

Cognitive Interview-Based Validation and Reliability of the Global Adolescent and Child Physical Activity Questionnaire (GAC-PAQ) in Nigeria

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Abstract

Physical inactivity among children and adolescents is a growing public health concern in low- and middle-income countries (LMICs) in Africa, where culturally appropriate physical activity (PA) surveillance tools remain scarce. The Global Adolescent and Child Physical Activity Questionnaire (GAC-PAQ) was developed to assess PA across multiple domains in diverse settings. This study evaluated the GAC-PAQ's cultural relevance, feasibility, and inter-rater reliability among children and caregivers in Nigeria. In Phase 1, we conducted cognitive interviews with 10 child-caregiver pairs from urban (n= 5) and rural (n= 5) settings, using think-aloud techniques and targeted probing to assess comprehension of the GAC-PAQ and its cultural appropriateness. Findings informed linguistic and contextual revisions prior to pilot testing. In Phase 2, the revised GAC-PAQ was pilot-tested with 45 youth-caregiver pairs (youth aged 8–17 years) from primary and secondary schools in Osogbo and Ede, Osun State, Nigeria. Inter-rater reliability between child and caregiver reports was assessed using Cohen's kappa (κ), and we examined associations between PA duration, age, sex, and residence using proportional-odds regression models. Cognitive interviews identified key cultural adaptations and post-revision app satisfaction was high (caregivers: 100%; youth: 95%). Inter-rater reliability ranged from fair to almost perfect across domains, with the strongest agreement for transportation mode ($\kappa= 0.81$) and the weakest for recess duration ($\kappa = 0.26$). Age, sex, and residence were each significantly associated with PA duration across selected domains. These findings provide preliminary evidence supporting the cultural appropriateness, content validity, and inter-rater reliability of the GAC-PAQ among children and adolescents in Nigeria.

Keywords: Physical activity measurement, cognitive interviewing, inter-rater reliability, children and adolescents, questionnaire validation, Nigeria, low- and middle-income countries, GAC-PAQ

Physical inactivity among children and adolescents is a growing global public health concern (Guthold et al., 2020; Aubert et al., 2022). Globally, more than 80% of school-aged children and adolescents do not meet the World Health Organization's recommended levels of at least an average of 60 minutes per day of moderate- to vigorous-physical activity (PA), and evidence indicates that PA declines progressively during adolescence (Guthold et al., 2020). In low- and middle-income countries (LMICs), particularly in sub-Saharan Africa, the burden of physical inactivity is compounded by the rising prevalence of inactivity-related noncommunicable diseases, including cardiovascular disease, type 2 diabetes, and obesity (Bigna & Noubiap, 2019; Todorovic et al., 2025). Studies across multiple African countries have consistently documented low levels of sufficient PA among school-aged youth, with disparities observed between males and females and between urban and rural populations (Ackah et al., 2022).

Accurate, culturally appropriate measurement of PA is essential for monitoring population-level trends, identifying at-risk subgroups, and informing evidence-based policy and intervention efforts in Africa (Oyeyemi et al., 2016). Despite their known limitations in accuracy, questionnaires remain the most feasible and cost-effective method for large-scale PA surveillance, particularly in resource-limited settings of Africa where objective measures such as accelerometry may be impractical (Oyeyemi et al., 2014). However, many PA questionnaires were developed in high-income countries (HICs) and have not been adequately validated for use in African or other LMIC countries. Systematic reviews have shown that commonly used PA instruments inadequately capture contextually relevant activity domains such as household chores, active transportation, outdoor play, and informal work that are central to children's daily PA patterns in LMICs (Larouche et al., 2024; Chinapaw et al., 2010). Furthermore, most tools omit active play, an important source of PA among children across diverse cultural settings.

Cultural adaptation and content validation are essential for generating meaningful, comparable PA data across diverse populations. Cognitive interviewing, a qualitative method in which participants verbalize their thought processes while responding to questionnaire items, is widely regarded as a gold-standard approach for assessing the comprehensibility, cultural relevance, and face validity of health measurement tools (Willis, 2005; Scott et al., 2021). By engaging both children and their caregivers in validation, cognitive interviews help researchers identify ambiguous, culturally inappropriate, or poorly understood items and make targeted refinements before large-scale field testing. Despite the recognized importance of this approach, cognitive interview-based validation of PA questionnaires among African child and adolescent populations remains limited (Larouche et al., 2024). Also, most existing PA questionnaires were not developed for the needs of underrepresented children and adolescents who are not attending school or residing in rural areas in resource-limited countries (Aubert et al., 2021). Despite the growing availability of smartphone technology, a recent systematic review by Nasruddin et al. (2023) found that all studies using mobile apps for PA surveillance among

children and adolescents were conducted in high-income countries, highlighting a critical gap in the feasibility and validity of mobile app-based PA measurement tools for children and adolescents in LMICs.

The Global Adolescent and Child Physical Activity Questionnaire (GAC-PAQ) was developed to address these gaps by providing a comprehensive, app-based instrument to assess PA across multiple domains, including school-based activities, household chores, active transportation, work or volunteering, organized activities, free play, and outdoor time for children and adolescents ages 8 to 17 years (Larouche et al., 2024). The GAC-PAQ was designed from the outset for use in both LMICs and HICs, with sociocultural adaptation integrated into its development. As part of a global cognitive interview study conducted across 15 countries on six continents, Nigeria was selected as one of two African countries to represent the African LMIC context (Larouche et al., 2024). Nigeria is Africa's most populous country, with a culturally diverse population and a growing burden of noncommunicable diseases, making it a critical setting for developing reliable PA surveillance tools for youth (Oyeyemi et al., 2026).

Despite the clear need for validated PA measurement tools for youth in Nigeria and across West Africa, no study has evaluated the content validity, cultural appropriateness, or inter-rater reliability of the GAC-PAQ in this setting. Prior work in Nigeria has primarily focused on adult populations or domain-specific instruments, leaving a significant evidence gap for child-focused, multidomain PA surveillance instruments (Oyeyemi et al., 2014; Onywerwa et al., 2018). The present study, therefore, aims to address this gap by (1) evaluating the GAC-PAQ's cultural relevance, clarity, and feasibility through cognitive interviews with children and their caregivers (e.g., parents, grandparents, guardians, siblings) in Nigeria, and (2) examining inter-rater reliability between child and caregiver reports across multiple PA domains in a pilot sample from Osun State, Southwest Nigeria. As part of the second aim, we also examined sociodemographic correlates of PA duration across GAC-PAQ domains. Consistent with well-established physical activity constructs and patterns in Africa, we hypothesize that multiple physical activity domains will be associated with male sex, urban residence, and younger age (Ackah et al., 2022; Akwaboah et al., 2026; Oyeyemi & Larouche, 2018; Sallis et al., 2016).

