Construct Validity of the Neighborhood Environment Walkability Scale for Africa

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ABSTRACT

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Although infectious diseases are still the main causes of mortality in sub-Saharan Africa, physical inactivity–related noncommunicable diseases (NCD) are now responsible for approximately 3 million deaths in the region (40). These deaths are projected to increase rapidly if urgent actions are not taken (1,40). Built environment and related policy interventions have been advocated by the World Health Organization and the United Nations as promising strategies to control the worldwide epidemic of NCD and

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related deaths (34,39) because such interventions are expected to affect virtually the entire population (30). Many studies have documented the relationship between supportive attributes of the built environment and physical activity done for transportation and recreation purposes (3,17,20,26,32,38). Yet most of this evidence was from studies conducted in high-income countries. In Africa, studies of built environment–physical activity relationships remain scarce (3,23). For research on environmental correlates of physical activity to progress and contribute to evidence-based solutions to NCD in sub-Saharan Africa there is a need to develop and evaluate measures of environmental variables that are tailored for use in the region (23,24).

The neighborhood environment walkability scale (NEWS) is one of the most comprehensive and widely used self-report measures of the built environment, and it has been used for within- and cross-country studies of built environment correlates of physical activity in many regions of the world (6,7,10,17,19,27). Despite the extensive evaluation of the NEWS instrument, its utility and applicability to sub-Saharan African countries remains unclear. The NEWS was developed in the United States to obtain residents' perceptions of how neighborhood features found in the transportation and urban planning literature were related to walking and physical activity (27,28), but its direct extrapolation to sub-Sahara Africa may be limited due to differences in sociocultural and environmental features (24). Thus, it is important to adapt the NEWS to Africa and evaluate its psychometric properties before using it to assess perceived built environments in Africa.

Two studies have provided partial support for the feasibility of using the NEWS questionnaire in Africa by reporting acceptable psychometric properties for its original subscales in Nigerian adults (24) and modest correlations between its subscales and accelerometer and self-reported estimates of physical activity in South African older adults (18). These studies were limited in terms of environmental variability available within any single country, small sample size, and use of NEWS in its original form or with limited adaptation. Thus, previous findings may not apply to other population subgroups or in other sub-Saharan African countries.

Recently, the NEWS was systematically adapted for Africa through a coordinated study in multiple African countries (23). The test–retest reliability of the resulting NEWS-Africa instrument was "good" (Intraclass Correlation Coefficient; ICC = 0.60–0.74) to "excellent" (ICC > 0.75%) for more than 90% of its items and scales, but no validity evidence has been reported for NEWS-Africa. Because accurate analyses of the built environment–physical activity relationships require the use of valid measures of attributes of the built environment as well as of physical activity (5,6), the present study aims to assess the construct validity of the NEWS-Africa instrument by examining relationships of its scales with self-reported walking for transportation and recreation among adults from six sub-Saharan African countries. An additional exploratory aim was to examine the construct validity of NEWS-Africa within each of the six African countries.

METHODS

Participants and Procedures

Participants were 469 adults (age 18–85 yr) who were involved in the coordinated study of adaptation and psychometric evaluation of NEWS-Africa in six sub-Saharan African countries, representing Central Africa (Cameroon), East Africa (Uganda), West Africa (Ghana and Nigeria), and Southern Africa (Mozambique and South Africa). A detailed description of the psychometric study methods has been reported elsewhere (23). Briefly, a cross-sectional design was used to collect self-reported information on neighborhood environmental attributes and physical activity. In all countries (except Mozambique, where no walkability information was available), participants were purposively recruited from neighborhoods chosen to maximize the variability in neighborhood walkability (high/low walkable) and socioeconomic status (SES) (high/low income), with some participants selected from rural villages in Ghana, Mozambique, and Uganda to enhance relevance to diverse African environments. Information on neighborhood area SES was obtained from government ministries, departments, or agencies in each country or based on previous experience from built environment studies in Africa (18,21,24). Neighborhood walkability classification was based on the criteria from the transportation literature (19,28) as previously described (23). Neighborhoods fitting the general criteria were identified based on local knowledge of the country team, with the goal of ensuring variability of environments.

Within identified neighborhoods, only one adult per household was eligible to participate. Those in group living establishments (e.g., health care facilities or military barracks), younger than 18 yr or who had not lived within the identified neighborhood for at least 6 months, were ineligible for the study. All participants were interviewed by trained research staff in English and/or a local language, using the NEWS-Africa interview manual that was developed to standardize interview strategies and improve quality and comparability of data across countries (23). The study was conducted between July 2014 and February 2015. All participants provided written informed consent, and the study was approved by the ethical review committee of the principal investigator's institution in each country.

