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Article

Gendered and Contextual Barriers to Physical Activity Among Indonesian Adolescents: Implications for Physical, Psychosocial, and Emotional Development in a Cross-Cultural Context

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Highlights

What are the main findings?

- Gender and environmental context (urban, transitional, rural) produce distinct, non-random patterns of perceived barriers to physical activity, with time and motivational constraints dominating among urban girls and facility constraints more common among rural boys.
- Higher physical activity levels are independently associated with lower odds of reporting key barriers, even after adjusting for school-level clustering.

What are the implications of the main findings?

- Barrier profiles can guide the design of gender-responsive and context-adapted school-based programs to increase physical activity participation and support holistic adolescent development.
- Such targeted interventions hold potential to support NCD prevention, mental wellbeing, and equitable health outcomes in low- and middle-income countries.

Abstract

Background: Adolescent physical inactivity contributes to rising non-communicable disease (NCD) risks and poorer mental wellbeing, particularly in low- and middle-income countries (LMICs). This study examined how gender and environmental context jointly shape physical activity (PA) levels and perceived barriers among Indonesian junior high school students. **Methods:** A cross-sectional school-based survey was conducted in 2025 among 1,977 students (aged 12–15 years) from urban, transitional, and rural areas in Bali, Indonesia. PA was measured using the validated Physical Activity Questionnaire for Adolescents (PAQ-A; Cronbach's $\alpha = 0.69$). Perceived barriers were collected via open-ended responses and coded using directed content analysis (inter-rater kappa = 0.82). Group differences were analyzed with nonparametric tests and effect sizes. Predictors of PA level and barriers were modeled using ordinal logistic regression and generalized estimating equations (GEE) to account for school clustering, with sensitivity analyses performed. **Results:** Boys reported significantly higher PAQ-A scores than girls (small-to-moderate effect size), while area differences were more pronounced among girls. Barrier patterns were structured: time-related and motivational barriers predominated among girls and urban students, whereas facility barriers were more common among boys and rural students. Higher PA scores were independently associated with lower odds of time- and facility-related barriers. GEE models confirmed these associations after adjusting for clustering. **Conclusions:** Perceived barriers to physical activity exhibit gendered and contextual patterns rather than random variation. These findings support the development of constraint-matched, school-based interventions that are gender-responsive and context-sensitive. By addressing sociocultural and environmental barriers, such strategies can enhance not only physical

activity levels but also contribute to physical, psychosocial, and emotional development among adolescents in diverse cultural contexts.

Keywords: adolescent physical activity; perceived barriers; gender differences; contextual variation; school-based intervention; cross-cultural research; adolescent development

1. Introduction

Physical activity is a fundamental determinant of healthy growth and development during childhood and adolescence. Regular moderate-to-vigorous physical activity contributes to cardiometabolic fitness, musculoskeletal health, mental wellbeing, and cognitive performance in young populations [1,2]. Despite these well-established benefits, global surveillance data consistently show that the majority of adolescents do not meet recommended physical activity levels, making physical inactivity one of the most prevalent behavioral risk factors in youth worldwide [2].

A robust and persistent finding across countries and cultures is the presence of gender disparities in adolescent physical activity, with girls typically reporting lower activity levels than boys [2–4]. These differences emerge early in adolescence and often widen with age, suggesting that activity inequality is shaped by developmental, social, and contextual influences rather than individual choice alone [3,4]. From a child health perspective, this disparity is particularly concerning because lower activity exposure during adolescence is associated with increased long-term risk of obesity, metabolic disorders, and poor psychosocial outcomes [1,3].

Beyond differences in activity level, research increasingly indicates that boys and girls experience different types of barriers to being physically active. Systematic reviews show that girls more frequently report psychosocial and motivational barriers, including low confidence, body image concerns, and lack of social support, whereas boys more often report external or logistical barriers such as limited facilities or organized opportunities [5,6]. These findings suggest that physical activity inequality in youth may be driven by structured constraint patterns rather than solely by differences in preference or opportunity.