Methods

Setting

Osun State is located in Southwest Nigeria, with an estimated population of 4.44 million people and a land area of 8,521 square kilometers (City Population, 2022; National Bureau of Statistics, 2017). The state is predominantly inhabited by the Yoruba ethnic group, who also constitute the majority of the study population. Yoruba is the primary language spoken across both urban and rural communities. This study was conducted at two sites within Osun State — Osogbo, the state capital, a classified urban area, and Ede, a smaller town classified as a rural area (Encyclopedia Britannica, 2024). The Yoruba language

served as the basis for translating the GAC-PAQ for use in this study.

Study Design

This study comprised two sequential phases: (1) a cognitive interview phase to assess the cultural relevance, clarity, and feasibility of the GAC-PAQ, and (2) a cross-sectional pilot reliability study to examine inter-rater agreement between child and caregiver reports and the association of GAC-PAQ scores with participants' sociodemographic characteristics. Both phases were conducted in Nigeria between July 2023 and August 2024 and received ethical approval from Redeemer's University Ethics Committee (RUN/REC/2023/052).

Phase 1: Cognitive Interviews and Cultural Adaptation

A structured in-person cognitive interview approach was used to evaluate the comprehensibility, cultural appropriateness, and face validity of the GAC-PAQ among children and their caregivers in Nigeria. We recruited ten child-caregiver pairs from both urban ($n = 5$) and rural ($n = 5$) settings to ensure diversity in sociodemographic characteristics. Prior to data collection, we followed a standardized method to translate the GAC-PAQ into the Yoruba language and back-translated into English for verification (Oyeyemi et al, 2011). The English version of the GAC-PAQ was translated into the Yoruba language by a Yoruba language expert who is bilingual in both the Yoruba and English languages. The translator was instructed to use simple terms that are understood by people across a wide range of educational levels. A university lecturer from the Yoruba ethnic group in Nigeria then back-translated the Yoruba version into English. An expert panel consisting of the translators, a physical therapist who specializes in exercise, sports and cardiopulmonary physical therapy with over 25 years of experience, the principal investigator (AO), and a graduate student who was raised in the Yoruba language and culture then reviewed and compared the original English GAC-PAQ and the back-translated version. The panel reviewed the two versions of the GAC-PAQ for conceptual equivalence (conceptual meaning to the terms and concepts in Yoruba), experiential equivalence (cultural relevance to the tasks and examples used in the questionnaire), linguistic equivalence (meaning and grammatical correctness), and metric equivalence (ensuring that substituting examples of activities or items are equivalent in intensity with the original items). Consensus discussion among the panel was used to resolve discrepancies between the original and back-translated versions before cognitive interviews commenced.

For the cognitive interview, participants' understanding of GAC-PAQ activity domains (school activities, household chores, transportation, work or volunteering, free time, and outdoor activities), PA intensity (not moving, easy effort, medium or hard effort), and duration (categorical time periods) was explored using think-aloud techniques and targeted probing. Participants were asked to verbalize their thought processes as they responded to each item and were subsequently probed about the clarity of the questions, response options, activity examples, and

accompanying images. Participants were also invited to suggest modifications to improve questionnaire comprehension and completion. All interviews were audio-recorded and transcribed verbatim. Findings were compiled into a structured spreadsheet documenting challenges perceived by participants and informed linguistic and contextual revisions to the GAC-PAQ prior to pilot testing.

The sample size for the cognitive interview phase was determined in accordance with the GAC-PAQ study protocol, which recommends 10–20 child-caregiver dyads per country to ensure diversity in sociodemographic characteristics while maintaining feasibility (Larouche et al., 2024). This range is consistent with established cognitive interviewing practice and broadly aligned with Willis's recommendation of 8–12 subjects per round across 1–3 rounds (Willis, 2014). Although formal saturation analysis was not conducted, the sample size was considered adequate given its alignment with both the GAC-PAQ protocol recommendation and established cognitive interviewing practice.

Phase 2: Pilot Study

The pilot study was conducted in the city of Osogbo and the town of Ede in Osun State, Southwest Nigeria. Forty-nine children-caregivers dyad participants were recruited from primary and secondary schools using a convenience-based stratified sampling approach designed to balance the sample by sex and place of residence. However, two rural child-caregiver pairs and two urban child-caregiver pairs declined to participate and were not included in the final sample. The final sample of 45 child-caregiver dyads was not based on power calculation, but followed the GAC-PAQ study protocol which recommended a minimum of 10–40 child-parent dyads per country across 15 countries (Larouche et al., 2024; Larouche et al, 2025). Our sample of 45 dyads exceeded the minimum recommended sample size, providing a basis for estimating domain-specific inter-rater reliability. Participants recruited from Osogbo were categorized as residing in an urban area, while those from Ede were classified as residing in a rural area.

Participants' sociodemographic characteristics, including the child's age, sex, ethnicity, and difficulties with daily activities; the caregiver's ethnicity and relationship to the child; place of residence; highest level of household education; and the family's perceived ease of meeting financial needs were self-reported. A single-item, study-specific measure assessed participants' satisfaction with the GAC-PAQ app. Within the app, parents and youth rated their satisfaction with the app using a Likert scale. The primary outcome variables comprised ordered categorical responses representing time spent across multiple PA domains of the GAC-PAQ, including school physical education, recess or break, household chores, work or volunteering, transportation, organized activities, play or free time, and outdoor activity.

Statistical Analysis

Phase 1: Cognitive Interview

Cognitive interview data from ten child-caregiver pairs were analyzed using the framework analysis method

developed by Ritchie and Spencer (1994), a pragmatic approach that accommodates both inductive and deductive issues and is well-suited to applied projects with a qualitative component embedded in a larger quantitative study. Two researchers with knowledge of the local Nigerian context independently analyzed the data, organizing findings by domain and respondent type (child vs. caregiver), and compiling participants' perceived challenges, suggestions for improvement, relevant quotes, and sociodemographic characteristics into a structured Excel spreadsheet. The analysis focused on four key areas: (1) comprehension of question wording and domain-specific terminology, (2) understanding of physical activity intensity categories, (3) accuracy of recall across physical activity domains, and (4) interpretation of images accompanying each GAC-PAQ domain. The Nigeria spreadsheet was subsequently jointly reviewed by the GAC-PAQ Steering Committee members and Nigerian Lead Investigators (Larouche et al. 2024). Culturally ambiguous terms were identified, and wording and visual prompts were refined to strengthen the instrument's content validity.

Phase 2: Pilot Study.

