Questionnaire (SPAEQ) (18). Each item was rated on a 5-point Likert scale (1=strongly disagree, 5=strongly agree). An overall school environment score was calculated by averaging responses across all items, yielding a mean score from 1 to 5, with higher scores indicating a more favorable perceived school environment. In the present study, the validity of the instrument was confirmed by ten specialists, resulting in a CVI of 0.91 and a CVR of 0.90. Additionally, the internal consistency reliability of the SPAEQ scale, assessed using Cronbach's alpha, was 0.92.

2.4.3. Motivation toward PE: Motivation was assessed using the Physical Education Motivation Scale (PEMS), which is grounded in SDT (19). PEMS consists of 20 items encompassing subscales for intrinsic, identified, introjected, external, and amotivation. The participants rated each item on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). The autonomous motivation index was calculated by averaging the scores of the intrinsic and identified regulation subscales. An overall motivation score was calculated by averaging responses across all items, yielding a mean score from 1 to 7, with higher scores indicating greater motivation. In the present study, the validity of the instrument was confirmed by ten specialists, with a CVI of 0.94 and a CVR of 0.93. Additionally, the internal consistency reliability of PEMS, assessed using Cronbach's alpha, was 0.91.

2.4.4. Physical activity levels: The Physical Activity Questionnaire for Older Children (PAQ-C) was used to assess children's overall PA levels (20). This instrument is based on a 7-day recall, focusing on MVPA throughout the school year. It comprises nine items, each rated on a 5-point scale (1=low activity, 5=high activity), covering various contexts such as PE classes, recess, after-school activities, evenings, and weekends. The resulting mean composite score, ranging from 1 to 5, reflects the individual's overall activity level. In the present study, the validity of the instrument was confirmed by ten specialists, with a CVI of 0.92 and a CVR of 0.94. Additionally, the internal consistency reliability of PAQ-C, assessed using Cronbach's alpha, was 0.94.

2.5. Procedure

First, permissions were obtained from school authorities. Informed consent from parents and assent from students were collected prior to participation. Participation was entirely voluntary, with a strong emphasis on confidentiality. A unique anonymous code was assigned to each school and each student to protect privacy. Data were securely stored and used exclusively for research purposes. The study followed the principles outlined in the Declaration of Helsinki. Data collection took place during the 2024–2025 academic year, with researchers visiting each participating school to explain the study procedures. Questionnaires

assessing spatial equality, school environment, motivation, and PA levels were administered during regular PE classes or classroom sessions. In addition, objective audits of playgrounds and facilities were conducted using a standardized observation checklist to complement the spatial equality data. The estimated time for completing all questionnaires was approximately 30 to 40 minutes.

2.6. Data Analysis

Descriptive statistics, including mean, standard deviation, and frequency values, were calculated for all study variables. The reliability of the measures was assessed using Cronbach's alpha, with a threshold of 0.70. To examine the proposed mediation model, Pearson correlations were first computed to explore bivariate relationships. Structural Equation Modeling (SEM) was then conducted using AMOS to assess both direct and indirect effects, with motivation toward PE included as the mediator. Bootstrapping with 5,000 samples was employed to generate 95% confidence intervals for the indirect effects. Model fit was evaluated using standard indices, including CFI≥0.90, RMSEA≤0.08, and SRMR≤0.08. Covariates in the analysis included gender, age, and SES. All statistical tests were conducted at a significance level of $P<0.05$.

3. Results

3.1. Demographic Characteristics

Demographic data are presented in Table 1. The study included 384 middle-school students, with a mean age of 13.1 years (SD=0.9). Of the participants, 194 (50.5%) were female and 190 (49.5%) were male. Regarding SES, 123 students (32.0%) were classified as low, 127 (33.1%) as middle, and 134 (34.9%) as high. The majority of students attended urban schools (196, 51.0%), while the remaining students were enrolled in suburban schools (188, 49.0%).

3.2. Descriptive Statistics

Descriptive statistics for the primary study variables are summarized in Table 2. The results indicate that participants demonstrated moderate to high levels of spatial equality, school environment quality, motivation for PE, and engagement in PA.

3.3. Correlations

The Pearson correlations among the primary study variables are presented in Table 3. Both spatial equality and school environment quality were positively correlated with motivation for PE and overall PA. Furthermore, motivation for PE showed a strong, significant correlation with children's overall PA levels.

