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# Parental Perceptions of Home and Neighborhood Environmental Factors Associated With Accelerometer-Assessed Physical Activity among School-Aged Children in Uganda

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## Abstract

The positive impacts of physical activity (PA) on children's health and overall well-being are widely recognized. Nevertheless, a significant number of children fail to achieve the recommended PA levels, heightening their susceptibility to overweight, obesity, and non-communicable diseases. Features of the home and neighborhood environments may limit opportunities for children to participate in PA, yet context-specific evidence is required to develop targeted interventions in underrepresented low-income settings. This research examined the links between parents' perceptions of home and neighborhood built environment factors and moderate-to-vigorous physical activity (MVPA) in children residing in Kampala, Uganda. This cross-sectional investigation involved 256 children (55.5% female) aged 10–12 years and their parents/guardians. Children's MVPA was objectively assessed via waist-mounted ActiGraph accelerometers. Parental views of the environments were captured through a validated self-report questionnaire. Associations between environmental factors and children's MVPA were evaluated using linear regression models adjusted for clustering with robust standard errors. Gender-specific associations were explored through stratified analyses. Key findings included associations with play equipment availability at home ($\beta = -2.37$, $p < 0.001$; contrary to expected positive direction), residential density ($\beta = 2.70$, $p < 0.05$), and perceived crime safety ($\beta = -5.29$, $p < 0.05$; unexpected negative direction). Gender-stratified results showed varied and inconsistent patterns: greater perceived land-use mix diversity was linked to lower MVPA in girls (regardless of school type), while better sidewalk infrastructure ($\beta = -12.01$, $p < 0.05$) and walking/cycling facilities ($\beta = -14.72$, $p < 0.05$) correlated with reduced MVPA among girls in public schools. Higher perceived crime safety was associated with lower MVPA in both boys and girls attending private schools ($\beta = -3.80$, $p < 0.05$). Only a limited number of environmental attributes were linked to children's MVPA in this Ugandan context, with results often showing inconsistencies, particularly for girls. Additional research is essential to better comprehend the socio-ecological influences on health-promoting PA patterns among Ugandan children.

**Keywords:** Parental perceptions, Physical activity, School-aged children, Neighborhood

## Introduction

Physical activity (PA) during childhood serves as a key lifestyle factor that helps prevent various non-communicable diseases (NCDs), with activity habits often persisting from adolescence into adulthood [1, 2]. Yet, recent worldwide data indicate that over 80% of adolescents in school fail to accumulate at least 60 minutes of moderate-to-vigorous physical activity (MVPA) daily, elevating risks for NCDs and early death in later years [3]. Global figures from 2013 highlight that physical inactivity contributed to more than 53 billion dollars in healthcare expenditures and approximately 3.2 million deaths [4]. Addressing physical inactivity is thus a critical public health priority, aligned with international targets to decrease inactivity by 15% by 2030 [5]. Identifying factors associated with children's PA is vital for designing effective interventions and policies to combat inactivity [4].

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PA is shaped by influences across multiple levels, including personal, social, environmental, and policy-related elements [5]. While individual traits (such as age, gender, and body weight) are known to affect children's PA [3, 4, 6–11], these alone do not account for the widespread low activity levels observed. Interventions targeting only individual factors tend to yield modest impacts and benefit mainly those already motivated [12]. Socio-ecological frameworks emphasize that PA occurs within specific environmental contexts [7]. The home and neighborhood settings are particularly influential for fostering an active lifestyle in children. The home environment significantly contributes by offering social encouragement, setting activity rules, and providing supportive resources like play items while restricting screen-based devices [13–15]. Parents play a central role by organizing home spaces, selecting available equipment, offering encouragement, facilitation, role modeling, supervision, and joint participation in activities [14, 16, 17]. Parental restrictions or rules can sometimes reduce children's MVPA [14]. Access to play, electronic, and media devices at home has also emerged as notable factors in children's PA levels [14, 15, 18–21]. Neighborhood environments encompass human-made elements like structures, roadways, recreational spaces, pedestrian/cycling paths, urban layout, and intangible aspects such as safety perceptions [22]. Environments supportive of PA enable children to engage easily, safely, and enjoyably [23]. Systematic reviews suggest positive correlations between access to parks, playgrounds [24–28], and walking/cycling infrastructure [27] with higher PA in children. Greater street connectivity has been linked to increased MVPA [29], while features like cul-de-sacs and neighborhood aesthetics also play roles [30]. Stronger perceptions of safety are generally associated with more PA [31]. However, parental worries about crime, traffic, or stranger dangers may prompt restrictions on active travel, outdoor play, or independent movement, thereby lowering overall PA [14, 23].