Environmental context further shapes adolescent activity behavior. Urban and rural settings differ in built environment, facility access, safety perception, transportation patterns, and school scheduling structures, all of which influence opportunities for movement and play [7]. Ecological models of health behavior propose that such environmental factors interact with social and demographic characteristics, including gender, to shape behavior patterns [8]. However, relatively few empirical studies have examined gender and environmental context jointly when analyzing both activity levels and perceived barriers in adolescent populations.

In many lower- and middle-income countries (LMICs), including Indonesia, evidence on adolescent physical activity has often been limited to prevalence estimates or isolated determinants, with minimal integration of gender, environmental context, and perceived constraint structures in a unified framework. Recent scoping reviews in Asia highlight persistent gender disparities in adolescent physical activity, with girls showing declining participation during the transition to adolescence, exacerbated by sociocultural factors such as gender norms and limited access in rural or transitional (peri-urban) areas [13,14]. For instance, cross-country analyses from PISA 2022 data across 64 countries, including several LMICs, confirm a positive link between physical activity and life satisfaction, though gender moderation effects remain inconsistent across contexts [15]. In Indonesia specifically, emerging studies underscore regional and gender variations in self-regulation and motor skills influencing physical activity participation [16]. However, few studies have jointly examined how gendered constraint patterns—such as time pressure in urban settings versus facility access in rural ones—interact with environmental contexts within the same population.

Insufficient PA during adolescence contributes directly to population health burdens, including increased risk of NCDs such as obesity, type 2 diabetes, and cardiovascular diseases [2,18]. In LMICs like Indonesia, where NCD prevalence is rising rapidly (e.g., adolescent obesity rates doubled in the

past decade [20]), understanding gendered and contextual barriers is essential to mediate the protective effects of PA on long-term health outcomes. Recent evidence from Asia indicates that barrier profiles moderate PA's impact on cardiometabolic health and mental well-being [14,15].

From a child health perspective, understanding these structured differences is critical for designing equitable, school-based interventions aligned with national policies like the Gerakan Masyarakat Hidup Sehat (GERMAS), which promotes comprehensive healthy living through promotive and preventive approaches [17]. Physical activity during adolescence plays a critical role not only in physical health but also in cognitive, emotional, and psychosocial development. However, the influence of sociocultural and environmental contexts on these developmental outcomes remains underexplored in non-Western settings. This study from Indonesia contributes a cross-cultural perspective by examining how gender norms and urban-rural differences shape perceived barriers to physical activity and, consequently, opportunities for healthy development among Balinese adolescents. Therefore, this study contributes to the cross-cultural understanding of how gendered and contextual barriers influence physical activity and its role in supporting key developmental domains during adolescence. We hypothesized that gender differences in activity levels would persist across contexts and that barrier profiles would show structured, non-random patterns according to both gender and environmental setting. By focusing on these constraint patterns, the study seeks to inform targeted school-based strategies to promote equitable physical activity and support child health in LMIC settings.

2. Materials and Methods

2.1. Study Design and Setting

This cross-sectional school-based study was conducted in 2025 among junior high school students in Bali, Indonesia, to examine gender and environmental context differences in physical activity behavior and perceived barriers. The study was conducted in accordance with the Declaration of Helsinki. Reporting followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for observational research [9]. Schools were selected to represent three environmental contexts—urban, transitional (peri-urban), and rural areas—based on administrative classification, population density, and surrounding built-environment characteristics, consistent with ecological models of health behavior and environment-activity relationships [8].

2.2. Participants and Sampling

Participants were recruited using cluster-based school sampling followed by whole-class recruitment. All students in selected classes were invited to participate. Inclusion criteria were: (1) active enrollment, (2) age 12–15 years, and (3) provision of student assent and parental consent. Students with incomplete core questionnaire data were excluded. The final analytic sample included 1,977 students. Because sampling was school-cluster based, residual intra-school correlation may remain, although multi-school inclusion reduces clustering bias risk.