Measures

NEWS-Africa. Reported attributes of built environments were measured using the adapted NEWS-Africa instrument. The adaptation process of NEWS-Africa has been described fully elsewhere (23). Briefly, the original NEWS was adapted to Africa based on input from researchers and practitioners with built environment and public health expertise, as well as residents in seven African countries. Many of the original

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NEWS items were retained to enhance comparability with results from other regions, but modifications were made to individual items and 14 new items and one new scale were added to capture important attributes relevant to the African environments. For example, the residential density scale was modified to a single item with response options enlarged to include rural areas and densely packed slums. Several items about informal roads and walking paths were introduced, and a new scale on personal safety was created from disparate items related to dangerous animals, lighting at night, and seeing people walking.

The adapted NEWS-Africa instrument consisted of 76 individual items and 13 scales that assessed the following perceived environmental characteristics: residential density (1 item), proximity to nonresidential land uses (mixed land use—diversity/proximity) (27 items), ease of access to nonresidential uses (mixed land use—access to services and places) (7 items), street (roads and walking paths), connectivity (5 items), infrastructure and safety for walking and cycling (12 items), aesthetics (8 items), traffic safety (6 items), safety from crime (4 items), personal safety (3 items), and child-related questions on stranger danger (3 items). The latter were answered only by parents of children younger than 18 yr. Two separate subscales were derived from the items on the mixed land use—diversity/proximity scale: proximity to diverse destinations (destinations scale [21 items]) and recreational areas (recreation scale [4 items]). Three subscales were computed from the items on infrastructure and safety for walking and cycling: sidewalks (5 items), crossings (4 items), and path infrastructure (informal walking paths) (2 items) (23).

Because there is evidence the pattern of environmental attributes is more strongly related to physical activity than individual items (4,29), a general "walkability index" was constructed by combining nine NEWS-Africa subscales that have been previously theorized to operationalize the larger construct of walkability (29). The nine subscales that were combined into a single "walkability index" by computing the mean of their standardized scores (i.e., each standardized subscale had mean = 0, SD = 1) were residential density, destinations, recreation, mixed land use accessibility, roads and walking paths, sidewalk, crossing, path infrastructure, and aesthetics.

All NEWS-Africa items, except residential density and land use mix diversity items, were rated by participants using Likert-type response options ranging from 1 (strongly disagree) to 4 (strongly agree). The one question on residential density reflected common housing patterns in urban and rural areas of Africa, and responses ranged from 1 (lowest density; e.g., few residential buildings/dwellings) to 6 (highest density; e.g., densely packed small houses, settlements, and slums). Land use mix diversity/proximity was assessed by the reported time it takes to walk from one's home to various types of destinations, with responses ranging from 1- to 5-min walking distance (coded as 5) to >30-min walking distance (coded as 1). All NEWS-Africa scales were computed as the mean of responses to items in the scale, with responses coded (or reverse-coded) such that higher values indicated higher walkability of the environment. The scales and individual items of NEWS-Africa have evidence of "good" (ICC = 0.60–0.74) to "excellent" (ICC > 0.75%) test–retest reliability (23).

Physical activity. Self-reported physical activity was assessed with the International Physical Activity Questionnaire (IPAQ; long version, assessing past 7 d) (9). The IPAQ assessed the frequency and duration of physical activity in four domains, but only two domains (transport and leisure) were used in present analyses. On separate items about walking for transportation and for recreation, participants reported the frequency ($d \cdot wk^{-1}$) they walked, which is at least 10 min at a time in the last 7 d, and the usual duration (in minutes) of walking for either purpose on one of those days. The weekly durations (computed as minutes per week = days per week × minutes per usual day during the past week) of walking for transportation and walking for recreation were the two outcome variables examined. IPAQ measures were found to have good test–retest reliability (ICC = 0.46–0.96) and fair-to-moderate criterion validity (median ρ = 0.30) for total physical activity scores compared against accelerometer measures in a 12-country study on five continents, including Africa (9). High test–retest reliability coefficients ranging from ICC = 0.71 to ICC = 0.82 have been reported for the transportation and leisure time walking items of the IPAQ in Nigeria (22). Walking represents an appropriate variable for evaluating the construct validity of NEWS-Africa because it is the most common physical activity behavior that occurs often in neighborhood environments (20), and "walkability" of neighborhoods is hypothesized to be related to walking, mainly for transportation (19,28).

Sociodemographic information. Self-reported sociodemographic variables included age, gender, educational level (no formal education, primary school, some high school, completed high school, diploma/higher diploma, bachelor's degree, or graduate/professional degree), marital status (married/living with partner or not), number of motorized vehicles in household (none, one, two, three or more), number of adults and number of youths living in the household, and months lived at the current address. Body mass index (BMI) was calculated as weight (kg) / height (m^2); participants self-reported their height and weight in Cameroon and Ghana, and these were directly measured in Mozambique, Nigeria, South Africa, and Uganda.