Inter-rater reliability between child and caregiver participants was assessed across all GAC-PAQ domains using kappa statistics. Cohen's kappa (κ), also known as the unweighted kappa, was used to assess inter-rater agreement for nominal measures (e.g., mode of transportation). Weighted kappa, including quadratic weighting, was used to assess agreement for ordinal measures (e.g., PA duration and intensity categories) (Cohen, 1968). Quadratically weighted kappa measures were selected because they account for both agreement and the degree of disagreement between the child and their caregiver (de Raadt et al., 2021). Disagreements that are farther apart are penalized more heavily than disagreements between adjacent categories. Agreement was interpreted using the benchmark classifications proposed by Landis and Koch (1977), where $\kappa < 0.00$ indicates poor agreement, 0.00–0.20 indicates slight, 0.21–0.40 indicates fair, 0.41–0.60 indicates moderate, 0.61–0.80 indicates substantial, and 0.81–1.00 indicates almost perfect. Although these benchmarks were originally developed for nominal data, they are widely applied to ordinal agreement when a weighted kappa approach is used in health and exercise science research. Analyses were restricted to complete child–caregiver pairs, and non-ordinal responses were excluded from weighted kappa calculations. Additionally, analyses were conducted with complete responses for the relevant PA domain. Consequently, sample sizes varied across domains because some activities were not applicable to all participants or were reported by only a subset of the sample.

Sociodemographic characteristics were examined as covariates, including the child's age, sex, ethnicity, and difficulties with daily activities; the parent or caregivers ethnicity and relationship to the child; place of residence; highest level of household education; and the family's perceived ease of meeting financial needs. Missing demographic data were minimal ($n = 1$) and addressed using mode imputation. The primary outcome variables

were ordered categorical responses representing time spent across multiple PA domains of the GAC-PAQ, including school physical education, recess or break, household chores, work or volunteering, transportation, organized activities, play or free time, and outdoor activity. Proportional-odds regression models were used to examine associations between PA duration in each domain and three sociodemographic covariates: age (continuous), sex (male vs. female), and place of residence (urban vs. rural). Age, sex, and residence were balanced in the pilot sample and were included as covariates in the regression models. Other variables were not included because of their sparse categories, which resulted in model convergence failures. The proportional odds assumption was evaluated using the Brant test. There was insufficient evidence that assumptions were violated. Likelihood ratio chi-square statistics and Wald confidence intervals were used to assess statistical significance and estimate precision, respectively. For play or free time, response categories were collapsed into four levels (none, <1 hour, 1 to <2 hours, and ≥ 2 hours) to achieve model convergence. All analyses were conducted in R/RStudio (Version 2025.05.0+496).

Results

Phase 1: Cognitive Interview Findings

Several modifications were made to the GAC-PAQ before the pilot reliability study to enhance its cultural appropriateness and comprehensibility in the Nigerian context. In the school domain, children reported greater familiarity with the term "physical health education" than with the original phrasing "physical education." Both children and caregivers raised concerns about the cultural relevance of effort-level images, which were subsequently replaced with images depicting physical activities commonly practiced in Nigeria. In the household chores domain, caregivers recommended replacing "vacuuming" with "broom sweeping," noting that this activity would be more culturally identifiable in the Nigerian context. In the transportation domain, both children and caregivers found the phrase "active mode" unclear or ambiguous, and caregivers also noted that "trip" is often understood as a long journey, leading them to replace it with simpler terms such as "go." For free time and outdoor play, participants recommended clarifying that these activities include outdoor play in both school and non-school settings. Across all domains, both children and caregivers emphasized the importance of incorporating images that reflect locally relevant Nigerian activities and contexts.

Phase 2: Pilot Study

Sample Characteristics

The pilot sample comprised 45 children (mean age = 13.0 $\pm$ 2.5 years; range: 8–17 years), with nearly equal representation of females (48.9%, $n = 22$) and males (51.1%, $n = 23$) as shown in Table 1. The majority of children (95.6%) and caregivers (97.8%) identified as Yoruba. Over half of participants (55.6%, $n = 25$) resided in rural areas, with the remaining 44.4% ($n = 20$) residing in urban areas. Caregivers included mothers (51.1%), fathers (24.4%), tutors or guardians (17.8%), grandmothers (4.4%), and brothers (2.2%). Approximately two-thirds of households

(67.7%) reported tertiary or university-level education as the highest level of household education, while 22.2% reported secondary or high school education. Regarding perceived ease of meeting financial needs, 46.6% of families reported it as easy or very easy, 28.9% as neither easy nor difficult, and 24.4% as difficult or very difficult. Caregivers reported the majority of children (89.1%) had no difficulties with daily activities; among those who did, reported difficulties

included seeing (4.3%), agility (2.2%), pain (2.2%), and speech (2.2%). Full sociodemographic characteristics are presented in Table 1. Caregivers were either satisfied (17.8%) or strongly satisfied (82.2%) with the app. Most youth reported being satisfied (24.4%) or strongly satisfied (71.1%). One youth was neutral with the app (2.2%), and another was strongly dissatisfied (2.2%) (Not shown in Table).

Table 1

Sociodemographic Characteristics of Participants (N = 45)

Covariate	Categories	Count (%)
Sex of Child	Female	22 (48.9)
	Male	23 (51.1)
Ethnicity of the Child	Yoruba	43 (95.6)
	Mix	1 (2.2)
	Other	1 (2.2)
Difficulties in Child's Daily Activities*	Agility	1 (2.2)
	Pain	1 (2.2)
	Seeing	2 (4.3)
	Speech	1 (2.2)
	None	41 (89.1)
Ethnicity of Guardian	Yoruba	44 (97.8)
	Other	1 (2.2)
Relationship to Child	Mother	23 (51.1)
	Father	11 (24.4)
	Brother	1 (2.2)
	Grandmother	2 (4.4)
	Tutor or Guardian	8 (17.8)
Residence	Rural	25 (55.6)
	Urban	20 (44.4)
Highest Level of Household Education	Primary	2 (4.4)
	Secondary or High School	10 (22.2)
	Vocational or College	3 (6.7)
	Tertiary or University	30 (67.7)
Ease of Meeting Family's Financial Needs	Very Difficult	2 (4.4)
	Difficult	9 (20.0)
	Neither Easy nor Difficult	13 (28.9)
	Easy	11 (24.4)
	Very Easy	10 (22.2)
Total Children (n)		45

Note. *Participants could select more than one difficulty option for the daily activities.

Inter-Rater Reliability

Inter-rater reliability between child and caregiver reports varied across PA domains and outcome types are shown in Table 2. Overall, agreement ranged from fair to almost perfect across domains, with transportation yielding the strongest agreement and recess or break duration yielding the weakest.

For school-based activities, moderate agreement was observed for both physical education duration ($\kappa = 0.53$) and intensity ($\kappa = 0.59$). Recess or break duration showed fair agreement ($\kappa = 0.26$), while recess intensity reached moderate agreement ($\kappa = 0.42$). For household chores, agreement was moderate for duration ($\kappa = 0.54$) and substantial for intensity ($\kappa = 0.63$). Work or volunteering yielded fair agreement for duration ($\kappa = 0.34$) and substantial agreement for intensity ($\kappa = 0.68$), though findings were based on a smaller subsample ($n = 19$ – 20).

Transportation consistently showed the highest agreement across all modes. School transportation mode reached almost perfect agreement ($\kappa = 0.81$), the highest observed across all domains, while school transportation duration showed moderate agreement ($\kappa = 0.41$). Work transportation mode ($\kappa = 0.75$) and other transportation mode ($\kappa = 0.72$) both showed substantial agreement, whereas duration estimates for work and other transportation were moderate ($\kappa = 0.56$) and fair ($\kappa = 0.21$), respectively.