Much of this evidence derives from high-income countries (HICs), where built environments and cultural norms differ markedly from those in Sub-Saharan Africa (SSA), potentially limiting applicability [6, 27, 28, 32]. Research on school-aged children in SSA remains scarce and yields mixed results. For instance, in Kenya (ages 9–11), positive parental views of social interactions, safety, and connectivity related to meeting MVPA guidelines [33], whereas in South Africa (ages 9–10), neighborhood perceptions showed no association with children's MVPA [34]. As Kampala undergoes urban redevelopment to support population growth [35], investigating these links is opportune for informing city planning.

Examining ties between objectively measured PA via accelerometers and parental perceptions of home and neighborhood features in Uganda can help fill gaps in high-quality PA data from low-income settings and supply localized insights for impactful interventions and policies. Thus, this study aimed to investigate associations between parents' perceived home and neighborhood environments and accelerometer-assessed MVPA in school-attending children in Uganda.

## Materials and Methods

*study design and participant recruitment*

This cross-sectional study employed a multistage sampling approach to recruit a gender-balanced sample of 600 children aged 10–12 years from mixed-day primary schools in Kampala, Uganda's capital city. Kampala consists of five administrative divisions (Central, Nakawa, Rubaga, Kawempe, and Makindye), spanning 189 km² with a population of approximately 1.5 million [36]. Ethical approval was obtained from the Uganda National Council of Science and Technology (SS 4340) and the Kenyatta University Ethical Review Board (PKU/619/703).

The primary sampling units were administrative divisions; two divisions (Central and Nakawa) were randomly chosen. Schools formed the second sampling unit. To account for socioeconomic differences—where public schools typically serve lower socioeconomic groups and private schools serve higher ones based on tuition fees—four private and three public schools were selected. The third sampling unit comprised classes in these schools that primarily included children aged 10–12 years (typically grades 5–7). From each school, 70–100 children were targeted.

A total of 600 child-parent pairs were provided with survey packages containing information sheets, consent/assent forms, and a parental questionnaire. Informed written parental consent and child assent were required for participation. Eligibility criteria included being 10–12 years old, residing in Kampala, and having no physical disabilities. Children in boarding schools were excluded. Complete data, including consent and all required measures, were obtained from 256 child-parent pairs (response rate: 42.6%).

Children's moderate-to-vigorous physical activity (MVPA) was objectively measured using accelerometers, while parents completed a questionnaire evaluating home and neighborhood environment characteristics as well as sociodemographic information. The questionnaire was adapted from the Neighborhood Impact on Kids study [18] and the Neighborhood Environment Walkability Scale for Africa (NEWS-Africa) [37].

*Measures*

*Children's physical activity*

Participants wore an ActiGraph GT3X+ accelerometer (ActiGraph LLC, Pensacola, Florida, USA) positioned at the waist for seven consecutive days (including two weekend days) on a 24-hour basis. Data were recorded at 80 Hz, initially in 1-second epochs, and then aggregated to 15-second epochs. Processing was conducted using ActiLife software (Version 6.13.3). Sleep periods were identified using the Sadeh algorithm to define waking wear time [38]. Non-wear time was defined as 20 consecutive minutes of zero counts. Valid data required at least four days (including one weekend day) with ≥10 hours of waking wear time per day. Average daily MVPA minutes were calculated using Evenson's age-specific cut-points (≥574 counts per 15 seconds) [39].

*Home environment*

Parental perceptions of the home environment were assessed via questionnaire items covering availability of play equipment, media/electronic devices in the child's bedroom and personally owned by the child, parental rules regarding physical activity, and parental social support [18]. These items showed good to excellent test-retest reliability (ICC = 0.51–0.96) [40].