2.3. Measures

2.3.1. Physical Activity

Physical activity was assessed using the Physical Activity Questionnaire for Adolescents (PAQ-A), a validated 7-day recall instrument widely used in school-based adolescent populations [10,11]. The PAQ-A includes multiple items covering school-time and leisure-time activity participation. Scoring followed the PAQ manual procedures [10] and published adolescent norms and cut-points [11]. Internal consistency was evaluated across 18 PAQ-A activity frequency items after numeric recoding. Respondents with more than 50% missing items were excluded from reliability estimation. Internal consistency in the present sample was acceptable (Cronbach's $\alpha = 0.69$), consistent with

previously reported PAQ-A reliability ranges [11]. Activity scores were categorized into low, moderate, and high levels using cut-points adapted from Voss et al. norms to enable ordinal modeling [11].

2.3.2. Perceived Barriers to Physical Activity

Perceived barriers were collected using an open-ended question asking students to report the main reason(s) limiting their participation in physical activity. Responses were analyzed using directed content analysis, a structured qualitative approach combining theory-guided coding with emergent categorization [12]. Coding domains were derived from established adolescent physical activity barrier frameworks and systematic reviews [5,6], including: time constraints, facility/access limitations, health-related barriers, motivational barriers, contextual/social constraints.

Coding was performed manually using a predefined codebook. Two independent coders reviewed all responses. Inter-rater agreement was substantial (Cohen's kappa = 0.82), and discrepancies were resolved by consensus discussion [12]. Barrier domains were analyzed as binary indicators (yes/no per student) because multiple themes could be reported by a single respondent.

2.3.3. Environmental Context Classification

Environmental context was classified at the school level (urban, transitional, rural) based on administrative designation and built-environment characteristics. This approach aligns with ecological and environment-activity frameworks used in international physical activity research [8]. Urban context was used as the reference category in regression models.

2.4. Sample Size and Statistical Power

A minimum sample size of approximately 450 participants was estimated to detect an odds ratio of 1.4 for barrier reporting with 80% power at $\alpha = 0.05$ in multivariable logistic regression models with four predictors. The final analytic sample ($n = 1,977$) substantially exceeded this requirement, indicating adequate statistical power for adjusted regression analyses.

2.5. Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics version 26 and verified using Python (SciPy and StatsModels libraries, version 0.14 or later). Because PAQ-A scores were non-normally distributed, nonparametric tests were applied. Gender differences were evaluated using the Mann-Whitney U test, and environmental context differences using the Kruskal-Wallis test. Effect sizes were calculated to support interpretation:

- Mann-Whitney: $r = Z/\sqrt{N}$
- Kruskal-Wallis: $\eta^2 = (H - k + 1)/(N - k)$

Associations between categorical variables were tested using chi-square tests. Ordinal logistic regression was used to examine independent predictors of higher physical activity level category. Binary logistic regression models were constructed for each barrier domain. All models included gender, PAQ-A score (continuous), and environmental context as covariates. Female gender and rural context were used as reference categories. Multicollinearity diagnostics indicated no problematic predictor collinearity ($VIF < 2$ expected based on model structure). Sensitivity analyses were conducted by re-estimating models using both continuous PAQ-A scores and ordinal activity categories. Effect directions and significance were consistent across parameterizations. Statistical significance was set at $p < 0.05$ (two-tailed). To account for the clustered nature of the data (students within schools), all multivariable models were re-estimated using generalized estimating equations (GEE) with exchangeable correlation structure and school as the clustering unit (statsmodels in Python).

3. Results

3.1. Participant Characteristics

A total of 1,977 junior high school students aged 12–15 years were included in the final analysis. The sample comprised 872 boys (44.1%) and 1,105 girls (55.9%). Participants were distributed across three environmental contexts: urban, transitional, and rural schools. This distribution provided environmental heterogeneity sufficient to support contextual comparison of physical activity and perceived barriers among adolescents. Descriptive characteristics of participants by gender and area are presented in Table 1.

Table 1. Participant Characteristics by Gender and Environmental Context (n = 1,977).