For the remaining domains, organized activities duration showed substantial agreement ($\kappa = 0.63$; $n = 21$), outdoor activity duration also reached substantial agreement ($\kappa = 0.65$), and play or free time duration showed moderate agreement ($\kappa = 0.49$).

Table 2

Inter-Rater Reliability Between Child and Adult Raters Across Physical Activity Domains

PA Domain	PA Component	n	% Agreement	κ [95% CI]	Agreement Level
School Physical Education	Duration	33	75.8	0.53 [0.25, 0.81]	Moderate
	Intensity	34	70.6	0.59 [0.31, 0.87]	Moderate
Recess/Break	Duration	43	60.5	0.26 [−0.07, 0.59]	Fair
	Intensity	44	70.5	0.42 [0.13, 0.71]	Moderate
Household Chores	Duration	45	51.1	0.54 [0.32, 0.75]	Moderate
	Intensity	44	75.0	0.63 [0.40, 0.86]	Substantial
Work/Volunteering	Duration	20	55.0	0.34 [−0.07, 0.75]	Fair
	Intensity	19	78.9	0.68 [0.40, 0.96]	Substantial
Transportation to School	Mode (UW)	45	88.9	0.81 [0.64, 0.97]	Almost Perfect
	Duration	45	46.7	0.41 [0.15, 0.68]	Moderate
Transportation to Work	Mode (UW)	20	85.0	0.75 [0.49, 1.00]	Substantial
	Duration	20	50.0	0.56 [0.19, 0.94]	Moderate
Transportation (Other)	Mode (UW)	35	91.4	0.72 [0.42, 1.00]	Substantial
	Duration	35	42.9	0.21 [−0.15, 0.57]	Fair
Organized Activities	Duration	21	57.1	0.63 [0.26, 1.00]	Substantial
Play/Free Time	Duration	45	64.4	0.49 [0.18, 0.80]	Moderate
Outdoor Activity	Duration	45	55.6	0.65 [0.42, 0.87]	Substantial

Note. Kappa (κ) values are quadratically weighted unless otherwise indicated by “(UW)” for unweighted. UW = unweighted kappa applied to nominal variables. Sample sizes (n) varied across the activity domains because child-caregiver pairs with only complete responses for the corresponding domain were included.

Sociodemographic correlates of PA

Correlates of PA were assessed by exploring the associations between PA and demographic characteristics. Table 3 presents the full proportional-odds regression estimates across all PA domains for residence, age, and sex. Significant associations were identified in four domains

(recess or break, household chores, transportation to school, and outdoor activity), and these are detailed below, with odds ratios and 95% confidence intervals summarized in Table 4.

For recess or break duration, increasing age was associated with significantly lower odds of reporting longer

duration ($\beta = -0.55$, $OR = 0.57$, $p = 0.0008$), indicating that older children were less likely to report longer recess activity. Male sex was associated with significantly higher odds of longer recess duration compared to females ($\beta = 1.81$, $OR = 6.14$, $p = 0.0112$). Residence was not significantly associated with recess duration ($p = 0.4750$).

For household chore duration, urban residence was associated with significantly higher odds of longer duration compared to rural residence ($\beta = 1.54$, $OR = 4.66$, $p = 0.0145$). Increasing age was also positively and significantly associated with longer household chore duration ($\beta = 0.39$, $OR = 1.48$, $p = 0.0046$). Sex was not significantly associated with household chore duration ($p = 0.5790$).

For the duration of transportation to school, urban residence was associated with substantially higher odds of longer travel time ($\beta = 2.42$, $OR = 11.20$, $p = 0.0008$), and older age was also significantly associated with longer transportation duration ($\beta = 0.55$, $OR = 1.74$, $p = 0.0003$). Sex was not significantly associated with the duration of transportation to school ($p = 0.5829$).

For outdoor activity duration, male sex was significantly associated with higher odds of longer duration than female sex ($\beta = 1.22$, $OR = 3.38$, $p = 0.0427$). Neither residence ($p = 0.9183$) nor age ($p = 0.3690$) was significantly associated with outdoor activity duration.

Table 3

Proportional-Odds Regression Estimates for Physical Activity Duration by Residence, Age, and Sex

Domain	Covariate	β	LR χ^2	df	95% CI*	p-value
School Physical Education	Residence (Urban)	0.49	0.46	1	[-0.93, 1.97]	0.4986
	Age	0.24	2.87	1	[-0.04, 0.54]	0.0904
	Sex (Male)	-0.72	1.12	1	[-2.13, 0.61]	0.2905
Recess/Break	Residence (Urban)	-0.49	0.51	1	[-1.88, 0.85]	0.4750
	Age	-0.55	14.79	1	[-0.92, -0.26]	0.0001 *
	Sex (Male)	1.81	7.34	1	[0.48, 3.33]	0.0067 *
Household Chores	Residence (Urban)	1.54	6.41	1	[0.34, 2.83]	0.0114 *
	Age	0.39	9.20	1	[0.13, 0.68]	0.0024 *
	Sex (Male)	0.32	0.31	1	[-0.81, 1.47]	0.5790
Work/Volunteering	Residence (Urban)	0.17	0.03	1	[-1.54, 1.87]	0.8523
	Age	-0.23	0.67	1	[-0.82, 0.32]	0.4142
	Sex (Male)	0.61	0.61	1	[-0.94, 2.25]	0.4350
Transportation to School	Residence (Urban)	2.42	13.50	1	[1.08, 3.94]	0.0002 *
	Age	0.55	16.61	1	[0.27, 0.88]	4.58e-05 *
	Sex (Male)	-0.33	0.30	1	[-1.56, 0.86]	0.5829
Transportation to Work	Residence (Urban)	0.35	0.18	1	[-1.25, 1.98]	0.6685
	Age	0.22	0.45	1	[-0.42, 0.87]	0.5001
	Sex (Male)	-0.41	0.27	1	[-2.00, 1.15]	0.6055
Transportation (Other)	Residence (Urban)	-0.56	0.79	1	[-1.82, 0.68]	0.3740
	Age	0.23	2.61	1	[-0.05, 0.52]	0.1061
	Sex (Male)	-0.60	0.99	1	[-1.82, 0.59]	0.3198
Organized Activities	Residence (Urban)	-0.35	0.12	1	[-2.51, 1.56]	0.7252
	Age	0.30	2.17	1	[-0.09, 0.78]	0.1405
	Sex (Male)	-0.78	0.73	1	[-2.74, 1.00]	0.3939
Play/Free Time†	Residence (Urban)	-0.34	0.27	1	[-1.62, 0.93]	0.6013
	Age	-0.003	0.00	1	[-0.25, 0.25]	0.9979

Outdoor Activity	Sex (Male)	0.57	0.82	1	[-0.66, 1.85]	0.3644
	Residence (Urban)	-0.06	0.01	1	[-1.27, 1.13]	0.9183
	Age	0.11	0.81	1	[-0.13, 0.37]	0.3690
	Sex (Male)	1.22	4.33	1	[0.07, 2.44]	0.0375 *

Note. Play/free time was collapsed into four categories for model convergence. LR χ^2 = likelihood ratio chi-square statistic and * 95% CI is for the β coefficient.

