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Psychometric properties of the newly developed self-report environmental determinants of health questionnaire (EDH-Q): development and validation

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Abstract

Background The environmental determinants of health (EDH) have a significant impact on people's physical, mental, and social wellbeing. Everyone needs access to environmental resources of all types, including food, materials, and energy, to survive. Currently, no valid and reliable instrument exists for evaluating individuals' perceived levels of EDH. Hence, the purpose of this study was to develop and validate the environmental determinants of health questionnaire (EDH-Q) among undergraduate students in Nigeria.

Method We conducted a cross-sectional survey among undergraduate students in Nigeria to assess the psychometric properties of the newly developed Environmental Determinants of Health Questionnaire (EDH-Q). Respondents were selected using a convenience sampling approach to evaluate their perceptions of environmental determinants of health. The Content Validity Index (CVI) and Face Validity Index (FVI) were calculated to ascertain the scale's content validity and response process validity, respectively. Additionally, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), composite reliability (CR), average variance extracted (AVE), Cronbach's alpha, and intraclass correlation coefficient (ICC) were computed to assess the scale's construct validity.

Results The study involved 300 respondents in the EFA (males 55.7%, females 44.3%) and 430 respondents in the CFA (males 54.0%, females 46.0%). In the EFA, two constructs were identified (the natural environment and the built environment). The EFA model was able to explain 63.57% of the total cumulative variance, and the factor correlation was 0.671. The whole scale Cronbach's alpha value was 0.947, while the two constructs' Cronbach's alpha values were 0.918 (natural environment) and 0.935 (built environment). In the CFA, six pairs of error covariances were included between items within the same construct to improve the fit indices of the initial proposed measurement model. The final re-specified measurement model showed that the EDH-Q, which has two constructs and 18 items, has adequate construct validity (CFI = 0.948, TLI = 0.938, SRMR = 0.046, RMSEA = 0.052, and RMSEA p-value = 0.344). The CRs were 0.845 (natural environment) and 0.854 (built environment). The ICCs were 0.976 (natural environment) and 0.970 (built environment).

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Conclusion The results show that the newly created EDH-Q has sufficient construct validity and may be utilized to assess participants' perceptions of their level of EDH. Researchers should examine this instrument in populations with different age ranges and other demographic characteristics, as the present study only applied it to undergraduate students who may share similar characteristics.

Keywords Environmental determinants of health, Questionnaire, Validity, Reliability, Construct

Background

The environment has a significant influence on our physical, mental, and social well-being [1]. Every one of us is supported by numerous environmental resources that originate in or are somehow derived from the environment, including food, materials, and energy [2, 3]. We absolutely require those resources to live [4]. The environment not only influences human life, but it can also have an impact on a population's health and quality of life [4]. Overall, environmental factors account for 25–33% of the world's disease burden [5, 6]. Thus, the dramatic changes in health conditions and the rise of new diseases demand new approaches to implementing environmental health policies [5].

The term "environmental determinants of health (EDH)" refers to a set of factors that encompass both objective and subjective aspects of the environment [7, 8]. These include air and water quality, noise levels, access to green spaces, neighbourhood safety, and exposure to environmental hazards such as pollution or toxins [9]. Subjective environmental aspects refer to individuals' perceived assessments or beliefs regarding the quality, safety, and influence of their surroundings on their overall well-being [10, 11]. Acknowledging and understanding individuals' perceptions of their environment is crucial for promoting holistic health and establishing supportive environments conducive to well-being across various dimensions [10, 11].

Over time, researchers have delved into exploring the impact of environmental determinants on the health and well-being of university students [12–15]. Researchers often focus on this group for studying these issues because they view them as future decision-makers and can easily reach them for surveys [14]. Movements like Friday for the Future or School Strikes for Climate show that there has been a noticeable increase in environmental sensitivity among young people, particularly students [16]. Some research suggests that individuals aged 18–24 may exhibit less concern about the environment and show reluctance to adopt pro-environmental behaviors, even when they express concern [17]. Consequently, this led to a growing acknowledgment of the necessity of addressing environmental determinants among university students through a holistic approach [12].

Recent studies have also focused attention on the influence of pollution and indoor air quality on university students' well-being [18–20]. Poor air quality can contribute to respiratory problems and other health issues among students, particularly those with underlying health conditions [20, 21]. Social, and cultural factors within the university setting, such as support networks and stress levels, significantly impact students' health outcomes [12, 14]. Understanding these environmental determinants is critical in order to develop effective interventions and strategies aimed at fostering a healthier university environment [12]. This entails enhancements in energy efficiency, waste management, transportation, and the implementation of green infrastructure [4, 22, 23]. Nigeria, characterized by its multiculturalism with over 250 ethnic groups, hosts a vast educational landscape comprising 570 tertiary institutions [24]. These institutions, beyond their roles as centres for teaching and research, bear the crucial responsibility of instigating and fostering societal change, thus significantly contributing to the advancement and evolution of communities [24].

The rapid population growth in Nigeria has spurred a multitude of environmental challenges, encompassing issues such as air and water pollution, inadequate solid waste management, urban poverty, desertification, wind erosion, flooding, and climate change [25, 26]. Factors such as urban expansion, road construction, reliance on biomass for cooking, utilization of wood in various constructions, and industrial activities have primarily depleted over 70% of Nigeria's forest cover [27]. These activities contribute to deforestation, habitat loss, and alterations in microclimates. Particularly in the northern Sahel-Savannah region, deforestation has intensified desert encroachment and sandstorms, further exacerbating air pollution and respiratory health issues [25].