Statistical Analyses

Overall descriptive statistics (mean, SD, percentage, and distribution statistics) were computed for the pooled sample (n = 469 adults) on all measures (IPAQ, NEWS-Africa, and sociodemographic measures). Analyses were conducted using the IBM Statistical Package for the Social Sciences version 21 (IBM Corp., Armonk, NY). The SPSS general linear model ANOVA procedure was used to assess associations between each physical activity outcome (self-reported walking for transportation and walking for recreation) and the NEWS-Africa

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measures for pooled and country-specific analyses. Both physical activity outcomes had skewed distributions (skewness = 1.72 and 2.67 for transportation and recreation walking, respectively). Therefore, median and interquartile range values were reported in the descriptives table and natural-log transformed physical activity measures were used in the general linear model analyses. Separate models were run for each physical activity outcome and NEWS-Africa measure, with each model adjusting for age, gender, marital status, education level, number of motor vehicles available in household, number of youth living in household, and country (latter variable included only in the pooled analyses). Because several NEWS-Africa measures had different scaling, for consistency of interpretation, partial η^2 was determined to indicate strength of independent associations (partial η^2 = 0.01–0.05, small effect; partial η^2 = 0.06–0.13, moderate effect; partial $\eta^2 > 0.13$, large effect) (8). Partial η^2 is the ratio of variance accounted for by a predictor divided by that variance plus error (residual) variance. It is an effect size representing the proportion of unexplained variation in the outcome uniquely explained by a given predictor, after adjusting for variance accounted for by other predictors in the model. These were tabulated for the pooled data (primary aim), as well as separately for each country (exploratory aim).

RESULTS

Sample characteristics and descriptive information on walking and environmental attributes. Table 1 reports descriptive characteristics for the pooled sample, including sociodemographic characteristics, perceived environmental attributes, walking for transportation, and walking for recreation. The pooled sample consisted of 469 participants; 49.7% were women, 45.8% were married or living with a partner, 36.4% had a bachelor's degree or higher, and 75.5% lived in urban areas. The mean age of the pooled sample was 32.0 yr (SD = 12.5 yr, range 18–85 yr), mean BMI was 24.7 kg·m^{-2} (SD = 4.8), 30.1% were overweight (BMI = 25.0–29.9 kg·m^{-2}), and 11.1% were obese (BMI ≥ 30.0 kg·m^{-2}). The median time participants reported walking for transportation was 2.3 h·wk^{-1}, with 25% reporting ≤ 50 min·wk^{-1} and 25% reporting ≥5.25 h·wk^{-1} of transportation walking. The median time spent walking for recreation was 20 min·wk^{-1}, with 25% of participants reporting zero recreation walking and 25% reporting ≥ 2.5 h·wk^{-1} of recreation walking.

Relationships of environmental attributes with walking for transportation. Results from the models predicting reported walking for transportation are shown in Table 2. In the pooled analyses with participants from all six countries, transport walking was positively and significantly associated with 3 of 14 environmental attributes assessed by NEWS-Africa. The overall "walkability index" (η^2 = 0.020, P = 0.005), the subscale for mixed land use—access to services and places (η^2 = 0.020, P = 0.006), and low score on the stranger danger scale (η^2 = 0.021, P = 0.049) were associated with transport walking. There also were trends ($P > 0.05$ to ≤0.10) for associations with five other environmental attributes, with all associations in the positive direction, except for crime safety scale. The effects sizes were small, accounting for approximately 2% of the variance in walking for transport in

TABLE 1. Descriptive characteristics for the pooled sample (n = 469).