Table 4

Significant Associations of Residence, Age, and Sex with Physical Activity Duration Across Domains

PA Domain	Covariate	β	OR	SE	95% CI*	p-value
Recess/Break	Residence (Urban)	-0.49	0.61	0.6886	[-1.88, 0.85]	0.4784
	Age	-0.55	0.57	0.1660	[-0.92, -0.26]	0.0008 *
	Sex (Male)	1.81	6.14	0.7159	[0.48, 3.33]	0.0112 *
Household Chores	Residence (Urban)	1.54	4.66	0.6294	[0.34, 2.83]	0.0145 *
	Age	0.39	1.48	0.1381	[0.13, 0.68]	0.0046 *
	Sex (Male)	0.32	1.38	0.5783	[-0.81, 1.47]	0.5794
Transportation to School	Residence (Urban)	2.42	11.20	0.7210	[1.08, 3.94]	0.0008 *
	Age	0.55	1.74	0.1522	[0.27, 0.88]	0.0003 *
	Sex (Male)	-0.33	0.72	0.6109	[-1.56, 0.86]	0.5838
Outdoor Activity	Residence (Urban)	-0.06	0.94	0.6070	[-1.27, 1.13]	0.9183
	Age	0.11	1.12	0.1268	[-0.13, 0.37]	0.3723
	Sex (Male)	1.22	3.38	0.6009	[0.07, 2.44]	0.0427 *

* 95% CI is for the β coefficient

Discussion

This study evaluated the cultural relevance, feasibility, content validity, and inter-rater reliability of the GAC-PAQ among children and caregivers in Nigeria. Phase 1 cognitive interviews showed that targeted cultural and linguistic adaptations were needed to improve the GAC-PAQ's comprehensibility and contextual relevance in the Nigerian setting. In Phase 2, the pilot reliability study found that inter-rater agreement between child and caregiver reports ranged from fair to almost perfect across PA domains, with transportation showing the strongest agreement and recess or break duration the weakest. Across the four domains with significant associations, age was the most consistent predictor of PA, showing significant associations with recess/break, household chores, and transportation-to-school PA. Together, these findings provide preliminary support for the GAC-PAQ as a feasible and reliable instrument for multidomain PA surveillance among children and adolescents in Nigeria.

Cultural Adaptation and Cognitive Interview Findings

The cognitive interview findings underscore the critical importance of cultural adaptation when developing PA

measurement tools for use in African LMICs. Participants identified several items and terms that required modification to reflect the Nigerian sociocultural context, spanning the school, household chores, and transportation domains on the GAC-PAQ. These findings align with prior evidence showing that directly translating or adopting instruments developed in HICs, without adequate sociocultural adaptation, may yield items that lack conceptual and experiential equivalence in African settings (Oyeyemi et al., 2011). Oyeyemi et al. (2011) similarly identified the need for context-specific modifications during the cross-cultural adaptation of the International Physical Activity Questionnaire (IPAQ) for use in Nigeria, noting that several activity descriptions and examples did not reflect common PA behaviors in Nigeria.

Incorporating locally relevant imagery and activity examples aligns with findings from the NEWS-Africa study, which used cognitive testing across seven African countries, including Nigeria, to identify important contextual differences in how community residents understood built environment and PA-related concepts (Oyeyemi et al., 2016B). Similarly, the Igbo adaptation of the Global Physical Activity Questionnaire (GPAQ) in Nigeria showed that cognitive debriefing interviews were

essential for identifying culturally inappropriate terminology and for ensuring that adapted items were linguistically clear and culturally meaningful (Onwuakagba et al., 2024). The present study extends this work to a child and adolescent population, highlighting that cultural adaptation considerations for youth may differ from those for adults, particularly regarding domain-specific terminology and accompanying visual content.

The high post-revision satisfaction rates among caregivers (100%) and youth (95%) indicate that the cultural adaptations made after the cognitive interviews were well received and meaningfully improved the GAC-PAQ's acceptability in the Nigerian context. This finding is encouraging for the broader GAC-PAQ validation effort across 15 countries, as it suggests that a cognitive interview-informed adaptation process can produce an instrument that resonates with diverse child and caregiver populations. High satisfaction with the revised instrument also supports its feasibility for use in future large-scale reliability and validity studies in Nigeria and potentially other West African LMICs.

Inter-Rater Reliability Findings

The inter-rater reliability findings showed a range of agreement levels across GAC-PAQ domains, consistent with the broader literature on child-caregiver proxy agreement for PA-related behaviors (Koning et al., 2018; Poulain et al., 2020). In a study of 10- to 12-year-old children and their caregivers across multiple health behavior domains, Poulain et al. (2020) found that parent-child agreement ranged from low to almost perfect, with higher agreement for well-defined, observable behaviors, such as organized PA, compared with less structured or school-based activities. This pattern mirrors the present findings, in which transportation mode — a well-defined, observable, and regularly occurring behavior yielded the highest agreement ($\kappa = 0.81$), whereas recess or break duration — a less structured and less observable activity showed the weakest agreement ($\kappa = 0.26$).

The near-perfect agreement observed for school transportation duration is noteworthy and suggests that caregivers are well-informed about how long their children spend travelling to school, likely because this is a routinely observed and logistically managed aspect of daily life. This finding is comparable to the Flemish PAQ-C validation study, in which weighted kappa values for inter-rater agreement between children and caregivers ranged from 0.48 to 0.69, with higher agreement for structured, regularly scheduled activities (Bervoets et al., 2014). A recent systematic review of PA questionnaire psychometric properties similarly highlights the importance of well-defined activity domains for achieving adequate reliability in child-reported PA measures (Rostami Haji Abadi et al., 2025). Also, the moderate-to-substantial agreement observed across household chores, organized activities, and outdoor activities tentatively suggests the potential utility of caregiver proxy reporting for activities that are directly observable or supervised by caregivers at home. However, these findings should be interpreted cautiously given the small pilot sample size and the relatively imprecise reliability estimates for some domains, particularly

household chores (Bervoets et al., 2014; Poulain et al., 2020).

The weaker agreement observed for recess or break duration and for work or volunteering duration is not surprising, given that these activities occur outside caregivers' direct observation. Recess occurs at school in the absence of caregivers, while work or volunteering may be irregular and less predictable. Prior research has consistently shown that parent-child agreement is lower for PA behaviors that caregivers cannot directly observe and for behaviors occurring during school hours (Poulain et al., 2020). These domain-specific patterns suggest that caregiver proxy reports may be reliable for home-based and transportation-related PA, whereas child self-reports should be prioritized over caregiver proxy reports when assessing school-based PA, such as recess, because caregivers are unlikely to have direct knowledge of these activities.