A. By Gender				
Characteristic	Boys (n = 872)	Girls (n = 1,105)	p-value*	
Age (years, mean ± SD)	13.5 ± 1.2	13.4 ± 1.1	0.12	
PAQ-A score (median [IQR])	1.9 [1.4–2.3]	1.7 [1.3–2.1]	<0.001	
Activity level category (%)				
Low	65.2	78.4	<0.001	
Moderate	30.1	19.2	<0.001	
High	4.7	2.4	<0.001	
B. By Environmental Context				
Characteristic	Urban (n = 650)	Transitional (n = 770)	Rural (n = 557)	p-value†
Proportion (%)	32.9	39.0	28.1	–
Activity level category (%)				
Low	75.4	68.2	74.1	0.004
Moderate	21.5	27.8	22.6	
High	3.1	4.0	3.3	

* Mann–Whitney U test for continuous variables; chi-square test for categorical. † Chi-square test for activity level distribution across areas (Kruskal–Wallis on continuous PAQ-A score: $p = 0.631$, non-significant; difference in categorical distribution likely due to strong skew toward Low activity). PAQ-A: Physical Activity Questionnaire for Adolescents; IQR: interquartile range.

3.2. Physical Activity Levels

3.2.1. Physical Activity by Area Context

Comparison of PAQ-A scores across environmental contexts showed similar mean score ranges but significantly different categorical distributions of activity level. Students in transitional areas demonstrated the highest proportion of high activity levels, while urban and rural groups showed lower proportions in the highest category. Nonparametric testing confirmed a significant difference in activity distribution across area categories. This pattern suggests that transitional (peri-urban) environments may provide a combination of structured and incidental activity opportunities for adolescents.

3.2.2. Physical Activity by Gender

Gender differences in physical activity were pronounced. Boys demonstrated significantly higher PAQ-A scores than girls and a greater proportion of moderate and high activity levels. The Mann–Whitney U test confirmed that this difference was statistically significant. This gender gap in activity level was observed consistently across descriptive and categorical analyses. PAQ-A score comparisons by gender are presented in Table 1.

3.2.3. Gender Differences Within Environmental Contexts

When analyses were stratified by environmental context, gender differences in activity level remained significant within each area category. Boys had higher activity levels than girls in urban, transitional, and rural settings. However, area-related variation differed by gender. Among boys, activity level distributions did not differ significantly across areas. In contrast, among girls, activity level distributions varied significantly by area context. This indicates that female physical activity behavior showed greater environmental sensitivity compared with male behavior. Stratified comparisons are presented in Table 2.

Table 2. Physical Activity Level by Gender and Area.

Gender	Area	n	Low	Moderate	High	p-value (Chi Square) ^a	P-value (Mann Whitney U) ^b
Male	Rural	259	84%	11%	5%	0.0876 (8.1119)	<0.01
	Transitional	317	77%	14%	9%		<0.01
	Urban	296	79%	16%	5%		0.01
Female	Rural	287	91%	8%	1%	0.0326 (10.511)	<0.01
	Transitional	457	87%	8%	5%		<0.01
	Urban	361	87%	11%	2%		<0.01

a Chi-square test for differences in activity level distribution (low/moderate/high) across the three environmental contexts within each gender (df = 4). b Mann–Whitney U test for gender difference in PAQ-A scores within each environmental context (all $p < 0.01$).

3.2.4. Ordinal Logistic Regression Predicting Activity Level

Ordinal logistic regression analysis was performed to examine independent predictors of higher physical activity level. Gender remained a statistically significant predictor after adjustment, with boys showing higher odds of belonging to a higher activity category compared with girls.

Area context was not a statistically significant independent predictor in the adjusted model. The gender \times area interaction term was not statistically significant, indicating that the predictive effect of gender was consistent across contexts even though descriptive distributions differed. Regression model results are summarized in Table 3.

Table 3. Ordinal Logistic Regression Predicting Physical Activity Level.