Characteristic	*n* (%)
Sociodemographics	
Country	
Cameroon	57 (12.2)
Ghana	72 (15.4)
Mozambique	79 (16.8)
Nigeria	79 (16.8)
South Africa	40 (8.5)
Uganda	142 (30.3)
Region	
Urban	354 (75.5)
Suburban/periurban	58 (12.4)
Rural	57 (12.2)
Study design quadrant	
High walkability/low income	126 (26.9)
High walkability/high income	89 (19.0)
Low walkability/low income	32 (6.8)
Low walkability/high income	143 (30.5)
Missing (Mozambique unable to select by quadrant)	79 (16.8)
Gender	
Female	233 (49.7)
Marital status	
Married or living with partner	215 (45.8)
Education	
No formal education	8 (1.7)
Primary school	30 (6.4)
Some high school	99 (21.1)
Completed high school	112 (23.9)
Diploma/higher diploma	49 (10.4)
Bachelor's degree	130 (27.7)
Graduate/professional degree	41 (8.7)
Motorized vehicles per household	
None	214 (45.6)
One	145 (30.9)
Two	79 (16.8)
Three or more	30 (6.4)
	Mean (SD)
Age (yr)	32.0 (12.5)
Adults in household	3.3 (2.6)
Youth in household	2.4 (2.2)
Number of months lived in house	102.3 (115.4)
BMI (kg·m^{-2})	24.7 (4.8)
NEWS-Africa measures	
Walkability index	−0.04 (0.47)
Types of residences (residential density item)	3.07 (1.78)
Destinations subscale (mixed land use—diversity/proximity)	2.93 (0.74)
Recreation subscale (mixed land use—diversity/proximity)	2.08 (1.00)
Access to services and places subscale (mixed land use—access)	2.84 (0.65)
Roads/walking paths scale (street connectivity)	3.03 (0.55)
Sidewalk infrastructure subscale	1.82 (0.71)
Crossings subscale	1.92 (0.63)
Path infrastructure subscale	2.46 (0.87)
Places for walking/cycling/playing, overall scale	1.93 (0.53)
Neighborhood surroundings (aesthetics) scale	2.68 (0.66)
Traffic safety scale	2.66 (0.75)
Crime safety scale	3.05 (0.84)
Personal safety scale	2.82 (0.60)
Low stranger danger scale (parents only, n = 228)	2.30 (1.09)
IPAQ PA outcomes[a]	Median (IQR)
Walking for transportation (min·wk^{-1})	140 (50–315)
Walking for recreation (min·wk^{-1})	20 (0–150)

Ranges of subscales varied across the NEWS-Africa measures. Walkability index values ranged from −1.61 to 1.40. Types of residences (residential density item) ranged from 1 to 6, and both of the mixed land use—diversity/proximity subscales (destinations and recreation) ranged from 1 to 5. All other NEWS-Africa subscales ranged from 1 to 4. IQR, interquartile range.

[a]Because the IPAQ measures were skewed, the median and the IQR (25th and 75th percentile values) are tabled.

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TABLE 2. Transport walking (min·wk^{-1}): associations with NEWS-Africa scales in adults.

	Pooled—Six Countries (n = 469)		Cameroon (n = 57)		Ghana (n = 72)		Mozambique (n = 79)		Nigeria (n = 79)		South Africa (n = 40)		Uganda (n = 142)	
Item/scale	**Partial η^2**	***P***	**Partial η^2**	***P***	**Partial η^2**	***P***	**Partial η^2**	***P***	**Partial η^2**	***P***	**Partial η^2**	***P***	**Partial η^2**	***P***
Walkability index	0.020(+)	0.005	0.025(+)	0.302	0.007(−)	0.609	0.000(−)	0.906	0.000(+)	0.910	**0.166(+)**	**0.020**	**0.031(+)**	**0.049**
A. Types of residences (residential density)														
Types of residences in your neighborhood (not weighted)	0.007(+)*	0.094	0.000(+)	0.937	0.007(−)	0.618	0.006(+)	0.590	0.006(−)	0.555	**0.146(+)**	**0.031**	0.020(+)	0.115
B. Stores, facilities and other things in your neighborhood (mixed land use—diversity/proximity)														
Destinations scale—mean of items 1–20 and 25	0.008(+)*	0.077	0.047(+)	0.163	0.007(+)	0.626	0.013(+)	0.424	0.005(−)	0.582	0.024(+)	0.398	0.010(+)	0.258
Recreation scale—mean of items 21–24	0.007(+)	0.116	0.044(+)	0.178	0.001(−)	0.893	0.031(+)	0.239	0.003(−)	0.664	0.002(+)	0.826	0.006(+)	0.389
C. Access to services and places (mixed land use—access)														
Access to services scale—mean of items 1–7	**0.020(+)**	**0.006**	0.077(+)*	0.072	0.007(+)	0.623	0.003(−)	0.701	0.000(−)	0.892	**0.189(+)**	**0.013**	0.006(+)	0.401
D. Roads and walking paths in my neighborhood (street connectivity)														
Roads and walking paths scale—mean of items 1–5 (after recodes)	0.007(+)*	0.100	0.078(+)*	0.070	0.024(+)	0.354	0.072(−)*	0.060	0.001(−)	0.804	0.092(+)*	0.092	0.007(+)	0.338
E. Places for walking, cycling, and playing (infrastructure)														
Sidewalk scale—mean of items 1–5	0.000(−)	0.865	0.045(+)	0.172	0.000(−)	0.929	0.009(−)	0.506	0.000(+)	0.952	0.005(+)	0.706	0.008(−)	0.328
Crossings scale—mean of items 6–9	0.001(−)	0.622	0.026(+)	0.299	0.070(−)	0.110	0.055(−)	0.101	0.001(+)	0.854	0.005(−)	0.710	0.008(+)	0.330
Path infrastructure scale—mean of items 10–11	0.001(−)	0.483	0.002(+)	0.769	0.022(+)	0.376	0.018(+)	0.355	0.001(+)	0.851	0.002(+)	0.833	0.000(−)	0.862
Places for walking, cycling, and playing, overall scale—mean of all Section E items	0.000(+)	0.867	0.048(+)	0.157	0.005(−)	0.687	0.014(−)	0.412	0.002(+)	0.740	0.002(+)	0.805	0.000(−)	0.856
F. Neighborhood surroundings (aesthetics)														
Neighborhood surroundings (aesthetics) scale—mean of items 1–8	0.002(−)	0.377	0.011(+)	0.497	0.012(−)	0.518	0.013(−)	0.434	0.001(+)	0.840	0.057(−)	0.187	0.002(−)	0.631
G. Safety from traffic														
Traffic safety scale—mean of items G1–G6	0.001(+)	0.614	0.006(−)	0.627	**0.137(−)**	**0.022**	0.002(+)	0.762	0.007(+)	0.507	0.005(−)	0.690	0.024(+)	0.084*
H. Safety from crime														
Crime safety scale—mean of items 1–4 after reverse coding	0.009(−)	0.057*	0.000(+)	0.972	0.013(−)	0.488	0.052(−)	0.110	0.008(−)	0.497	0.045(−)	0.242	0.006(−)	0.380
I. Personal safety														
Personal safety scale—mean of I1–I3	0.000(−)	0.787	0.004(+)	0.674	0.000(−)	0.999	0.034(−)	0.198	0.004(−)	0.615	0.042(+)	0.261	0.000(−)	0.888
J. Low stranger danger (parents only, n = 288)														
Low stranger danger scale—mean of parent-reported items 1–3 (reversed)	**0.021(+)**	**0.049**	0.009(+)	0.614	N/A		0.000(−)	0.943	0.007(+)	0.652	N/A		**0.068(+)**	**0.003**