Parental social support for the child's physical activity was measured through questions about frequency of encouragement, providing transportation to activity locations, watching the child engage in activity, and co-participating in physical activity. Responses used a 5-point Likert scale from "none" to "daily," and the four items were averaged to form a social support score.

A parental rules score was created by summing "yes" responses to 15 yes/no items (e.g., "stay close/within sight of the house/parent" or "respect others, particularly adults").

Parents indicated the presence of various play equipment at home, including: bicycle, basketball hoop, jump rope, active video games (e.g., Wii), sports equipment (e.g., balls, racquets, bats, sticks), skateboard/roller skates/scooter, fixed play structures (e.g., swings), home aerobic machines (e.g., treadmill, stationary bike), weight training equipment (e.g., free weights, exercise balls), yoga/exercise mat, dedicated recreational room, trampoline, and stairs. A total play equipment score was computed as the sum of items present (range: 0–13).

Parents also reported media and electronic items in the child's bedroom: television, computer, VCR/DVD player, and video game console (e.g., Xbox, PlayStation). A bedroom media score was the sum of these items (range: 0–4).

Additionally, personal media/electronic items owned by the child were reported: mobile phone/2-way radio, handheld gaming device (e.g., Sony PSP), and portable music player (e.g., MP3 player, iPod). A personal media score was the sum of these items (range: 0–3).

*Neighborhood environment*

Parents' views on neighborhood characteristics that might promote children's physical activity were measured with the Neighborhood Environment Walkability Scale for Africa (NEWS-Africa) [36]. This scale was adjusted for African settings to support research on the built environment in neighborhoods. The 76-item tool showed excellent (ICC > 0.75) or good (ICC = 0.60–0.74) test-retest reliability [36].

NEWS-Africa includes 14 subscales: residential density (one item), land use mix-diversity for destinations (twenty one items), land use mix-diversity for recreation (four items), land use mix access (seven items), street connectivity (five items), sidewalk infrastructure (five items), path infrastructure (two items), crossing infrastructure (four items), overall walking/cycling infrastructure (twelve items), esthetics (eight items), traffic safety (six items), crime safety (four items), personal safety (three items), and stranger danger (three items).

Except for residential density and the two land use mix-diversity subscales (destinations and recreation), all items were rated on a 4-point Likert scale from “strongly agree” to “strongly disagree.” Residential density was based on one unweighted item. Land use mix-diversity (destinations and recreation) used a 5-point scale reflecting walking time (1–5 min, 6–10 min, 11–20 min, 21–30 min, and 31+ min). Items were scored according to the developers' recommendations, with reverse-coding applied as needed [36]. Subscale scores were averaged,

and higher scores were anticipated to correspond with higher levels of MVPA.

*Covariates*

Parents provided the child's date of birth, sex, and duration of residence at the current address.

*Data analysis*

Analysis included only the 256 children with complete parental surveys and valid accelerometer data. Descriptive statistics (percentages, means, and standard deviations) were calculated for participant characteristics and physical activity. Independent t-tests compared parental perceptions of home and neighborhood environment variables across child sex, school type, and compliance with physical activity guidelines. Associations between parent-perceived home and neighborhood environment variables and children's MVPA were examined using linear regression models with robust standard errors (adjusted for clustering). Both overall and sex-stratified analyses were performed. Analyses were conducted in STATA (version 14.2, StataCorp, Texas, USA), with significance defined as $p \leq 0.05$.

## Results and Discussion

The sample comprised 256 children. Most were aged 10–11 years (71.5 percent), 58.6 percent attended private schools, and 55.9 percent were girls. On average, children had resided at their current address for 6.1 ± 3.3 years and accumulated 56 ± 25.7 minutes per day in MVPA. Boys engaged in significantly more MVPA (60.1 ± 28.2 minutes/day) than girls (58.2 ± 23.0 minutes/day). Children in public schools (lower SES) accumulated about 26 minutes more MVPA per day than those in private schools (higher SES). There were no significant differences in characteristics between children included in the analysis and those excluded. Results are displayed in **Table 1.**