Schulz and Northridge [8] developed the "Social Determinants of Health and Environmental Health Promotion" model, which outlines three main domains: the natural environment (involving topography, climate, and water supply), macrosocial factors (encompassing historical circumstances, political and economic systems, and principles of human rights), and inequalities (addressing the distribution of wealth, employment and educational opportunities, and political influence). These domains contain foundational components that impact two intermediate factors: the built environment (covering land use, transportation systems, and structures) and the social context (encompassing community investment, public and fiscal policies, and civic engagement). These factors, in turn, interact to influence proximate factors,

such as stressors (including violent crime, financial insecurity, and environmental pollutants) and social integration and support (comprising the structure of social networks and the resources available within them). This intricate interplay ultimately shapes the health and well-being of both individuals and populations [8]. Therefore, this model served as the basis for identifying key constructs, their interrelationships, and relevant variables.

Moreover, researchers have recently recognized EDH as a crucial component of holistic health [4, 28]. However, to date, there are no valid and reliable instruments to assess, both quantitatively and qualitatively, the EDH. Existing instruments predominantly focus on measuring certain environmental risk factors associated with EDH, including the Environmental Health Risk Perception Questionnaire [29], the Urban Traffic-Related Determinants of Health Questionnaire (UTDHQ) [30], the Neighbourhood Environment Walkability Scale (NEWS) [31], and the Physical Environment for Physical Activity Scale [32]. Hence, the aim of the present study is to develop the Environmental Determinants of Health Questionnaire (EDH-Q) using the conceptual model of social determinants of health and environmental health promotion [8]. Subsequently, the study seeks to determine the psychometric properties of the EDH-Q among university undergraduate students in Nigeria.

Methods

Study Design

The study was a cross-sectional survey conducted between April 2023 and June 2023.

Participants

The study involved separate groups of 300 undergraduate students (for the exploratory factor analysis, EFA) and 430 undergraduate students (for the confirmatory factor analysis, CFA) enrolled in the College of Medicine and Allied Medical Sciences at Federal University Dutse, Nigeria (FUD). These participants were selected due to their higher likelihood of familiarity with and comprehension of the fundamental concepts and constructs under assessment. Participants possessing a certain level of familiarity with a particular scale enhance its construct validity, ensuring that it accurately measures its intended variables [33]. In addition, in Nigeria's public universities, students come from diverse regions across the country, reflecting the nation's rich cultural and ethnic tapestry [34]. Universities thus attempt to preserve balance in the student body by admitting applicants from various states and areas in an effort to foster inclusivity and diversity [34]. Therefore, the present study sample reflects the diverse regional representation.

Instrument

The study instrument consists of two sections. The first section involves demographic information, including age, gender, ethnicity, field of study, study year, frequency of exercise, and duration of exercise. We presented information about the students' physical activity level in order to provide some information about their lifestyles. The second section included questions that assessed participants' perceptions of EDH.

Sampling technique

The researchers used a convenience sampling method to recruit participants from the College of Medicine and Allied Medical Sciences, FUD, because it is more accessible, easier, and cost-effective, making it suitable for exploratory studies, pilot studies, or preliminary investigations where the primary goal is to gain initial insights or generate hypotheses [35]. Participants were provided with the Google Form link to complete the survey. Google Forms are a popular option for many types of research and surveys because they provide a practical, adaptable, and affordable way of collecting data and reducing response bias [36].

Inclusion and exclusion criteria

Students from the College of Medicine and Allied Medical Sciences; undergraduate students who were in their first to final year; registered students during the data collection period; and those who gave consent to participate. All foreign students were excluded.

Ethical approval

Prior to the commencement of the study, the Human Research Ethics Committee, Ministry of Health, Jigawa State, Nigeria granted ethical approval [JGHREC/2023/151], and the study was carried out in conformity with the Helsinki Declaration.

Construct definition

The natural environment encompasses elements such as physical, chemical, or biological pollutants (or enhancers) present in the air, water, soil, or biota. Conversely, the built environment encompasses all structures, areas, and products that have been created or substantially modified by humans [8].

Items generation

Based on the conceptual model of "Social Determinants of Health and Environmental Health Promotion" developed by Schulz and Northridge [8], the researchers generated the items for the present study. The initial creation of the EDH-Q involved consulting additional literature, which incorporated information from the European environmental questionnaire for physical activity

participation [37] and the Meikirch model of health [4]. Subsequently, we sought content ideas from experts with experience in health psychology, psychometrics, public health, and questionnaire development. Also, an in-depth interview with 12 undergraduate students was conducted to generate more information on the topic. In the initial stage of development, the items were generated based on two (2) hypothesized factors: the natural environment (8 items) and the built environment (10 items). However, a total of 72 items were created (18×4), making four alternative options for each item. Subsequently, five experts in the relevant fields assessed these items to determine the optimal 18 items (i.e., one item from each set of four), and the authors formulated a draft of 18 items through consensus. This process is just to ensure the items are clear and written in standard English before proceeding to content analysis. All the items were evaluated using a five-point rating ranging from 1 (strongly disagree) to 5 (strongly agree).