Analyses adjusted for marital status, age, gender, number of motor vehicles, number of youth in household, and education; country was included in the pooled analyses with all six countries. Partial η^2 is the proportion of unexplained variation in the outcome uniquely explained by a given predictor, after adjusting for all other predictors. Positive sign (+) next to partial η^2 indicates positive association, and negative sign (−) indicates negative association. N/A, stranger danger results not available because of $n < 15$ cases for Ghana and South Africa.

The complete NEWS-Africa is available at http://sallis.ucsd.edu/measures.html and https://static-content.springer.com/esm/art%3A10.1186%2Fs12966-016-0357-y/MediaObjects/12966_2016_357_MOESM1_ESM.pdf.

*$P \leq 0.10$ trends; bolded values are significant at $P \leq 0.05$.

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the pooled data, although they were larger in some instances in the within-country results, especially in South Africa.

Country-specific analyses showed only a few significant associations with transport walking: South Africa had three, walkability index ($\eta^2 = 0.166$, $P = 0.020$), residential density ($\eta^2 = 0.146$, $P = 0.031$), and mixed land use—access to services and places ($\eta^2 = 0.189$, $P = 0.013$), and Uganda had two, walkability Index ($\eta^2 = 0.031$, $P = 0.049$) and low score on the stranger danger scale ($\eta^2 = 0.068$, $P = 0.003$). All associations were in a positive direction. Ghana had one significant negative association with safety from traffic ($\eta^2 = -0.137$, $P = 0.022$).

Relationships of environmental attributes with walking for recreation. Results from the models for recreational walking are shown in Table 3. In the pooled analyses, recreational walking was positively and significantly associated with 5 of 14 environmental attributes assessed by NEWS-Africa. The overall walkability index ($\eta^2 = 0.013$, $P = 0.028$), mixed land use—diversity/proximity to recreation facilities/places ($\eta^2 = 0.016$, $P = 0.015$), connectivity of roads and walking paths ($\eta^2 = 0.025$, $P = 0.002$), path infrastructure ($\eta^2 = 0.021$, $P = 0.005$), and overall walking/cycling infrastructure scale ($\eta^2 = 0.012$, $P = 0.029$) were associated with recreation walking. There was also a negative trend for the association with safety from crime scale ($P = 0.062$). Similar to the first model on walking for transport, the effects sizes were small, accounting for 1% to 2% of the variance in walking for recreation in the pooled sample.

Country-specific analyses showed only a few significant associations with recreation walking. Uganda had three significant positive associations: walkability index ($\eta^2 = 0.038$, $P = 0.028$), mixed land use—diversity/proximity to recreation facilities/places ($\eta^2 = 0.031$, $P = 0.049$), and the street crossings subscale ($\eta^2 = 0.033$, $P = 0.043$). South Africa had two significant positive associations: street crossings subscale ($\eta^2 = 0.154$, $P = 0.026$) and overall walking/cycling infrastructure scale ($\eta^2 = 0.122$, $P = 0.050$). Ghana had one significant positive association with the mixed land use—diversity/proximity to recreation facilities/places scale ($\eta^2 = 0.142$, $P = 0.020$). Mozambique had two significant associations but in negative directions: neighborhood surroundings (aesthetics) ($\eta^2 = -0.147$, $P = 0.006$) and safety from crime ($\eta^2 = -0.158$, $P = 0.004$).