**Table 1.** Characteristics and descriptive statistics of the children (n = 256)

| Variable | % | n |
|---|---|---|
| **School type** | | |
| **Private (high SES)** | 58.5 | 150 |
| **Public (low SES)** | 41.4 | 106 |
| **Sex** | | |
| **Male** | 44.1 | 113 |
| **Female** | 55.9 | 143 |
| **Age (years)** | | |
| **10** | 34.8 | 88 |
| **11** | 36.7 | 94 |
| **12** | 28.5 | 74 |
| **Time lived at current residence (years, Mean ± SD)** | | 6.1 ± 3.3 |
| **Average daily MVPA (minutes/day)** | **p-value** | **Mean ± SD** |
| **Overall** | | 56 ± 25.7 |
| **By sex** | 0.023* | |
| **Female** | | 52.8 ± 23.0 |
| **Male** | | 60.1 ± 28.2 |
| **By school type** | <0.001** | |
| **Private (high SES)** | | 45.4 ± 17.8 |
| **Public (low SES)** | | 71.2 ± 27.5 |
| **By age** | 0.268 | |
| **10 years** | | 52.7 ± 20.9 |
| **11 years** | | 56.5 ± 26.5 |
| **12 years** | | 59.6 ± 29.4 |

SD = standard deviation; MVPA = moderate-to-vigorous physical activity; SES = socioeconomic status. *p < 0.05, **p < 0.001.

*Associations between perceived home and neighborhood features and children's profiles (MVPA guideline achievement, gender, and school category)*

**Table 2** illustrates the average differences in parents' ratings of home and neighborhood environment factors grouped by whether children achieved the recommended MVPA levels, their gender, and the type of school they attended.

Parents whose children did not reach the MVPA guidelines indicated a greater amount of play equipment available at home ($p < 0.001$) and stronger feelings of safety from crime in the neighborhood ($p = 0.022$), yet they rated residential density as lower ($p = 0.012$) compared to parents of children who did achieve the guidelines.

Further variations in parents' views of home and neighborhood attributes based on school type and child gender are outlined in **Table 2**. Parents of children in private schools (higher socioeconomic status) noted significantly higher numbers of rules concerning physical activity ($p = 0.033$), more personal electronic media devices belonging to the child ($p = 0.002$), and increased presence of play equipment in the home ($p < 0.001$) relative to parents of children enrolled in public schools (lower socioeconomic status).

Perceptions of neighborhood characteristics similarly differed according to school type and gender. Parents

with children in private (higher SES) schools reported greater perceived safety from crime than parents of children in public (lower SES) schools (p = 0.012). Conversely, parents of public school (lower SES) children viewed their areas as having higher residential density (p < 0.001) and improved street connectivity (p = 0.024) in comparison to parents of private school (higher SES) children. Parents of female children perceived significantly greater residential density than parents of male children (p = 0.024).

**Table 2.** Average differences in parents' views of home and neighborhood built environment features based on children's school type (school socioeconomic status), gender, and adherence to moderate-to-vigorous physical activity (MVPA) guidelines