Content validity

We determined the content validity by inviting six experts from the fields of health psychology (2 experts), public health (2 experts), and questionnaire development (2 experts) to evaluate the relevance of each item to its respective domain. Through a Google Form, these experts evaluated the relevance of each item to its designated domain, providing ratings based on four options: (1) not relevant, (2) somewhat relevant, (3) quite relevant, and (4) highly relevant. The Item Content Validity Index (I-CVI) and Scale Content Validity Index (S-CVI) were calculated in accordance with recommended guidelines [38–40]. Relevance ratings were recoded as either 1 (indicating the item is quite relevant or highly relevant) or 0 (indicating the item is not relevant or somewhat relevant). The I-CVIs were determined by calculating the proportion of content experts who rated items as 1 for relevance. S-CVIs were calculated by averaging the I-CVIs for all items within each domain. Finally, the Scale Content Validity Index for Universal Agreement (S-CVI/UA) was determined by calculating the proportion of items on the scale that received a rating of 1 from all experts.

Face validity

We assessed face validity by randomly selecting 10 students using a simple random sampling method from a compiled list of registered students at the College of Medicine and Allied Medical Sciences, FUD. Through a Google Form, these students evaluated the degree of clarity and comprehension of each item, providing ratings based on four options: (1) not clear and understandable, (2) somewhat clear and understandable, (3) clear and understandable, and (4) very clear and understandable. The Item Face Validity Index (I-FVI) and Scale Face Validity Index (S-FVI) were calculated in accordance with recommended guidelines [41, 42]. The relevance rating was recoded as 1 (the item is clear and understandable, or the item is very clear and understandable) or 0 (the item is not clear and understandable, or the item is somewhat clear and understandable). The I-FVIs were determined by calculating the proportion of students who rated items as 1 for relevance. S-FVIs were calculated by averaging the I-FVIs for all items within each domain. Finally, the Scale Face Validity Index for Universal Agreement (S-FVI/UA) was determined by calculating the proportion of items on the scale that received a rating of 1 from all students.

Sample size

For EFA, the minimum recommended sample size is 100–250 [43]. In the current study, we initially set the minimum sample size for EFA at 200. We added 30% for missing values; the adjusted sample size was 286. Therefore, we rounded the sample size to a total of 300 for the EFA. Also, according to Tabachnick and Fidell [35], the acceptable sample size for EFA is 300. For CFA, the recommended minimum sample size for seven or fewer constructs should be 300 [36]. Therefore, in the present study, we set the sample size for CFA at 300. We added 30% for missing values; the adjusted sample size was 430.

Data analysis

There were 300 participants in the EFA sample. Principal axis factoring with Promax rotation was used to test the 18 completed items on the EDH-Q scale in order to identify the primary contributing factors. When anticipating a theoretical rationale for correlated factors, EFA may employ Promax rotation [44]. Additionally, it facilitates closer alignment of the hypothesized model with established theories or expectations [44]. After investigating the factors with eigenvalues greater than one, those with factor loadings greater than 0.40 were deemed to be statistically relevant and kept for further CFA [45, 46].

With 430 participants, the CFA was applied to further test the EFA model. For the purposes of the current study, the recommended factor loading of equal to or greater than 0.40 was applied as the threshold for maintaining or removing an item [47]. The acceptable fit indices for a sample size greater than 250 with 12 items and higher were: comparative fit index (CFI) or Tucker and Lewis index (TLI) greater than 0.94; standardized root mean square residual (SRMR) less than 0.08; and root mean square error of approximation (RMSEA) less than 0.07 [48]. In order to improve the model fit indices, the model was re-specified based on the CFA modification index after taking adequate theoretical guidance into account [48].

In CFA, evaluating construct validity among item measures involved assessing convergent validity and discriminant validity. Convergent validity quantifies the extent to which items within a particular construct share variance [49]. According to Hair et al. [49], factor loadings, average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha were among the several ways available for estimating the relative amount of convergent validity. For AVE and CR, respectively, the acceptable cut-off values were equal to or greater than 0.50 and 0.70 [45–47]. If the AVE values are less than 0.50 but the CR values are above 0.60, construct validity is still considered acceptable [50]. Furthermore, discriminant validity refers to the extent to which a factor is distinct from other factors and can be examined by investigating the correlations between the factors in the models [46]. A correlation coefficient of 0.85 or less between two factors was considered sufficient for discriminant validity [46]. Also, Fornell and Larcker [51] noted that the AVE of the constructs must be greater than the squared of the correlation coefficient (i.e., the shared variance between the factors) for discriminant validity to be confirmed.

Additionally, Cronbach's alpha was computed to determine the internal consistency of the EDH-Q; for each factor, an acceptable Cronbach's alpha value of 0.60 or above was considered acceptable [45]. In order to assess test-retest reliability, a sub-sample of 70 respondents completes the EDH-Q questionnaire twice over a period of 7 days. An intra-class correlation coefficient (ICC) was computed using a two-way mixed effects model, and a value greater than 0.70 indicates sufficient test-retest reliability [52].

The Statistical Product and Service Solution (SPSS) version 27.0 (IBM, Armonk, NY, USA) was used for EFA, Cronbach's alpha, and ICC. Mplus 8 was used for CFA, CR, and AVE. For this study's CFA, we used the MLR Estimator because of its robustness to non-normal data distributions [53].