DISCUSSION

The primary aim of the present study was to examine the construct validity of the NEWS-Africa instrument among African adults using pooled data from six sub-Saharan African countries. Of 13 NEWS-Africa subscales, 6 were significantly associated with either walking for transport or for recreation. The overall walkability index was significantly related to walking both for transport and for recreation in pooled analyses. The effect sizes were small, with NEWS-Africa scores accounting for 1%–2% of variance in walking for both purposes in the pooled analyses. However, the estimated public health effect may be substantial considering that any environmental influences apply to the whole population, not just participants in a "program" (28,30). The significant relationship of the overall "walkability index" with walking for transport and recreation provides some support for the coherence and consistency of the NEWS-Africa's subscales that made up the walkability index. The findings with the index are consistent with studies in more-developed countries (3,4,14,29,31,35,36), suggesting that a pattern or cluster of activity-friendly attributes rather than single environmental attributes would be needed to support more walking and physical activity.

For the pooled analyses, similar to many previous studies (10,17,20,26,33,36), we found access to services and places and low stranger danger to be significantly related to walking for transportation. Most environmental scales, including residential density, diversity/proximity of destinations, and connectivity of streets/roads/paths and safety from crime, were not significantly related to walking for transport. However, several of these scales were components of the walkability index, which was significantly related to walking for transport. Another important finding was that none of the infrastructure for walking/cycling/playing scales (sidewalk, crossings, paths, or overall scales) were related with walking for transport in the present study, which is in contrast to the international literature (3,17,20,26,33,36,38). Possibly, these features are not as important to facilitate walking for transportation in Africa as in the western developed countries. It could also be that many people in Africa need to walk for transportation regardless of the type and quality of pedestrian infrastructures in their neighborhood. Similar to pedestrian infrastructures, safety from traffic was not related to walking for transport in the present study. Perhaps confidence in personal ability to judge and deal with traffic safety concerns is higher in Africans than in people in high-income countries. However, it may be that there were too few examples of high quality and safe pedestrian infrastructures in the study settings, and this limited variability reduced power to detect associations with walking for transport.

For recreation-related walking, the associations with some of the built environment features in the pooled analyses provide modest support for the construct validity of the NEWS-Africa instrument. Consistent with some international studies, proximity of recreation facilities, connectivity of roads and paths, and pedestrian infrastructures were significantly and positively related to leisure walking (3,20,33,35). It was surprising that path infrastructure was related to leisure but not transport walking. Perhaps because leisure walking is more of a choice, quality paths may encourage walking for recreation among African adults. Although not anticipated, the significant relationship of leisure time walking to connectivity of roads and walking paths and the overall "walkability" index found in the present study have been reported in some studies (31,33,35). Possibly, a neighborhood that is well connected and designed better for walking creates a more pleasant environment that may encourage walking for recreation. Contrary to the consistent evidence in international literature (3,20,26,32,33,36), aesthetics was not related to

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TABLE 3. Recreation walking (min·wk^{-1}): associations with NEWS-Africa scales in adults.