| Variable | School Type: Mean (SD) Public (Low SES) | School Type: Mean (SD) Private (High SES) | P-value (School Type) | Sex: Mean (SD) Female | Sex: Mean (SD) Male | P-value (Sex) | MVPA Compliance: Mean (SD) Sufficient PA | MVPA Compliance: Mean (SD) Insufficient PA | P-value (MVPA) |
|---|---|---|---|---|---|---|---|---|---|
| Home Level | | | | | | | | | |
| Parental support for physical activity | 2.6 (1.1) | 2.7 (0.9) | 0.411 | 2.6 (1.0) | 2.6 (0.9) | 0.725 | 2.5 (1.0) | 2.7 (1.0) | 0.121 |
| Parental rules for physical activity | 12.7 (1.9) | 13.2 (1.9) | 0.033* | 12.9 (2.1) | 13.1 (1.7) | 0.235 | 12.9 (1.7) | 13.0 (2.0) | 0.479 |
| Media equipment in child's bedroom | 0.5 (0.9) | 0.5 (1.0) | 0.756 | 0.5 (0.9) | 0.5 (1.0) | 0.575 | 0.5 (1.0) | 0.5 (0.9) | 0.995 |
| Child's personal media equipment | 0.4 (0.7) | 0.7 (0.9) | 0.002* | 0.5 (0.8) | 0.6 (0.9) | 0.203 | 0.4 (0.8) | 0.6 (0.9) | 0.055 |
| Play equipment at home | 2.7 (2.1) | 4.8 (2.5) | <0.001** | 3.6 (2.6) | 4.2 (2.5) | 0.062 | 3.1 (2.3) | 4.4 (2.6) | <0.001** |
| Neighborhood Level | | | | | | | | | |
| Residential density | 3.8 (2.0) | 2.4 (1.2) | <0.001** | 3.2 (1.8) | 2.7 (1.6) | 0.024* | 3.4 (1.9) | 2.8 (1.6) | 0.012* |
| Land use mix-diversity (destinations) | 2.6 (0.8) | 2.7 (0.7) | 0.176 | 2.7 (0.7) | 2.6 (0.7) | 0.413 | 2.7 (0.8) | 2.7 (0.7) | 0.618 |
| Land use mix-diversity (recreation) | 2.0 (1.1) | 2.0 (1.0) | 0.695 | 2.0 (1.0) | 2.1 (1.0) | 0.395 | 2.0 (1.0) | 2.0 (1.0) | 0.720 |
| Land use mix-access | 2.9 (0.6) | 2.9 (0.6) | 0.698 | 2.9 (0.6) | 2.9 (0.6) | 0.710 | 2.8 (0.6) | 2.9 (0.6) | 0.440 |
| Street connectivity | 3.0 (0.6) | 2.8 (0.5) | 0.024* | 2.9 (0.6) | 2.9 (0.5) | 0.834 | 2.9 (0.6) | 2.8 (0.6) | 0.297 |
| Sidewalks infrastructure | 2.2 (0.7) | 2.3 (0.7) | 0.077 | 2.2 (0.7) | 2.3 (0.7) | 0.069 | 2.2 (0.7) | 2.3 (0.7) | 0.236 |
| Crossing infrastructure | 2.2 (0.8) | 2.0 (0.7) | 0.086 | 2.1 (0.7) | 2.0 (0.7) | 0.697 | 2.0 (0.7) | 2.1 (0.7) | 0.458 |
| Paths infrastructure | 2.6 (0.9) | 2.5 (0.8) | 0.379 | 2.6 (0.8) | 2.5 (0.9) | 0.379 | 2.5 (0.8) | 2.5 (0.9) | 0.894 |
| Walking and cycling infrastructure | 2.2 (0.6) | 2.2 (0.5) | 0.276 | 2.2 (0.6) | 2.2 (0.6) | 0.708 | 2.1 (0.5) | 2.2 (0.6) | 0.357 |
| Aesthetics | 2.6 (0.7) | 2.7 (0.6) | 0.099 | 2.6 (0.6) | 2.7 (0.6) | 0.237 | 2.6 (0.7) | 2.7 (0.6) | 0.417 |
| Crime safety | 2.6 (0.8) | 2.9 (0.8) | 0.012* | 2.8 (0.8) | 2.7 (0.8) | 0.722 | 2.6 (0.8) | 2.8 (0.8) | 0.022* |
| Traffic safety | 2.6 (0.7) | 2.5 (0.7) | 0.431 | 2.5 (0.7) | 2.6 (0.7) | 0.912 | 2.6 (0.7) | 2.5 (0.7) | 0.931 |
| Personal safety | 2.8 (0.6) | 2.7 (0.6) | 0.491 | 2.8 (0.6) | 2.7 (0.6) | 0.523 | 2.7 (0.6) | 2.8 (0.6) | 0.472 |
| Stranger danger | 2.0 (0.9) | 2.2 (0.9) | 0.067 | 2.5 (0.5) | 2.5 (0.6) | 0.386 | 2.1 (0.1) | 1.9 (0.1) | 0.194 |

PA= Physical Activity; MVPA= Moderate-to-Vigorous Physical Activity; SD= Standard Deviation; LSES= Low Socioeconomic Status; HSES= High Socioeconomic Status. ** p < 0.001, * p < 0.05.

*Associations between parent-perceived home and neighborhood built environment factors and children's MVPA*

In the full-sample regression model, home environment findings indicated that greater availability of play equipment, as reported by parents, was linked to lower minutes of moderate-to-vigorous physical activity (MVPA) in children ($\beta$ = -2.37, $p < 0.001$). At the neighborhood level, higher parental perceptions of residential density were positively associated with children's MVPA ($\beta$ = 2.70, $p < 0.05$). In contrast, stronger parental perceptions of crime safety were negatively associated with children's MVPA ($\beta$ = -5.29, $p < 0.05$).