The kappa values observed in this study, ranging from fair ($\kappa = 0.26$ for recess duration) to almost perfect ($\kappa = 0.81$ for school transportation mode), are broadly consistent with patterns reported in child-parent PA agreement studies in both LMICs and HICs (Bervoets et al., 2014; Poulain et al., 2020). However, the preliminary nature of these findings, derived from a pilot sample of 45 child-caregiver pairs, warrants caution in drawing definitive conclusions about the GAC-PAQ's reliability across all domains. In addition, reliability estimates for some PA domains, particularly work/volunteering, transportation to work, and organized activities, should be interpreted with caution because these analyses were based on relatively small subsamples of participants who reported engaging in those activities. The limited sample sizes in these domains may have reduced the precision of the kappa estimates and widened the confidence intervals. Consequently, the observed agreement levels in these domains should be treated as preliminary estimates that require confirmation in larger samples before definitive conclusions about domain-specific reliability can be drawn.

Sociodemographic Correlates of Physical Activity

Across the four domains with significant associations, age was the most consistent predictor, showing significant associations with recess/break, household chores, and transportation-to-school duration. Residence was a significant predictor of household chores and transportation to school, while sex was a significant predictor of recess/break and outdoor activity. Together, these findings suggest that sociodemographic characteristics differentially influence PA duration across domains in this Nigerian sample. These patterns provide preliminary evidence for the construct validity of the GAC-PAQ. The finding that daily MVPA decreased with age among Nigerian children is consistent with evidence from the PAAT Study, which found that MVPA declined significantly with age among Nigerian children (Wachira et al., 2022), and with Nigeria's 2016 Report Card, which documented declining overall PA levels among Nigerian children and youth (Adeniyi et al., 2016). The association between urban residence and longer school transportation duration aligns with evidence that children in less urbanized areas in Nigeria and Mozambique are more likely to use active transportation

(Wachira et al., 2022). The finding that boys reported longer outdoor activity duration than girls is also consistent with the PAAT Study, which found that girls accumulated less daily MVPA than boys across all three African countries examined (Wachira et al., 2022). Together, these patterns suggest that the GAC-PAQ is sensitive to known sociodemographic correlates of PA in Nigerian children, providing preliminary support for its construct validity.

Strengths and Limitations

This study has several notable strengths. The two-phase sequential design, which combines cognitive interviews with a pilot reliability study, aligns with best-practice recommendations for instrument development and validation in cross-cultural settings (Willis, 2005; Larouche et al., 2024). Including both urban and rural participants in both phases strengthens the applicability of the findings across diverse Nigerian settings. Stratified sampling to balance the pilot sample by sex and place of residence further enhances the representativeness of the reliability estimates. Additionally, engaging child-caregiver dyads throughout both phases is consistent with the GAC-PAQ's dual-report design and aligns with recommendations for child-focused PA surveillance in LMICs (Larouche et al., 2024).

Several limitations should be acknowledged. First, the pilot sample was relatively small ($n = 45$ dyads), and reliability and regression estimates for domains with smaller subsamples (e.g., work, volunteering, organized activities) should be interpreted cautiously. Second, both phases were conducted in Osun State, Southwest Nigeria, limiting the generalizability of the findings to other regions, ethnic groups, and linguistic communities within Nigeria. Third, there is a potential for Type I error due to multiple comparisons analysis without adjustment. Fourth, this study did not assess test-retest reliability or criterion validity against an objective measure of PA, such as accelerometry, which will be an important next step in the broader GAC-PAQ validation process. Finally, the interpretation of kappa coefficients was based on Landis and Koch benchmarks, and therefore, should not be interpreted as an absolute measure of reliability.

Implications and Future Directions

The findings of this study have important implications for PA surveillance among children and adolescents in Nigeria and across sub-Saharan Africa. The successful cultural adaptation of the GAC-PAQ, together with preliminary evidence of acceptable inter-rater reliability across most domains, supports its potential utility as a multidomain PA surveillance tool in this setting. Given the well-documented scarcity of validated, child-focused PA instruments in African LMICs (Larouche et al., 2024; Rostami Haji Abadi et al., 2025), the GAC-PAQ represents a promising advance for monitoring PA behaviors across the full range of domains relevant to children's daily lives in Nigeria.

Future studies should assess the GAC-PAQ's test-retest reliability and criterion validity in larger, more diverse samples across multiple Nigerian states and ethnic communities. Concurrent validity studies using

accelerometry as the reference standard will be especially important for establishing the instrument's accuracy in estimating PA levels (Larouche et al., 2024). Replicating the cognitive interview process in other Nigerian languages, such as Hausa and Igbo, would further strengthen the GAC-PAQ's cultural appropriateness for use beyond Yoruba-speaking communities (Onwuakagba et al., 2024). More broadly, the GAC-PAQ's ongoing validation across 15 countries on six continents positions it as a potentially valuable tool for cross-national comparisons of children's PA, including active play, which remains poorly captured by existing surveillance instruments in LMICs (Larouche et al., 2024; Rostami Haji Abadi et al., 2025).

Conclusion

This study provides preliminary evidence that the GAC-PAQ can be meaningfully adapted for cultural and linguistic relevance in Nigeria through a structured cognitive interview process, and that inter-rater agreement between child and caregiver reports is acceptable across most PA domains. These findings contribute to the growing body of work supporting the development of culturally appropriate PA surveillance tools for children and adolescents in African LMICs and lay the groundwork for future large-scale reliability and validity testing of the GAC-PAQ in Nigeria and across the broader West African region.

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Acknowledgements

The authors wish to thank Dr. Ashaolu Joseph of Redeemer's University, Nigeria, and the officials of the Osun State Ministry of Education, Nigeria, for their invaluable support in data collection for this study. The authors also express their sincere gratitude to the children, adolescents, and their parents and other caregivers for generously giving their time to participate in this study. We also thank Dr. Richard Larouche at the GAC-PAQ coordinating center at the University of Lethbridge, Canada, for the overall support and development of the GAC-PAQ app in Nigeria. The views presented in this publication are solely the responsibility of the authors and do not necessarily represent the views of the University of Lethbridge, Canada.

Author Contributions

GOO: Writing - Original Draft. **OCB:** Methodology, Investigation, Data curation, Writing - Review and Editing. **SML:** Formal Analysis, Data Curation, Writing - Review and Editing. **UAA:** Writing - Review and Editing. **MAC:** Data Curation, Writing - Review and Editing. **RAA:** Methodology, Investigation, Writing - Review and Editing. **ALO:** Conceptualization, Methodology, Investigation, Data Curation, Writing - Review and Editing. All the authors were involved in interpreting the analyses and read and approved the final manuscript.