Table 1 General Characteristics of the Respondents in EFA and CFA ($n=730$)

	EFA (300)		CFA (430)	
Variables	**Mean (SD)**	***n* (%)**	**Mean (SD)**	***n* (%)**
Age	21.1 (3.00)		22.4 (2.43)	
Frequency of exercise/week	4.1 (2.25)		3.4 (2.12)	
Duration of exercise (min)	46.2 (37.42)		46.2 (52.01)	
Gender				
Male		167 (55.7)		232 (54.0)
Female		133 (44.3)		198 (46.0)
Ethnicity				
Hausa		212 (70.7)		305 (70.9)
Yoruba		31 (10.3)		45 (10.5)
Igbo		11 (3.7)		6 (1.4)
Others		46 (15.3)		74 (17.2)
Field of study				
MBBS		131 (43.7)		229 (53.4)
Human anatomy		109 (36.3)		118 (27.5)
Human physiology		60 (20.0)		82 (19.1)
Study year				
Year 1		131 (43.7)		16 (3.7)
Year 2		51 (17.0)		14 (3.3)
Year 3		5 (1.7)		301 (70.0)
Year 4		113 (37.7)		99 (23.0)

Note n=number, SD=standard deviation

Results

Content validity

All six experts provided responses, resulting in a 100% response rate. For the I-CVIs, all items received uniform ratings of 1.00. Similarly, the S-CVI and the S-CVI/UA were 1.00 for both the natural environment and the built environment domains, respectively. Therefore, the EDH-Q demonstrates sufficient content validity [40].

Face validity

All 10 selected students provided responses, resulting in a 100% response rate. The I-FVIs for all the items ranged from 0.90 to 1.00. The S-FVI were 0.99 (natural environment) and 1 (built environment), and the S-FVI/UA were 0.88 (natural environment) and 1 (built environment). Therefore, the EDH-Q demonstrates sufficient face validity [42].

General characteristics of the respondents

The general characteristics of the study respondents' for the EFA and CFA samples are shown in Table 1. The study consisted of 300 participants (in the EFA) and 430 participants (in the CFA), with no missing values. In the EFA, males make up 55.7% and females make up 44.3%. The mean age was 21.1 (SD=3.00). The mean weekly exercise frequency and exercise duration were 4.1 (SD=2.25) and 46.2 (SD=37.42), respectively. The majority of the students (70.7%) were Hausa, and 43.7% were studying medicine. In addition, 44.7% of the students were in Year 1. In the CFA sample, the mean age was 22.4 (SD=2.43), with males making up 54.0% and females making up 46.0%. The mean weekly exercise frequency and exercise duration were 3.4 (SD=2.12) and 46.2 (SD=52.01), respectively. The majority of the students (70.9%) were

Hausa and 53.4% were studying medicine. In addition, the majority (70.0%) were in Year 3.

EFA results of the EDH Scale

The estimated Kaiser-Meyer-Olkin (KMO) value of the EFA model of the initial EDH-Q with 18 items was 0.937, and the Bartlett's test of sphericity was significant (p-value < 0.001). As a result, the model is considered to have sufficient validity. In the initial EFA model, three factors exhibited eigenvalues exceeding 1; however, the items demonstrated satisfactory factor loadings on only two of these factors. Thus, in accordance with the hypothesized structure of the EDH-Q, the number of factors was fixed at two in the subsequent stage. Two factors were obtained via Promax rotation and Principal Axis Factoring. The results indicate that the two factors displayed factor loadings exceeding 0.40, with no instances of cross-loadings. The factor correlation was 0.671, and the cumulative percentage was 63.5%. Consequently, all items were retained in the final EFA, as shown in Table 2. Figure 1 displays the scree plot.

CFA results of the EDH Scale

The EFA measurement model was further tested using CFA with an independent sample of 430 students with 18 items and two factors: the natural environment (8 items) and the built environment (10 items). The results of model 1 show that the fit indices were not satisfactory (Table 3). However, all the items had a factor loading greater than 0.40 (Fig. 2). After including six pairs of error covariances between items belonging to the same factor, the model fit indices were enhanced (Fig. 3). The respecified model's (Model-2) fit indices were satisfactory (Table 3), and none of the items were removed from the model. The final model's (Model-2) results revealed acceptable factor loadings that ranged from 0.422 to 0.806 and were regarded as moderate to very good (Fig. 3).

Composite Reliability (CR), average variance extracted (AVE), and Discriminant Validity

The CRs for natural and built EDH, respectively, were 0.845 and 0.854. The AVEs for natural and built EDH, respectively, were 0.449 and 0.436. Though the AVE values were below the recommended cut-off of 0.50, the EDH-Q is considered to have adequate convergent validity given that all the CR values were above 0.60 [51]. The two factors have a correlation coefficient of 0.193. Additionally, the squared correlation coefficient between the factors (0.037) is lower than all the AVE values. This shows adequate discriminant validity [51]. Table 4 displays the CR, AVE, correlation coefficients, and squared correlation coefficient for the final EDH-Q model. The EDH-Q development process is presented in Fig. 4.