Models stratified by school type were conducted to explore potential differences between children attending private (higher SES) and public (lower SES) schools **(Table 3).** No home environment factors were significantly associated with MVPA in either private or public school children. Regarding neighborhood factors, greater perceived crime safety was linked to reduced MVPA among children in private (higher SES) schools ($\beta$ = -3.80, $p < 0.05$).

Sex-stratified results are also shown in **Table 3**. Higher parental ratings of land use mix accessibility were associated with lower MVPA in girls, irrespective of school type (SES). Additionally, among girls attending public (lower SES) schools, stronger parental perceptions of sidewalk infrastructure ($\beta$ = -12.01, $p < 0.05$) and overall walking/cycling infrastructure ($\beta$ = -14.72, $p < 0.05$) were related to decreased MVPA. No home environment variables showed significant associations with MVPA in girls, and none of the home or neighborhood environment attributes were significantly linked to MVPA in boys.

**Table 3.** Results of full model, school type (school SES) and sex-stratified models assessing correlations between home and neighborhood environmental characteristics and children's MVPA.

| | Overall | School type (school SES) | | Sex | | | |
|---|---|---|---|---|---|---|---|
| | | | | Boys | | Girls | |
| | | Private (HSES) | Public (LSES) | Private (HSES) | Public (LSES) | Private (HSES) | Public (LSES) |
| **Home Environment** | | | | | | | |
| **Parental support for PA** | 5.30 (0.240) | 3.50 (0.404) | 9.88 (0.176) | 9.78 (0.140) | -3.58 (0.807) | -2.55 (0.622) | 10.48 (0.174) |
| **Parental rules for PA** | -1.48 (0.076) | -0.79 (0.249) | -0.34 (0.814) | -0.69 (0.585) | 0.60 (0.855) | -0.972 (0.270) | -1.00 (0.493) |
| **Media equipment in child's bedroom** | -0.14 (0.934) | 0.46 (0.752) | -0.50 (0.870) | 0.77 (0.717) | 4.58 (0.353) | -0.35 (0.858) | -2.97 (0.398) |
| **Child's personal media equipment** | -3.37 (0.081) | 0.46 (0.782) | -2.05 (0.577) | 1.42 (0.570) | 1.42 (0.823) | -1.11 (0.617) | -4.39 (0.283) |
| **Play equipment at home** | -2.37 (< 0.001) ** | 0.23 (0.698) | -1.68 (0.187) | 0.74 (0.433) | -0.27 (0.917) | -0.44 (0.545) | -2.07 (0.119) |
| **Neighborhood Environment** | | | | | | | |
| **Residential density** | 2.70 (0.004) * | 1.13 (0.345) | -0.80 (0.550) | 2.04 (0.302) | -2.95 (0.191) | 0.82 (0.570) | 1.04 (0.494) |
| **Land use mix-diversity (destinations)** | -2.37 (0.279) | -1.24 (0.562) | -0.55 (0.870) | 1.72 (0.579) | 1.11 (0.865) | -5.45 (0.056) | 2.33 (0.530) |
| **Land use mix-diversity (recreation)** | -1.11 (0.487) | -0.93 (0.536) | -0.65 (0.801) | 0.07 (0.974) | 0.55 (0.901) | -2.08 (0.278) | -2.83 (0.326) |
| **Land use mix-access** | -4.24 (0.11) | -3.27 (0.176) | -6.86 (0.112) | 0.39 (0.916) | -1.94 (0.794) | -6.54 (0.031) * | -11.12 (0.026) * |
| **Street connectivity** | 2.87 (0.298) | -2.41 (0.372) | 2.11 (0.624) | -1.04 (0.826) | 13.63 (0.071) | -3.64 (0.234) | -3.50 (0.457) |
| **Sidewalks infrastructure** | -3.21 (0.168) | -0.48 (0.814) | -6.49 (0.108) | -0.44 (0.897) | -5.58 (0.359) | -1.06 (0.671) | -12.01 (0.015) * |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Crossing infrastructure** | -0.16 (0.942) | 0.49 (0.826) | -4.79 (0.161) | 6.37 (0.095) | -3.50 (0.510) | -3.20 (0.206) | -6.33 (0.120) |
| **Paths infrastructure** | -0.86 (0.652) | 0.52 (0.768) | -4.50 (0.144) | 1.92 (0.515) | -2.37 (0.603) | -0.35 (0.868) | -5.11 (0.181) |
| **Walking and cycling infrastructure** | -2.32 (0.423) | 0.27 (0.921) | -9.09 (0.050) | 3.89 (0.400) | -6.05 (0.374) | -2.28 (0.468) | -14.72 (0.010) * |
| **Aesthetics** | -2.54 (0.317) | 2.55 (0.285) | -4.13 (0.311) | 6.11 (0.106) | -5.32 (0.397) | -0.87 (0.766) | -6.17 (0.207) |
| **Crime safety** | -5.29 (0.006) * | -3.80 (0.038) * | -1.85 (0.562) | -3.61 (0.212) | 5.73 (0.290) | -3.71 (0.103) | -5.05 (0.154) |
| **Traffic safety** | 1.99 (0.375) | 0.12 (0.953) | 2.47 (0.506) | -0.52 (0.870) | 7.23 (0.229) | 0.963 (0.712) | -1.94 (0.650) |
| **Personal safety** | 0.09 (0.972) | 1.07 (0.649) | -3.53 (0.424) | 0.11 (0.976) | -1.69 (0.797) | 2.75 (0.348) | -6.85 (0.204) |
| **Stranger danger** | 2.84 (0.106) | -0.36 (0.825) | 3.33 (0.245) | 0.63 (0.788) | 1.85 (0.697) | -2.84 (0.221) | 0.78 (0.817) |