Human Subjects Approval Statement

This study was approved by the Institutional Review Board at Redeemer's University RUN/REC/2023/052

Funding Source

This work was supported by a Project Grant (grant # PJT 183705) and an Early Career Investigator Prize (grant # ECP 184184) from the Canadian Institutes of Health Research".

Conflict of Interest

The authors declare no competing interests.

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References

- Ackah, M., Owiredun, D., Salifu, M. G., & Yeboah, C. O. (2022). Estimated prevalence and gender disparity of physical activity among 64,127 in-school adolescents (aged 12–17 years): A multi-country analysis of Global School-based Health Surveys from 23 African countries. *PLOS Global Public Health*, 2(10), e0001016. <https://doi.org/10.1371/journal.pgph.0001016>
- Adeniyi, A. F., Odukoya, O. O., Oyeyemi, A. L., Adedoyin, R. A., Ojo, O. S., Metseagharun, E., & Akinroye, K. K. (2016). Results from Nigeria's 2016 report card on physical activity for children and youth. *Journal of Physical Activity and Health*, 13(Suppl. 2), S231–S236. <https://doi.org/10.1123/jpah.2016-0305>
- Akwaboah, P. K., Pierson, A., Obrutu, K., Rostami Haji Abadi, M., Oyeyemi, A. L., & Larouche, R. (2026). Testing the physical activity transition model among children and adolescents in low- and middle-income countries: A systematic review and meta-analysis. *Journal of Physical Activity and Health*, 23(7), 923–935. <https://doi.org/10.1123/jpah.2025-0372>
- Aubert, S., Barnes, J. D., Demchenko, I., Hawthorne, M., Abdeta, C., Abi Nader, P., Adsuar Sala, J. C., Aguilar-Farias, N., Aznar, S., Bakalár, P., Bhawra, J., Brazo-Sayavera, J., Bringas, M., Cagas, J. Y., Carlin, A., Chang, C.-K., Chen, B., Christiansen, L. B., Christie, C. J.-A., . . . Tremblay, M. S. (2022). Global Matrix 4.0 physical activity report card grades for children and adolescents: Results and analyses from 57 countries. *Journal of Physical Activity and Health*, 19(11), 700–728. <https://doi.org/10.1123/jpah.2022-0456>
- Aubert, S., Brazo-Sayavera, J., González, S. A., Janssen, I., Manyanga, T., Oyeyemi, A. L., Picard, P., Sherar, L. B., Turner, E., & Tremblay, M. S. (2021). Global prevalence of physical activity for children and adolescents; inconsistencies, research gaps, and recommendations: A narrative review. *International Journal of Behavioral Nutrition and Physical Activity*, 18, 81. <https://doi.org/10.1186/s12966-021-01155-2>

- Bervoets, L., Van Noten, C., Van Roosbroeck, S., Hansen, D., Van Hoorenbeeck, K., Verheyen, E., Van Hal, G., & Vankerckhoven, V. (2014). Reliability and validity of the Dutch Physical Activity Questionnaires for Children (PAQ-C) and Adolescents (PAQ-A). *Archives of Public Health*, 72, 47. <https://doi.org/10.1186/2049-3258-72-47>
- Bigna, J. J., & Noubiap, J. J. (2019). The rising burden of non-communicable diseases in sub-Saharan Africa. *The Lancet Global Health*, 7(10), e1295–e1296. [https://doi.org/10.1016/S2214-109X\(19\)30370-5](https://doi.org/10.1016/S2214-109X(19)30370-5)
- Chinapaw, M. J. M., Mokkink, L. B., van Poppel, M. N. M., van Mechelen, W., & Terwee, C. B. (2010). Physical activity questionnaires for youth: A systematic review of measurement properties. *Sports Medicine*, 40(7), 539–563. <https://doi.org/10.2165/11530770-000000000-00000>
- City Population (2022). Osun State Nigerai. Population Statistics, Chart and Map. https://www.citypopulation.de/en/nigeria/admin/NGA030__osun/
- Cohen, J. (1968). Weighted kappa: Nominal scale agreement with provision for scaled disagreement or partial credit. *Psychological Bulletin*, 70, 213–220. <https://doi.org/10.1037/h0026256>
- de Raadt, A., Warrens, M. J., Bosker, R. J., & Kiers, H. A. L. (2021). A comparison of reliability coefficients for ordinal rating scales. *Journal of Classification*, 38(3), 519–543. <https://doi.org/10.1007/s00357-021-09386-5>
- Encyclopedia Britannica. (2024). *Osogbo*. <https://www.britannica.com/place/Osogbo>
- Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2020). Global trends in insufficient physical activity among adolescents: A pooled analysis of 298 population-based surveys with 1.6 million participants. *The Lancet Child & Adolescent Health*, 4(1), 23–35. [https://doi.org/10.1016/S2352-4642\(19\)30323-2](https://doi.org/10.1016/S2352-4642(19)30323-2)
- Koning, M., de Jong, A., de Jong, E., Visscher, T. L. S., Seidell, J. C., & Renders, C. M. (2018). Agreement between parent and child report of physical activity, sedentary and dietary behaviours in 9–12-year-old children and associations with children's weight status. *BMC Psychology*, 6, 14. <https://doi.org/10.1186/s40359-018-0227-2>
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159–174. <https://doi.org/10.2307/2529310>
- Larouche, R., Rostami Haji Abadi, M., Aubert, S., Bhawra, J., Brazo-Sayavera, J., Carson, V., Colley, R. C., Delisle Nyström, C., Esliger, D. W., Harper-Brown, R., Gonzalez Cifuentes, S. A., Jáuregui, A., Katewongsa, P., Khadilkar, A., Kira, G., Kuzik, N., Liu, Y., Lof, M., Loney, T., . . . Tremblay, M. S. (2024). Development and validation of the Global