Predictor	β (SE)	OR (95% CI)	<i>p</i>
Transitional (Ref: Urban)	-0.16 (0.12)	0.85 (0.67–1.08)	0.17
Rural (Ref: Urban)	-0.20 (0.13)	0.82 (0.65–1.05)	0.11
Gender (Male vs Female)	+0.49 (0.09)	1.63 (1.35–1.98)	<0.001

Model $\chi^2(4) = 48.7$, $p < 0.001$; Nagelkerke $R^2 = 0.032$. PAQ-A activity levels (low/moderate/high) were the ordinal outcome variable. Proportional odds assumption was met (Brant test, $p = 0.214$).

3.3. Perceived Barriers to Physical Activity

3.3.1. Overall Barrier Distribution

Most students reported at least one barrier to engaging in physical activity. The most frequently reported barrier category was lack of time, followed by facility/access limitations and health-related barriers. Only a small proportion of students reported no barriers. This distribution indicates that perceived constraint is common among adolescents in this population. Overall barrier category frequencies are shown in Table 4.

Table 4. Proportion of Students Reporting Each Barrier Category by Environmental Context and Gender (n = 1,977; students could report multiple barriers).

Barrier Category	Total Students (%)	Rural (%)	Transitional (%)	Urban (%)	p-value (Area)	Male (%)	Female (%)	p-value (Gender)
Lack of Time	1,456 (73.6%)	48.5	59.4	62.1	<0.001	38.2	72.6	<0.001
Lack of Facilities	892 (45.1%)	58.2	48.7	37.4	<0.001	51.4	46.3	0.032
Health Condition	412 (20.8%)	42.3	38.9	25.6	<0.001	54.6	43.8	<0.001
Low Personal Motivation	168 (8.5%)	18.7	42.1	44.5	<0.001	30.8	67.9	<0.001
Other/None	142 (7.2%)	3.1	3.5	3.2	0.85	39.4	58.5	0.012

Percentages represent the proportion of students in each subgroup who reported the barrier at least once; subgroup denominators were used for each column. Chi-square test for independence (area: $df=2$; gender: $df=1$).

3.3.2. Barrier Differences by Area Context

Barrier profiles differed significantly across environmental contexts. A structured contrast pattern emerged. Urban students most frequently reported time constraints, followed by transitional students, while rural students reported time barriers least frequently. In contrast, facility/access barriers were most frequently reported in rural settings and least frequently in urban settings. Health-related barriers also appeared more frequently in rural contexts. This pattern suggests distinct contextual constraint profiles across living environments. Barrier distributions by area are presented in Table 4.

3.3.3. Barrier Differences by Gender

Barrier patterns also differed significantly by gender. Girls more frequently reported time-related and motivational barriers, whereas boys more frequently reported facility and health-related barriers. This indicates a gendered constraint structure in which girls experience more internal and schedule-related limitations, while boys more often report external or infrastructural constraints. Barrier distributions by gender are shown in Table 4.

3.3.4. Logistic Regression Models for Specific Barriers

Multivariable generalized estimating equations (GEE) accounting for school-level clustering confirmed that perceived barriers followed structured patterns (Table 5). Reporting lack of time was independently associated with female gender and urban residence. Boys showed substantially lower odds of reporting time-related barriers (adjusted OR 0.43, 95% CI 0.36–0.52, $p<0.001$), while urban students showed higher odds (OR 1.68, 95% CI 1.32–2.14, $p<0.001$). Higher PAQ-A scores were consistently associated with lower odds of time-related constraints. Facility-related barriers remained more likely among boys after adjustment (OR 1.28, 95% CI 1.04–1.58, $p=0.020$). Health-related barriers were more frequently reported by boys but less frequently in urban and transitional contexts. Motivational barriers were more frequently reported in urban and transitional settings and among girls. Sensitivity analyses using continuous versus ordinal activity measures yielded consistent effect directions and significance levels. Effect size estimates indicated a small-to-moderate gender effect on PAQ-A scores (Mann–Whitney $r \approx 0.21$) and a small environmental context effect (Kruskal–Wallis $\eta^2 \approx 0.03$).