Table 2 Items Descriptive Statistics, Exploratory Factor Analysis, and Reliability Analysis ($n = 300$)

Item content	Mean (SD)	Item-total correlation	Factor loading	
Natural environment			1	2
The weather is always favourable	2.52 (1.11)	0.574	0.570	
There is assistance available during extreme weather	2.47 (1.13)	0.638	0.580	
There is always clean and available drinking water	3.06 (1.22)	0.762	0.804	
I always have access to clean drinking water	3.37 (1.25)	0.768	0.841	
Fresh and heathy foods are always available	3.33 (1.24)	0.787	0.796	
I can always afford fresh and healthy foods	3.29 (1.26)	0.791	0.848	
There is always fresh air without any sign of pollution.	2.89 (1.30)	0.720	0.745	
The workplaces are extremely safe	3.25 (1.16)	0.772	0.782	
Built environment				
There is appropriate land use protection for residential purposes in my neighbourhood	3.23 (1.19)	0.716		0.628
There is appropriate land use protection for industrial purposes in my neighbourhood	3.08 (1.14)	0.679		0.634
The public and private transport systems are always convenient and reasonably priced	3.06 (1.21)	0.769		0.731
There are sufficient locations to make purchases, including markets and shops	3.46 (1.16)	0.672		0.660
There are sufficient banks and other locations for cash transactions	3.38 (1.15)	0.724		0.767
There are sufficient healthcare facilities in my neighbourhood	3.09 (1.17)	0.784		0.823
In my neighbourhood, waste products are disposed of properly.	2.89 (1.23)	0.727		0.742
Public resources like parks, museums, and libraries are available for use	3.08 (1.28)	0.721		0.839
The quality of the dwelling environment is good in my neighbourhood	3.30 (1.11)	0.800		0.813
The quality of the school environment is good in my neighbourhood	3.36 (1.15)	0.806		0.813
Eigenvalue			9.50	1.95
Variance explained (%)			52.75	10.82
Cumulative variance (%)			52.75	63.57
Cronbach's alpha			0.918	0.935

SD = standard deviation, Factor correlation = 0.671

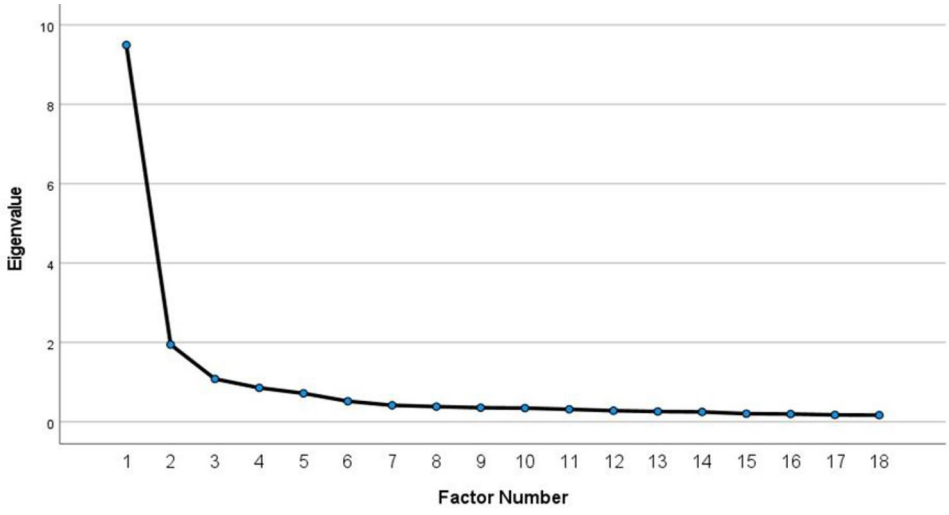

Fig. 1 The Scree Plot of Exploratory Factor Analysis (EFA)

Table 3 Summary for EDH-Q Model fit indices ($n=430$)

Path model	RMSEA (90% CI)	CFI	TLI	SRMR	RMSEA *P*-value
Model-1	0.084 (0.077, 0.092)	0.857	0.836	0.059	< 0.001
Model-2	0.052 (0.044, 0.060)	0.948	0.938	0.046	0.344

Model-2 with six correlated items residual: EDH10 with EDH9; EDH13 with EDH12; EDH2 with EDH1; EDH18 with EDH17; EDH14 with EDH13; EDH8 with EDH7

Test-retest reliability

The mean score for the natural EDH dropped from 24.9 (SD = 5.50) on day 1 to 24.4 (SD = 5.56) on day 7, with an ICC value of 0.976 (95% CI: 0.961, 0.985, p-value < 0.001). The mean score for the built EDH was 31.3 (SD = 6.09) on day 1 and 31.3 (SD = 5.89) on day 7, with an ICC value of 0.970 (95% CI: 0.951, 0.981, p-value < 0.001).

Discussion

Environmental health has been described as the area of public health that addresses all external physical, chemical, and biological parameters that affect a person's health and quality of life, as well as any associated factors that have an impact on behaviors [5, 54]. The built and natural environments are increasingly being recognized as fundamental health determinants by public health and planning professionals [22]. Hence, in the present study, we developed a brief self-report measure for evaluating the perceived level of EDH comprising two factors (natural environment and built environment) among university undergraduate students. The EDH-Q had five rating options, ranging from 1 (strongly disagree), 2 (disagree), 3 (somewhat agree), 4 (agree), and 5 (strongly agree). At the macro level, the natural environment reflects essential factors, including natural resources [8]. At the level of the community, the built environment reflects physical factors that safeguard and support chances for a living, good health, and sustainable development [8].