- Adolescent and Child Physical Activity Questionnaire (GAC-PAQ) in 14 countries: Study protocol. *BMJ Open*, 14, e082275. <https://doi.org/10.1136/bmjopen-2023-082275>
- Larouche, R., Neves de Oliveira, S., Rostami Haji Abadi, M., Benavides-Castro, J. K., Sarmiento, O. L., Angulo Garay, G., Argumedo, G., Ashaolu, J. O., Baghestani, A., Bhawra, J., Brazo-Sayavera, J., Choonak, N., Nyström, C. D., Evance, S., Hamrik, Z., Jáuregui, A., Kaewpikul, P., Katewongsa, P., Khadilkar, A., Kira, G., ... Tremblay, M. S. (2025). Content validation of the Global Adolescent and Child Physical Activity Questionnaire (GAC-PAQ) in low-, middle-, and high-income countries across 6 continents. *Journal of sport and health science*, 15, 101074. Advance online publication. <https://doi.org/10.1016/j.jshs.2025.101074>
- Nasruddin, N. I. N., Murphy, J., & Armstrong, M. E. G. (2023). Physical activity surveillance in children and adolescents using smartphone technology: Systematic review. *JMIR Pediatrics and Parenting*, 6, e42461. <https://doi.org/10.2196/42461>
- National Bureau of Statistics. (2017). *Annual abstract of statistics 2016* (Vol. 1). Federal Republic of Nigeria. <https://www.nigerianstat.gov.ng/pdfuploads/ANNUAL%20ABSTRACT%20STATISTICS%20VOLUME-1.pdf>
- Onwuakagba, I. U., Obiekwe, S. J., Okoye, E. C., Kanu, F. C., Amaechi, I. A., & Akosile, C. O. (2024). The Igbo version of the Global Physical Activity Questionnaire (GPAQ): A cross-cultural adaptation study. *Journal of Activity, Sedentary and Sleep Behaviors*, 3, 20. <https://doi.org/10.1186/s44167-024-00061-9>
- Onywera, V. O., Larouche, R., Oyeyemi, A. L., Prista, A., Akinroye, K. K., Heyker, S., Owino, G. E., & Tremblay, M. S. (2018). Development and convergent validity of new self-administered questionnaires of active transportation in three African countries: Kenya, Mozambique and Nigeria. *BMC Public Health*, 18, 1018. <https://doi.org/10.1186/s12889-018-5954-z>
- Oyeyemi, A. L., Moss, S. J., Monyeke, M. A., & Kruger, H. S. (2016). Measurement of physical activity in urban and rural South African adults: A comparison of two self-report methods. *BMC Public Health*, 16, 1004. <https://doi.org/10.1186/s12889-016-3693-6>
- Oyeyemi, A. L., Kasoma, S. S., Onywera, V. O., Assah, F., Adedoyin, R. A., Conway, T. L., Moss, S. J., Ocansey, R., Kolbe-Alexander, T. L., Akinroye, K. K., Prista, A., Larouche, R., Gavand, K. A., Cain, K. L., Lambert, E. V., Aryeetey, R., Bartels, C., Tremblay, M. S., & Sallis, J. F. (2016B). NEWS for Africa: Adaptation and reliability of a built environment questionnaire for physical activity in seven African countries. *International Journal of Behavioral Nutrition and Physical Activity*, 13, 33. <https://doi.org/10.1186/s12966-016-0357-5>

- Oyeyemi, A. L., & Larouche, R. (2018). Prevalence and correlates of active transportation in developing countries. In R. Larouche (Ed.), *Children's active transportation* (pp. 173–191). Elsevier. <https://doi.org/10.1016/B978-0-12-811931-0.00012-0>
- Oyeyemi, A. L., Ogunleye, A. B., Okafor, A. C., Kollipara, N., ChinAPaw, M. J. M., & Omotoso, D. R. (2026). Social and physical environmental correlates of movement behaviors, body weight status, and well-being among adolescents in Nigeria: A youth-centered participatory action project narrative review. *International Journal of Behavioral Nutrition and Physical Activity*, 23, 42. <https://doi.org/10.1186/s12966-026-01904-1>
- Oyeyemi, A. L., Oyeyemi, A. Y., Adegoke, B. O., Oyetoke, F. O., Aliyu, H. N., Aliyu, S. U., & Rufai, A. A. (2011). The short International Physical Activity Questionnaire: Cross-cultural adaptation, validation and reliability of the Hausa language version in Nigeria. *BMC Medical Research Methodology*, 11, 156. <https://doi.org/10.1186/1471-2288-11-156>
- Oyeyemi, A. L., Umar, M., Oguche, F., Aliyu, S. U., & Oyeyemi, A. Y. (2014). Accelerometer-determined physical activity and its comparison with the International Physical Activity Questionnaire in a sample of Nigerian adults. *PLOS ONE*, 9(1), e87233. <https://doi.org/10.1371/journal.pone.0087233>
- Poulain, T., Vogel, M., Meigen, C., Spielau, U., Hiemisch, A., & Kiess, W. (2020). Parent-child agreement in different domains of child behavior and health. *PLOS ONE*, 15(4), e0231462. <https://doi.org/10.1371/journal.pone.0231462>
- Ritchie, J., & Spencer, L. (1994). Qualitative data analysis for applied policy research. In A. Bryman & R. G. Burgess (Eds.), *Analyzing qualitative data* (pp. 173–194). Routledge, London, 173-194. https://doi.org/10.4324/9780203413081_chapter_9.
- Rostami Haji Abadi, M., Kwaghbo, N., Onyeso, O. K., Sadia, F., Benavides Castro, J. K., Santos Silva, D. A., Yan, Y., Shen, Y., Hamrik, Z., Sarmiento, O. L., Liu, Y., Tremblay, M. S., & Larouche, R. (2025). Psychometric properties of physical activity questionnaires for children and adolescents: An updated systematic review. *Sports Medicine*, 55(9), 2225–2301. <https://doi.org/10.1007/s40279-025-02270-x>
- Sallis, J. F., Bull, F., Guthold, R., Heath, G. W., Inoue, S., Kelly, P., Oyeyemi, A. L., Perez, L. G., Richards, J., Hallal, P. C., & Lancet Physical Activity Series 2 Executive Committee. (2016). Progress in physical activity over the Olympic quadrennium. *The Lancet*, 388(10051), 1325–1336. [https://doi.org/10.1016/S0140-6736\(16\)30581-5](https://doi.org/10.1016/S0140-6736(16)30581-5)

- Scott, K., Ummer, O., & LeFevre, A. E. (2021). The devil is in the detail: Reflections on the value and application of cognitive interviewing to strengthen quantitative surveys in global health. *Health Policy and Planning*, 36(6), 982–995.
<https://doi.org/10.1093/heapol/czab048>
- Šuc, A., Einfalt, L., Šarabon, N., & Kastelic, K. (2024). Validity and reliability of self-reported methods for assessment of 24-h movement behaviours: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, 21, 83. <https://doi.org/10.1186/s12966-024-01632-4>
- Todorovic, N., Ranisavljev, M., Korovljev, D., Mauti, J., Neumann, C., Mboya, I., Ferrero, E., Ourohiré, M., Somé, S., Liu, S., Shinde, S., Noor, R. A., Bärnighausen, T., & Ostojic, S. M. (2025). Promoting adolescent and youth health through physical activity initiatives and interventions in Sub-Saharan Africa: The ARISE-NUTRINT and DASH initiatives. *International Journal of Public Health*, 70, 1608609. <https://doi.org/10.3389/ijph.2025.1608609>
- Wachira, L.-J., Hayker, S. O., Larouche, R., Oyeyemi, A. L., Prista, A., Owino, G. E., Tremblay, M. S., & Onywera, V. O. (2022). Physical activity and active transportation behaviour among rural, peri-urban and urban children in Kenya, Mozambique and Nigeria: The PAAT Study. *PLOS ONE*, 17(1), e0262768.
<https://doi.org/10.1371/journal.pone.0262768>
- Willis, G. B. (2005). *Cognitive interviewing: A tool for improving questionnaire design*. SAGE Publications.
<https://doi.org/10.4135/9781412983655>