PA= Physical Activity. MVPA= moderate-to-vigorous physical activity; SD= standard deviation; LSES= low socioeconomic status; HSES= socioeconomic status;
** p <0.001,
*p <0.05.

The present investigation examined the relationships between parents' views of home and neighborhood environmental factors and accelerometer-assessed moderate-to-vigorous physical activity (MVPA) in a group of school-aged children in Uganda. The results revealed limited and variable links between these environmental aspects and children's MVPA, aligning with existing research patterns in low- and middle-income countries (LMICs) [28]. As far as we are aware, this is the first published research exploring how home and neighborhood environments relate to physical activity (PA) patterns among children in Uganda.

The primary outcome indicated that only one out of five home environment factors and two out of 14 neighborhood environment factors showed significant correlations with children's MVPA across the entire sample. Notably, two of these three significant relationships were contrary to expectations. Regarding the home setting, greater parental reports of available play equipment were linked to reduced MVPA in children. This inverse relationship mirrors findings from the International Study of Childhood Obesity, Lifestyle, and the Environment in Kenya (another low-income nation), in contrast to trends observed in high-income countries (HICs) like Australia, Canada, and Finland, where greater access to home play equipment corresponded to increased MVPA [41]. In LICs compared to HICs, the mere presence of play equipment at home might be less influential for children's activity than having unrestricted opportunities and sufficient time to engage with it [42]. Social support represents a key element in understanding children's PA within the home [13, 15, 43], yet, in line with prior research in LICs [6, 34, 41], no connections were identified between social support and children's MVPA here. Social support could play a larger role for children in HICs, who often participate in structured sports requiring parental fees and transportation [41], as opposed to the prevalent free play and active transport seen in LICs such as Uganda [11].

Concerning the neighborhood setting, elevated parental ratings of crime safety were unexpectedly associated with decreased MVPA among children, implying that greater perceived crime insecurity might drive higher MVPA engagement. The common inverse links between perceived crime safety and PA in children and adults across African contexts often stem from environmental inequities, where individuals must rely on walking for transport and daily needs despite widespread risks from crime and traffic [44]. To mitigate the adverse effects of environments forcing activity amid high crime perceptions, a emerging proposal advocates for "physical activity security" as a priority to foster supportive PA conditions in LMICs and other unequal contexts [45].