In the present study, the perceived natural environment encompasses physical exposures such as extreme weather conditions, the quality and accessibility of drinking water and food, exposure to air pollutants, and ensuring a secure work environment. On the other hand, the perceived built environment includes an evaluation of diverse factors such as housing, land use, infrastructure, transportation, public spaces, schools, and healthcare facilities. Previous studies indicated that perceived environmental health refers to individuals' subjective evaluations or opinions concerning the quality, safety, and influence of their immediate surroundings on their holistic well-being [10, 11, 21]. Individuals' assessments of environmental cleanliness, safety, and susceptibility to environmental risks can have a direct bearing on their physical health. Moreover, perceptions of poor air quality, contaminated water sources, and exposure to pollutants or toxins can exacerbate respiratory ailments, cardiovascular conditions, and various other health concerns, thereby affecting overall quality of life [4, 10].

Research on school facilities has revealed that environmental comfort factors profoundly influence the learning process [55]. Undoubtedly, the physical learning environment significantly shapes students' learning outcomes and motivation, influencing their willingness to engage actively in academic activities [56]. Moreover, recent studies have integrated the subjective aspect, considering students' perceptions regarding classroom attributes and their potential impact on performance or satisfaction [11]. For instance, Brink and Loomans [57] explored student perceptions of higher education classrooms and elucidated how classroom attributes affect both student satisfaction and performance.

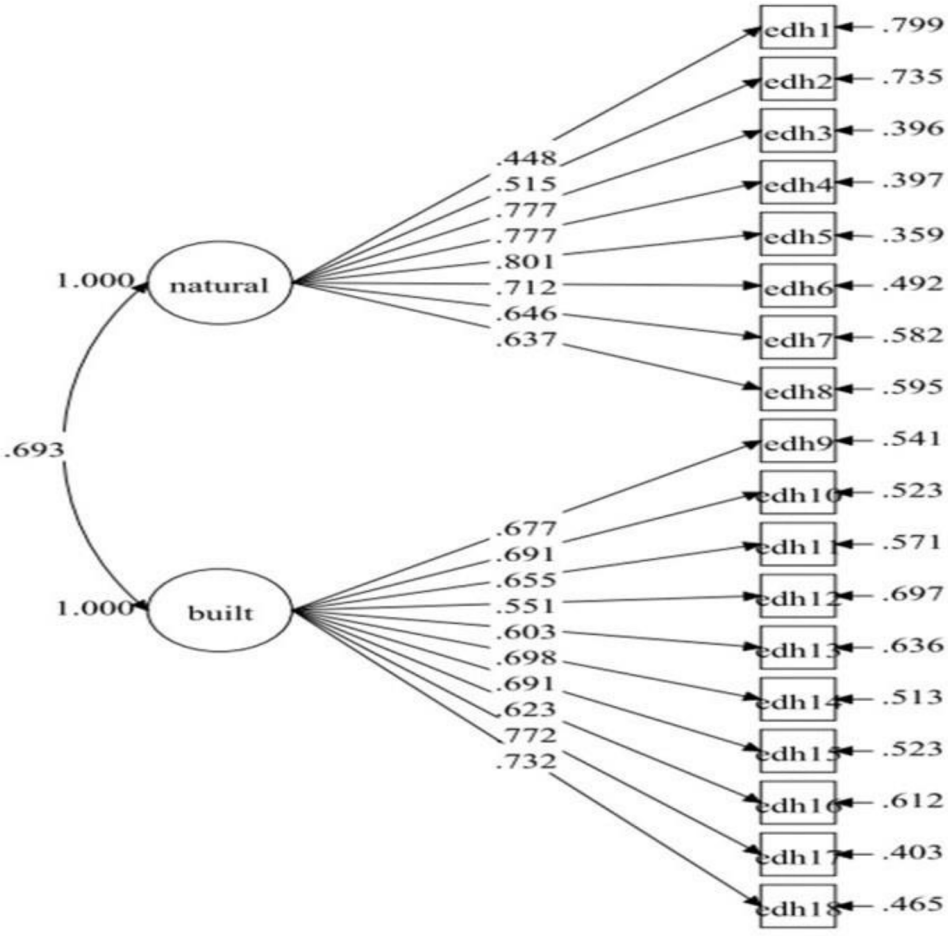

Fig. 2 EDH-Q measurement (Model-1)

The results of content validity reveal that the I-CVIs and S-CVIs of all 18 items were 1. For face validity, the results reveal that the I-FVI values ranged from 0.90 to 1, and the S-FVIs were 0.99 and 1. These results indicate sufficient content validity and face validity [40–42]. Further, two separate samples of undergraduate students—mostly adolescents—were used to test the EDH-Q for EFA (300 respondents) and CFA (430 respondents). The development of economies across countries and the general well-being of the population depend on how these environmental determinants affect adolescents health [23, 58]. This is because there is a strong correlation between health and health behaviors throughout adolescence and adulthood. The transition from adolescence to adulthood also has an impact on the way individuals develop in regard to their well-being and quality of life. The environmental and financial factors that exist in each nation have an impact on these changes [59].