	Pooled—Six Countries (n = 469)		Cameroon (n = 57)		Ghana (n = 72)		Mozambique (n = 79)		Nigeria (n = 79)		South Africa (n = 40)		Uganda (n = 142)	
Item/scale	**Partial η^2**	***P***	**Partial η^2**	***P***	**Partial η^2**	***P***	**Partial η^2**	***P***	**Partial η^2**	***P***	**Partial η^2**	***P***	**Partial η^2**	***P***
Walkability index	**0.013(+)**	**0.028**	0.021(+)	0.377	0.010(+)	0.555	0.013(−)	0.430	0.003(+)	0.697	0.047(+)	0.234	**0.038(+)**	**0.028**
A. Types of residences (residential density)														
Types of residences in your neighborhood (not weighted)	0.003(+)	0.285	0.031(+)	0.287	0.027(−)	0.329	0.028(+)	0.247	0.031(+)	0.188	0.086(−)	0.104	0.003(+)	0.539
B. Stores, facilities, and other things in your neighborhood (mixed land use—diversity/proximity)														
Destinations scale—mean of items 1–20, 25	0.000(+)	0.981	0.040(+)	0.224	0.001(+)	0.850	0.006(−)	0.587	0.028(−)	0.201	0.037(+)	0.290	0.005(+)	0.414
Recreation scale—mean of items 21–24	**0.016(+)**	**0.015**	0.046(+)	0.188	**0.142(+)**	**0.020**	0.008(−)	0.540	0.006(+)	0.551	0.006(−)	0.680	**0.031(+)**	**0.049**
C. Access to services and places (mixed land use—access)														
Access to services scale—mean of items 1–7	0.003(+)	0.308	0.030(+)	0.291	0.019(+)	0.404	0.016(−)	0.384	0.000(+)	0.883	0.047(+)	0.235	0.008(+)	0.332
D. Roads and walking paths in my neighborhood (street connectivity)														
Roads and walking paths scale—mean of items 1–5 (after recodes)	**0.025(+)**	**0.002**	0.021(+)	0.383	0.046(+)	0.194	0.000(−)	0.974	0.014(+)	0.362	0.065(+)	0.158	0.027(+)*	0.069
E. Places for walking, cycling, and playing (infrastructure)														
Sidewalk scale—mean of items 1–5	0.001(+)	0.613	0.009(+)	0.556	0.024(+)	0.350	0.002(+)	0.752	0.050(−)*	0.087	0.047(+)	0.234	0.004(+)	0.462
Crossings scale—mean of items 6–9	0.005(+)	0.174	0.008(−)	0.595	0.009(−)	0.577	0.013(−)	0.426	0.001(+)	0.836	**0.154(+)**	**0.026**	**0.033(+)**	**0.043**
Path infrastructure scale—mean of items 10–11	**0.021(+)**	**0.005**	0.038(+)	0.232	0.054(+)	0.162	0.020(+)	0.332	0.006(+)	0.550	0.020(+)	0.434	0.010(+)	0.265
Places for walking, cycling, and playing, overall scale—mean of all section E items	**0.012(+)**	**0.029**	0.006(+)	0.641	0.023(+)	0.363	0.002(+)	0.787	0.002(−)	0.753	**0.122(+)**	**0.050**	0.025(+)*	0.079
F. Neighborhood surroundings (aesthetics)														
Neighborhood surroundings (aesthetics) scale—mean of items 1–8	0.003(−)	0.265	0.032(−)	0.278	0.052(−)	0.167	**0.147(−)**	**0.006**	0.028(+)	0.201	0.030(+)	0.346	0.000(+)	0.958
G. Safety from traffic														
Traffic safety scale—mean of items G1–G6	0.001(−)	0.560	0.000(+)	0.964	0.079(−)	0.087	0.033(−)	0.206	0.009(−)	0.480	0.046(+)	0.239	0.004(+)	0.475
H. Safety from crime														
Crime safety scale—mean of items 1–4 after reverse coding	0.009(−)*	0.062	0.044(−)	0.199	0.001(+)	0.867	**0.158(−)**	**0.004**	0.009(−)	0.470	0.001(+)	0.874	0.000(+)	0.958
I. Personal safety														
Personal safety scale—mean of I1–I3	0.000(+)	0.833	0.070(−)	0.103	0.021(+)	0.387	0.026(−)	0.268	0.002(+)	0.726	0.020(+)	0.436	0.005(−)	0.455
J. Low stranger danger (parents only, n = 288)														
Low stranger danger scale—mean of either child- or parent-reported items 1–3 (reversed)	0.000(−)	0.913	0.009(−)	0.631	N/A		0.094(−)	0.107	0.008(+)	0.630	N/A		0.012(+)	0.404

Analyses adjusted for marital status, age, gender, number of motor vehicles, number of youth in household, and education; country was included in the pooled analyses with all six countries. Partial η^2 is the proportion of unexplained variation in the outcome uniquely explained by a given predictor, after adjusting for all other predictors. Positive sign (+) next to partial η^2 indicates positive association, and negative sign (−) indicates negative association. N/A, stranger danger results not available because of $n < 15$ cases for Ghana and South Africa.

*$P \leq 0.10$ trends; bolded values are significant at $P \leq 0.05$.

The complete NEWS-Africa is available at http://sallis.ucsd.edu/measures.html and https://static-content.springer.com/esm/art%3A10.1186%2Fs12966-016-0357-y/MediaObjects/12966_2016_357_MOESM1_ESM.pdf.

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recreational walking in the present study. Perhaps there is a different distribution of aesthetics in Africa, or African adults may have lower expectations about aesthetics so they are not much of a decision factor to walk for recreation in Africa.

Although perceptions of safety from crime seem to be related more often to increased transport and leisure time physical activity of adults in low- and middle-income countries (15,16,21,25) compared with the inconsistent patterns in Western developed countries (13,26,35,38), present findings that perceived safety from crime was related to lower walking for transportation and leisure in African adults are difficult to interpret. The unexpected association could reflect higher crime rates in dense urban areas of Africa where walking is most common. It may be that walkers in the present study may just be more aware of threats to safety compared with those who do not walk. However, safety from crime may not influence travel decisions among African adults because they often have limited choice (e.g., they do not own a car or have to travel in areas not serviced by public transport), or because they are more confident and resilient in the event of crime-related circumstances than people in high-income countries.