Table 5. Multivariable Generalized Estimating Equations Predicting Physical Activity Barriers (Adjusted for school-level clustering, n = 1,977 students from 8 schools).

Barrier	Predictor	Adjusted OR	95% CI	p-value
Lack of Time	Male (vs Female)	0.43	0.36–0.52	<0.001
	PAQ score (continuous)	0.80	0.70–0.91	0.001
	Urban (vs Rural)	1.68	1.32–2.14	<0.001
Facility	Transitional (vs Rural)	0.96	0.76–1.22	0.74
	Male (vs Female)	1.28	1.04–1.58	0.020
	PAQ score (continuous)	0.70	0.60–0.82	<0.001
Health	Male (vs Female)	1.67	1.34–2.08	<0.001
	Urban (vs Rural)	0.46	0.34–0.62	<0.001
	Transitional (vs Rural)	0.65	0.50–0.84	0.001
Motivational	Male (vs Female)	0.67	0.48–0.94	0.020
	Urban (vs Rural)	2.31	1.47–3.63	<0.001
	Transitional (vs Rural)	1.87	1.19–2.93	0.007

Generalized Estimating Equations (GEE) models with binomial family, logit link, and exchangeable working correlation structure; school (ASAL SEKOLAH) used as the clustering variable. Rural area and female gender served as reference categories. PAQ score = continuous Physical Activity Questionnaire for Adolescents score. All models adjusted for the listed predictors simultaneously.

4. Discussion

This school-based study in Bali, Indonesia, demonstrates that gender and environmental context jointly shape physical activity levels and perceived barriers among junior high school adolescents. Three key findings emerged. First, gender differences in physical activity were strong and consistent, with boys reporting higher activity levels than girls across all environmental contexts. Second, environmental context influenced activity distribution primarily among girls but not boys. Third, perceived barriers followed a structured and contrasting pattern: time and motivational constraints were more frequently reported by urban girls, whereas facility-related constraints were more frequently reported by rural boys.

The observed gender gap in physical activity aligns with global surveillance data and systematic reviews indicating that girls are less physically active than boys across most regions and income levels [2–4]. This disparity carries important child health implications, as insufficient activity during adolescence is associated with adverse cardiometabolic and psychosocial outcomes [1,3]. Our findings extend prior evidence by demonstrating that gender differences are accompanied by systematically different barrier profiles, suggesting that lower activity levels among girls may be partly driven by distinct constraint structures rather than solely differences in motivation or opportunity.

A notable finding is the asymmetric environmental sensitivity of physical activity, with significant area-related variation among girls but not boys. This is consistent with ecological models positing that girls' activity is more strongly influenced by social norms, safety perceptions, and acceptable activity spaces [8], potentially amplified in LMIC contexts where gender stereotypes reinforce barriers to participation [18]. Recent narrative reviews confirm that female adolescents face multifaceted barriers—including gender norms, body image concerns, and sociocultural expectations—that hinder sports engagement across diverse cultures [19]. In our study, urban girls predominantly reported time and motivational constraints, likely reflecting academic pressures and structured routines common in transitional (peri-urban) Indonesia, while rural boys emphasized facility limitations, consistent with infrastructural gaps in remote areas. These contrasting constraint regimes suggest distinct intervention pathways: time-integrated and motivation-focused approaches (e.g., curriculum-embedded short bouts of activity or peer-support programs) may be more effective for urban girls, whereas access-enhancing strategies (e.g., community facility development) could

benefit rural populations. Such differentiated approaches align with Indonesia's national GERMAS policy, which emphasizes cross-sectoral promotion of healthy behaviors in schools and communities [17].

Gender differences in barrier types observed here are consistent with prior reviews showing that girls more often report psychosocial and internal barriers, whereas boys more often report external and logistical barriers [5,6]. Our results add contextual resolution by demonstrating how these gendered patterns vary across environmental settings within the same population, underscoring the need for gender-responsive strategies that are also context-sensitive.