In the EFA, two factors (natural environment and bult environment) were identified (KMO = 0.937; p-value < 0.001), containing all 18 items with satisfactory factor loadings (above 0.50) on their respective constructs. The EFA model was further tested using the CFA. The final model showed adequate fit indices, and all the items had sufficient factor loading on their respective constructs. The two constructs had acceptable internal consistency, composite reliability, and discriminant validity. Overall, the results show that the EDH scale has sufficient psychometric properties and may be used to evaluate individuals perceived environmental determinants of health [46–48, 50]. In addition, six pairs of error covariances were included in the final model (2 for the natural environment and 4 for the built environment) after taking enough theory into account. These residual covariances were added by referring to the MI values reported in the Mplus output. In social psychology, residual covariances can be added to the model when they have a significant meaning [60].

The present study is not without some limitations. First, given that the survey was carried out at one university, it is essential to tread cautiously when drawing inferences from the results. However, the size of the sample might give the study's findings and conclusions more weight. Second, using a self-reported survey may

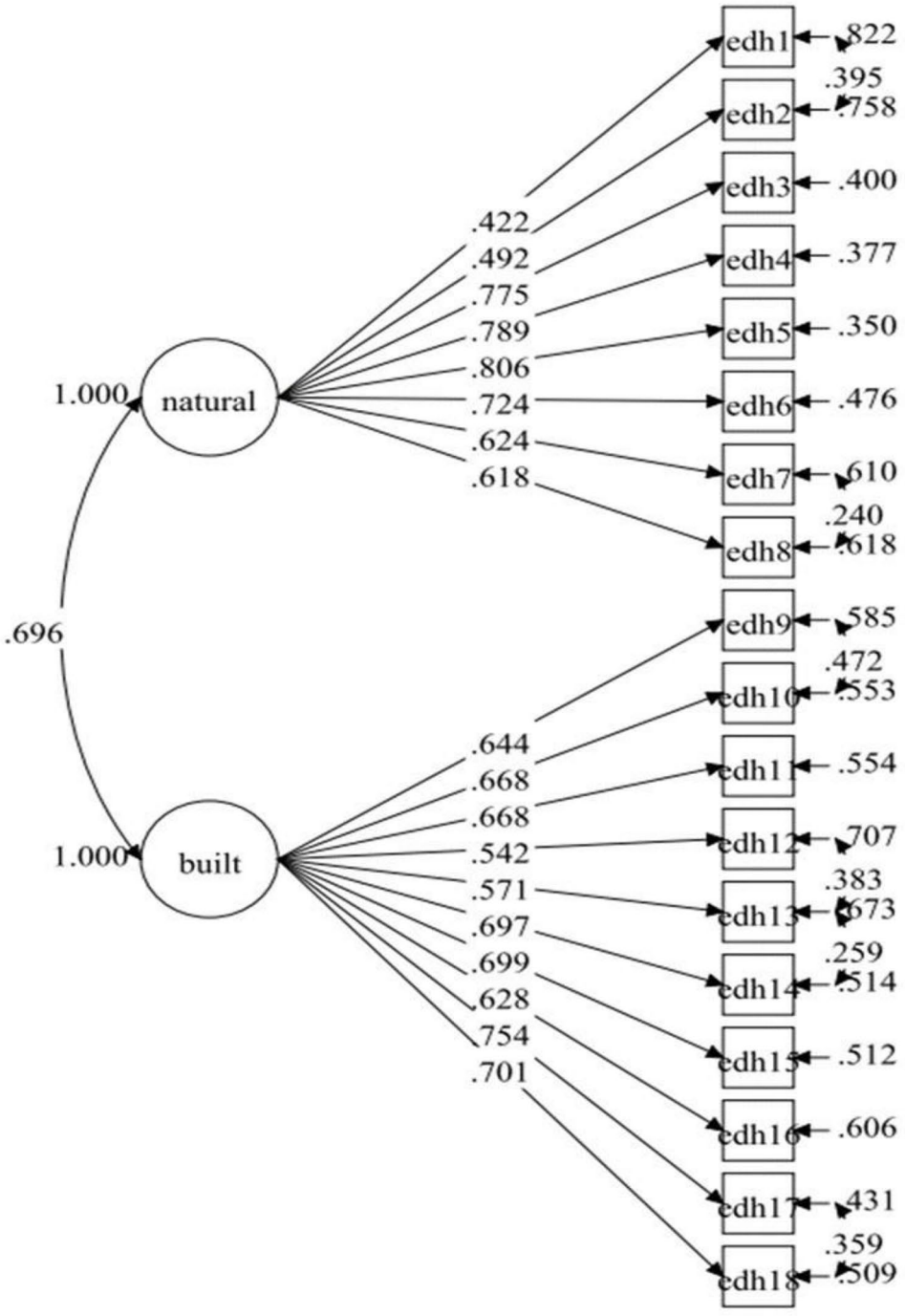

Fig. 3 EDH-Q measurement (Model-2)

Table 4 Composite reliability (CR), average variance extraction (AVE), factor correlation and squared correlation for EDH-Q final model

Construct	CR (95% CI)	AVE	1	2	r^2
Natural	0.845 (0.820, 0.870)	0.449	1	0.193	0.037
Built	0.854 (0.829, 0.879)	0.436			1

result in response bias and reduce the accuracy of the data collected. To address this issue, all participants were assured that their information would be kept private and were advised to respond to all of the questions accurately and truthfully, as well as avoid discussing the survey with their friends. Thirdly, we employed a convenience sample method to select the study participants, which may have limitations inherent to this sampling approach.