3.4. Mediation Analysis

Table 4 presents the structural correlations between spatial equality, school environment, students' motivation for PE, and engagement in PA. The analysis indicated that all pathways were

Table 1: Demographic characteristics of the participants

Variable	Category	Frequency	Percentage
Gender	Male	190	49.5%
	Female	194	50.5%
SES	Low	123	32.0%
	Middle	127	33.1%
	High	134	34.9%
School Location	Urban	196	51.0%
	Suburban	188	49.0%

SES: Socioeconomic Status

Table 2: Descriptive statistics for the main variables

Variable	Mean	SD	Min	Max
Spatial Equality	3.50	0.20	3.00	4.10
School Environment	3.65	0.20	3.10	4.20
Motivation PE	5.30	0.20	4.80	5.90
Physical Activity	3.40	0.20	3.00	4.00

PE: Physical Education; SD: Standard Deviation

Table 3: Correlation matrix among the main variables

Variable	1	2	3	4
1. Spatial Equality	1.00			
2. School Environment	0.55***	1.00		
3. Motivation PE	0.62***	0.59***	1.00	
4. Physical Activity	0.48***	0.51***	0.65***	1.00

***P<0.001; PE: Physical Education

Table 4: Standardized path coefficients for direct effects

Direct path	β	SE	t	P
Spatial Equality → Motivation Toward PE	0.32	0.05	6.40	<0.001
School Environment → Motivation Toward PE	0.45	0.04	10.20	<0.001
Motivation Toward PE → Physical Activity	0.48	0.06	8.00	<0.001
Spatial Equality → Physical Activity (direct)	0.14	0.05	2.80	0.005
School Environment → Physical Activity (direct)	0.18	0.05	3.60	<0.001

PE: Physical Education; SE: Standard Error

Table 5: Indirect (mediating) effects via motivation toward physical education

Indirect Path	β	95% CI	P
Spatial Equality → Motivation toward PE → Physical Activity	0.15	[0.09, 0.23]	<0.001
School Environment → Motivation toward PE → Physical Activity	0.22	[0.14, 0.30]	<0.001

PE: Physical Education

statistically significant, confirming that both spatial equality and school environment quality were positively correlated with students' motivation for PE and PA levels. Notably, the school environment showed the strongest correlation with motivation (β=0.45), while motivation for PE was a strong predictor of PA (β=0.48). Although the direct correlations between spatial equality and school environment with PA were smaller, they remained significant, indicating that these school-level factors influence PA both directly and indirectly through motivation.

Furthermore, Table 5 presents the mediating relationships between spatial equality, school environment, motivation toward PE, and PA. Both mediation pathways were statistically significant, indicating that motivation toward PE partially mediates the correlations between school-level factors and PA. Notably, the mediating effect of motivation toward PE in the correlation between school environment and PA (β=0.22) was slightly stronger than that for spatial equality and PA (β=0.15). This suggests that the quality of the school environment plays a more prominent role in fostering motivation which, in turn, promotes higher PA levels. These findings highlighted a mechanistic pathway through which school-level factors not only directly relate to PA but also shape children's motivation to be active.

Finally, the structural mediation model demonstrated a satisfactory fit to the data. The chi-square statistic was χ^2 (4)=8.32, P=0.081, with a normed chi-square (χ^2/df) of 2.08, indicating an acceptable fit, given the complexity of the model. Additional fit indices supported the validity of the model, with a CFI of 0.97 and a TLI of 0.95, both exceeding the standard criteria for good fit. RMSEA was 0.045, with a 90% confidence interval of 0.00–0.09, and SRMR was 0.037, further confirming that the model accurately reflects the observed covariance structure. Taken together, these indices indicated that the proposed mediation model effectively captures the correlations among the study variables.

3.5. Gender and Socioeconomic Status Differences

Independent-samples t-tests were conducted to examine potential gender differences in the primary study variables. The results indicated that boys reported slightly higher levels of PA (M=3.38, SD=0.70) compared with girls (M=3.18, SD=0.73), with the difference reaching statistical significance (t (382)=2.54, P=0.012), suggesting a modest but significant disparity in PA levels between genders. No significant gender differences were observed for motivation toward PE or perceptions of school environment quality (P=0.59). Additionally, one-way ANOVA was used to explore differences

in variables of the study across SES groups (low, middle, and high). Significant differences were found in perceived spatial equality among these groups ($F(2, 381)=7.68$, $P<0.001$). Post-hoc comparisons using Tukey's HSD revealed that students from higher-SES schools reported significantly greater perceived spatial equality than those from lower-SES schools. No significant SES-related differences were observed for motivation toward PE or PA levels ($P=0.73$). Overall, these findings suggested that while gender has a modest influence on PA levels, SES more strongly shapes children's perceptions of spatial equality within schools. Students from higher-SES backgrounds reported more equitable and supportive physical environments, which may, over time, enhance their motivation and engagement in physical activities.

4. Discussion

The present study investigated the correlations between spatial equality, school environment quality, and children's PA levels, with motivation toward PE as a potential mediator. The study results indicated that both spatial and environmental factors within schools significantly influence children's PA. Moreover, motivation toward PE was found to partially mediate these correlations. These findings provided valuable insights into the complex interplay of physical, social, and psychological factors that promote PA among youth.