For the exploratory aim, the country-specific results provided little support for the construct validity of NEWS-Africa. Only in South Africa and Uganda were the walkability index and a few individual scales from NEWS-Africa significantly associated with walking for transport in the expected direction, providing poor replication of findings from Western developed countries. It is notable that South Africa is one of the two African countries with the most supportive evidence of validity for NEWS-Africa because it is the country with the most Western-like built environments, consistent with the urban design concepts assessed by NEWS. However, there are several potential explanations for the present discrepant findings in country-specific analyses for the other countries. First, sub-Saharan Africa may have country-specific patterns of environments that NEWS-Africa does not adequately characterize. This seems unlikely given that NEWS-Africa was developed by investigators in the countries where it was evaluated, along with input from, and pretesting with, local residents and experts in built environments. Second, there may be subtle cultural differences between residents of different regions in Africa that lead to different perceptions of neighborhood environments. For example, validity evidence was better in East African Uganda but poor in West African countries of Ghana and Nigeria. It is difficult to examine cultural differences in perceptions, but this could be an important research direction that could help explain inconsistencies in findings across African countries. Third, most countries recruited participants from a single city (e.g., urban or semiurban areas) with limited environmental variation (e.g., few good sidewalks and crosswalks or just informal paths). Thus, there may not have been enough environmental variation to allow associations to be detected. Fourth, environmental infrastructures conducive for people to walk for transport in Western developed countries may not be perceived as important for individuals in Africa where walking for transportation is often a necessity rather than choice. However, previous studies in Nigeria (21,24) and findings in the present study (for South Africa and Uganda) provide some support that environmental attributes such as proximity to recreation facilities, connectivity, pedestrian infrastructures, and overall walkability of neighborhoods could have relevance for recreational walking of adults in Africa. Fifth, the simplest explanation for limited evidence of validity in each country was the small sample sizes that reduced statistical power.

A strength of the present study was that it was a multicountry study conducted using standardized data collection methods to evaluate an instrument designed specifically for use in sub-Saharan Africa. The present study also used a robust analytical method, which allowed us to examine not only the direction of associations, but also the effect sizes. This is one of the few studies from Africa documenting the psychometric properties of built environment measures and the first to explore the relationships of built environment variables with physical activity across several sub-Saharan African countries. The study also had some limitations. The cross-sectional design means that causal relationships cannot be determined. A second limitation was the use of self-reported physical activity as the criterion measures to determine construct validity of NEWS-Africa. Self-reported measures are prone to measurement bias, recall problems, and inaccurate estimates of physical activity intensities. However, objective measures of physical activity such as accelerometers or pedometers do not provide information on the domain of activity, and environments are expected to have domain-specific associations (30). Third, although participants were purposely recruited from areas that differed in walkability and SES, the nonrepresentative nature of the sample could limit generalizability of the findings. Fourth, social support, self-efficacy, car availability, education, and gender have been shown to be related to travel behaviors (2,3,12). These variables have been suggested as potential moderators of the relationships between walkability and physical activity (11,37), but such moderating influences were not explored in the present study. Thus, it is important that future African studies examine the moderating influence of sociodemographic, behavioral, and psychosocial factors on neighborhood environment–physical activity associations.

CONCLUSIONS

Of 14 NEWS-Africa scales, 7 were related to reported walking behavior in the pooled analyses, providing initial support for the construct validity of the NEWS-Africa instrument. Most notably, the overall walkability index was related to walking for both transportation and leisure purposes, whereas findings with single attributes were inconsistent, suggesting that the pattern of neighborhood built environments may be most relevant for facilitating walking

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among adults in sub-Saharan Africa. Although the direction of associations of NEWS-Africa scores with physical activity was generally similar to studies from Western countries, effect sizes were smaller. There is adequate evidence of reliability (23) and construct validity to justify further evaluation of NEWS-Africa toward understanding the role of built environments in the physical activity and health of Africans, but additional questions remain to be answered. It is unclear whether NEWS-Africa is similarly relevant for urban, periurban, and rural areas. It would be useful to explore additional summary scores to identify patterns of environmental variables of most relevance for Africa. Further study of the validity of NEWS-Africa in specific countries is needed with larger samples and careful attention to assuring the environments studied represent the full range of variation in that country. The present study provides initial evidence that built environments are related to physical activity of African adults, so further studies are needed to define activity-supportive environments that can be recommended as partial solutions to the growing epidemics of NCD in sub-Saharan Africa (40).

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The authors declare that the results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation. Results of this study do not constitute endorsement by the American College of Sports Medicine.

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