The sole association aligning with anticipated directions involved parental perceptions of greater residential density, consistent with broader international evidence [6, 46]. Neighborhoods with high residential density typically offer proximity to destinations (e.g., friends' residences, stores, or public transit), along with strong connectivity, creating more chances for walking and

thereby boosting PA [47, 48]. Elevated residential density has likewise been tied to PA in adolescents [49, 50] and adults [48], suggesting it as a vital aspect of neighborhood walkability relevant across age groups, including in African settings [51].

Analyses stratified by sex yielded variable results. Regardless of school type, girls showed reduced MVPA when parents reported better access to destinations, services, and transit. A prior review similarly noted inverse relationships between destination access and children's PA [25]. Among girls in public (lower socioeconomic status) schools, higher parental perceptions of walking and cycling infrastructure—especially sidewalks—were linked to lower MVPA. Given that girls from lower-SES public schools often reside in denser, more compact areas, this may limit available space for walking and cycling, thereby lowering PA [52]. For instance, neighborhood descriptions in the study's supplementary table indicated that many parents viewed sidewalks as poorly separated from vehicular traffic and inadequately maintained, with prevalent informal paths lacking dedicated walking or cycling spaces. Such infrastructure conditions could deter girls from walking, consequently reducing their PA. These results prompt inquiry into the reasons girls achieved lower MVPA despite parental reports of supportive neighborhood features. Cultural, social, and gender norms, alongside parental restrictions and safety worries regarding unsupervised neighborhood activity, likely play pivotal roles. Cultural and social norms can foster gender-based stereotypes that constrain girls' expressions; for example, assigning vigorous play to boys and calmer activities to girls [53]. Research highlights marked gender disparities in independent mobility, with boys enjoying greater autonomy and access to activity-promoting outdoor spaces [46, 54, 55]. Outdoor time consistently correlates positively with PA levels [56]. Alternatively, other downtime pursuits, particularly screen-based sedentary behaviors (e.g., television, video games, computer use), may draw girls indoors rather than encouraging neighborhood exploration [57]. Conversely, the absence of links between perceived neighborhood factors and boys' MVPA might relate to the study's neighborhood definition (areas walkable in 10–15 minutes from home). Given boys' reportedly greater independent mobility, factors beyond this defined neighborhood could influence their MVPA [46]. Future research should explore the enablers and obstacles girls face in attaining adequate PA within home and neighborhood contexts.

*Strengths and limitations*

The main strength of this investigation lies in its application of accelerometers to objectively assess children's moderate-to-vigorous physical activity (MVPA) within a largely under-researched area. Furthermore, it offers initial insights into the connections between home and neighborhood environmental features and physical activity (PA) patterns among children in Uganda. Nevertheless, the findings warrant cautious interpretation due to the cross-sectional design, which precludes establishing causality. Moreover, reliance on self-reported data for home and neighborhood characteristics introduces potential risks of social desirability bias and reporting inaccuracies. The modest response rate, combined with participant recruitment confined to Kampala city, restricts the broader applicability of results to diverse populations. This research did not examine distinct PA domains, such as leisure or transportation activities [58], nor did it evaluate the specific contexts (home versus neighborhood) where MVPA occurred [30, 34]. Additionally, we aggregated multiple items into composite scales for home and neighborhood environment variables, diverging from approaches in other studies that analyzed individual items separately [16, 33], potentially masking certain relationships with children's MVPA. Prior research indicates that home environments tend to correlate more strongly with sedentary behaviors—which primarily take place indoors—than with MVPA, which accrues throughout the day across various locations [15, 59]. There was also restricted variation in parents' perceptions of home and neighborhood environments in this sample, possibly diminishing statistical power to identify links with children's MVPA [60]. Thus, further investigation into the relationships between home/neighborhood environments and children's PA is essential, employing greater specificity and refined measurement tools to enhance evidence quality.

## Conclusion

In summary, only a small number of home and neighborhood environmental factors emerged as correlates of MVPA in Ugandan children. The ways in which home and neighborhood settings influence PA among these children appear to vary by gender and differ

from patterns observed in high-income countries (HICs). Qualitative research delving into girls' own views, enablers, and obstacles to PA engagement in low- and middle-income countries (LMICs) is particularly valuable, given that girls consistently demonstrate lower PA levels compared to boys. Additional studies are required to explore associations between the built environment and PA in Uganda, ideally incorporating objective assessments of the built environment and longitudinal designs to inform more effective interventions and policies for health promotion.

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