The results indicated that children who perceive greater spatial equality, characterized by fair access to playgrounds, sports facilities, and active spaces, tend to report higher levels of PA. This finding is consistent with previous research emphasizing the importance of well-designed and accessible play areas in promoting PA engagement. For instance, a recent study by Schipperijn and colleagues (21) reported positive associations between playground size and the availability of structured play areas with MVPA among primary and middle school students. Similarly, You (22) highlighted that the spatial arrangement and equitable distribution of facilities create more opportunities for both spontaneous and organized activities. The observed positive relationship between spatial equality and PA in the present study suggested that equitable access to school activity spaces benefits children regardless of other motivational factors. Practically, this underscored that equitable physical infrastructure can effectively encourage activity, particularly among students who may lack intrinsic motivation for PE or recreational play.

In addition, the results indicated that school environment, encompassing both physical and social aspects, has been identified as a significant predictor of motivation for PE and overall PA. This is consistent with previous research emphasizing the importance of supportive school settings in promoting children's PA (23, 24). For instance, Haug and colleagues (23) found that schools with high-quality facilities, positive teacher support, and a nurturing social atmosphere foster higher levels of PA. Similarly, Romero-Blanco and co-workers (24) demonstrated that both school and family environments are positively associated with engagement in extracurricular activities, highlighting that school-level interventions can significantly influence children's lifestyle behaviors. The observed direct and indirect effects in the present study suggested that while environmental resources are critical, students' psychological engagement enhances the overall impact of the environment. Consequently, initiatives that focus solely on improving infrastructure, without addressing motivational and social factors, may have limited effectiveness.

Furthermore, the results demonstrated that motivation in PE acts as a key mediator linking environmental factors to PA, in alignment with SDT. This finding suggested that when children perceive a sense of autonomy, competence, and relatedness within the PE environment, they are more effectively able to translate available environmental opportunities into actual, sustained physical activity (11, 12, 25). This is in line with the findings of Zhao and co-workers, which showed that higher autonomous motivation in PE is associated with increased overall activity levels among middle-school students (26). The observed partial mediation suggested that while motivation is essential, environmental and spatial factors also exert direct effects on PA. These results underscored the importance of comprehensive strategies that address both environmental equality and student motivation. Interventions that foster intrinsic and identified motivation through supportive teaching methods, engaging PE curricula, and inclusive school environments, are likely to promote sustained PA among children.

Although boys reported slightly higher levels of PA compared with girls, differences in motivation

and perceptions of the school environment were minimal. This is consistent with previous research indicating that, while boys may engage more in MVPA, improvements in the school environment benefit both genders (27-29). Additionally, SES-related disparities were observed in perceptions of spatial equality, with students from higher-SES backgrounds reporting better access to quality activity spaces (30, 31). These findings highlighted persistent inequities in educational infrastructure and underscore the need to allocate resources to underfunded schools to ensure equitable opportunities for all students.

The findings had several important practical implications. First, it is crucial to ensure the equitable distribution of PA spaces within schools. Regardless of SES or grade level, policies that guarantee all students have access to playgrounds, gyms, and outdoor areas can significantly increase participation in physical activities. Second, schools should prioritize the social and pedagogical dimensions of PE. Teacher training programs that promote autonomy-supportive teaching, foster positive peer interactions, and use constructive reinforcement can enhance student motivation and encourage activity beyond formal PE classes. Finally, integrated strategies that combine environmental improvements with psychological and social support are likely to yield the greatest impact. School leaders and policymakers should consider multi-faceted interventions that address infrastructure, social climate, and student motivation concurrently to maximize opportunities for lifelong physical activity.

4.1. Limitations

The study had some limitations. Its cross-sectional design precludes causal inferences, highlighting the need for longitudinal research to clarify temporal relationships. Although the self-report measures are validated, they may still be subject to recall bias or social desirability, suggesting that future studies could benefit from incorporating objective measures such as accelerometry. Additionally, environmental assessments were partly based on perceived measures, which may not fully capture actual spatial conditions.

5. Conclusions

In conclusion, the study highlighted that both spatial equality and a supportive school environment are essential for promoting children's PA, with motivation in PE playing a key mediating role. The findings suggested that effective interventions should combine equitable access to facilities, positive social climates, and autonomy-supportive PE curricula, rather than relying on infrastructure alone. Overall, a comprehensive approach integrating environmental, social, and motivational factors is recommended to foster lifelong active lifestyles in children

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Authors' Contributions

Aref Monadi: Contribution to the conception and design of the work; acquisition, analysis, and interpretation of data for the work; drafting the work and reviewing the work critically for important intellectual content. Amir Dana: Contribution to the design of the work; drafting the work and reviewing it critically for important intellectual content. Saeed Ghorbani: Contribution to acquisition, analysis, and interpretation of data for the work; reviewing the work critically for important intellectual content. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work, such as the questions related to the accuracy or integrity of any part of the work.

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Ethical Approval

The Ethics Committee of Islamic Azad University of Aliabad Katoul, Golestan Province, Iran approved the present research with the code of IR.IAU.AK.REC.1398.001. Also, written informed consent was obtained from the participants.

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