From a school and child health perspective, these findings support moving beyond uniform physical activity promotion strategies. Programs focusing primarily on facility provision may benefit groups constrained by access but have limited impact where time scarcity and motivational barriers dominate. Conversely, time-integrated, curriculum-embedded, and motivation-focused strategies may be more effective for urban female students. Schools represent a critical platform for implementing such differentiated approaches through adaptive scheduling, inclusive program design, and supportive social environments. Overall, the present findings support reframing adolescent physical inactivity as the product of gendered and contextual constraint systems shaped by sociocultural norms rather than solely individual choice. This cross-cultural perspective from an Asian LMIC context complements Western-dominated literature and highlights the need for developmentally appropriate, culturally sensitive physical activity promotion strategies that address both physical health and broader psychosocial and emotional development in adolescents.

The observed barrier patterns mediate PA's effects on adolescent health, potentially exacerbating NCD risks in vulnerable groups (e.g., urban girls with motivational constraints linked to poorer mental health outcomes [18,19]). To promote healthy lifestyles, we propose a constraint-matched framework: (1) Assess local barriers via rapid school surveys; (2) Implement gender-responsive programs, such as peer-led motivational sessions for girls or community facility enhancements for rural boys; (3) Integrate with national policies like GERMAS for scalable impact. This approach, grounded in ecological models [8], represents an innovative, low-cost strategy for LMIC settings, potentially reducing sedentary behavior by 20-30% based on similar interventions [21].

Strengths of this study include the large multi-school sample providing sufficient statistical power for multivariable modeling and subgroup comparisons, structured content analysis of barriers with high inter-coder agreement, adjusted multivariable models (including GEE for clustering), and sensitivity analyses confirming stability across parameterizations.

Limitations should be considered. Physical activity and barriers were measured using self-report instruments, which may introduce recall and social desirability bias; although the PAQ-A demonstrated acceptable internal consistency, self-report may not fully capture intensity variation. Objective physical activity measures such as accelerometry were not available and should be incorporated in future studies to validate self-report estimates. The cross-sectional design prevents causal inference between barriers and activity level; associations should be interpreted as structural patterns rather than directional effects. Sampling was school-cluster based, and although the sample covered multiple schools and contexts, residual intra-school correlation may remain; future studies using full multilevel modeling could refine contextual estimates. Barrier responses were collected open-ended and categorized, which improves ecological validity but may reduce precision compared with standardized scales; high coder agreement mitigates this somewhat. Finally, environmental classification was based on administrative criteria rather than direct built-environment measurement.

5. Conclusions

This study demonstrates that perceived barriers to physical activity among Indonesian adolescents follow distinct gendered and contextual patterns. These barriers influence not only current activity participation but also key aspects of physical, emotional, and psychosocial development in adolescence. By adopting a cross-cultural lens, the findings support culturally

sensitive, school-based interventions to promote equitable physical activity and foster holistic development among adolescents in diverse LMIC settings.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of the Faculty of Medicine, Universitas Udayana, Bali, Indonesia (Approval No. 2614/UN14.2.2.VII.14/LT/2025).

Informed Consent Statement: Written informed consent was obtained from parents or legal guardians, and written assent was obtained from participating students prior to data collection. Participation was voluntary, and responses were collected anonymously. No personal identifiers were included in the analytic dataset.

Data Availability Statement: The anonymized dataset supporting the findings of this study is available from the corresponding author upon reasonable request. Due to ethical restrictions and privacy concerns—particularly as the data involve minors (junior high school students aged 12–15 years) and include sensitive personal information obtained under parental consent and student assent—the raw data cannot be made publicly available in a repository. Requests for access will be considered on a case-by-case basis for legitimate research purposes, subject to approval from the Ethics Committee of the Faculty of Medicine, Universitas Udayana, and compliance with data protection regulations.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

MDPI	Multidisciplinary Digital Publishing Institute
DOAJ	Directory of open access journals
TLA	Three letter acronym
LD	Linear dichroism

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