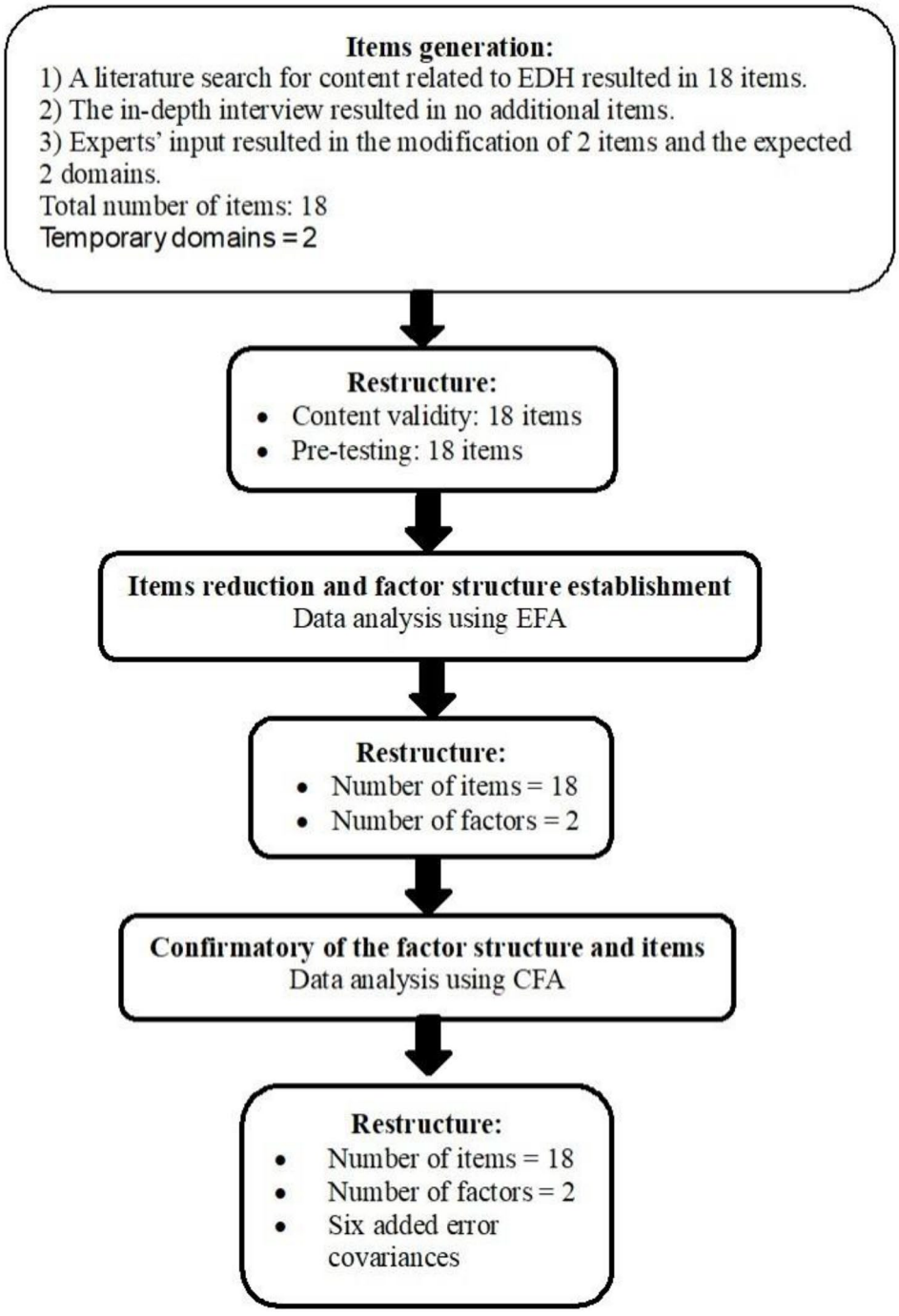

Fig. 4 Summary of questionnaire development process

Furthermore, the study's focus on undergraduate students only limits the generalizability of its findings to the general population. Researchers should conduct future studies to test the EDH-Q in a more diverse population with diverse sociodemographic characteristics.

Conclusions

The aim of this study was to create a new self-report instrument for evaluating perceived environmental determinants of health (EDH) among Nigerian undergraduate students. The final results provide psychometric evidence of the underlying structure, which consists of the natural environment and the built environment. Researchers and healthcare professionals can use the

EDH scale to determine an individual's EDH for easily accessible environmental support services and to direct service growth.

Abbreviations

FUD	Federal University Dutse
EDH	Environmental determinants of health
CSDH	Commission on social determinants of health
EFA	Exploratory factor analysis
CFA	Confirmatory factor analysis
CVI	Content validity index
FVI	Face validity index
KMO	Kaiser-Meyer-Olkin
CR	Composite reliability
AVE	Average variance extracted
ICC	Intraclass correlation coefficient

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Author contributions
Conceptualization: Y.C.K, G.K; Data curation: A.S, Y.C.K; Formal analysis: A.S, Y.C.K; Investigation: Y.C.K, G.K, S.A, H.S.K; Methodology: Y.C.K, G.K, S.A, H.S.K; Data collection: A.S Software: Y.C.K; Supervision: Y.C.K, G.K, S.A, H.S.K; Validation: Y.C.K, G.K, S.A, H.S.K; Writing original draft – A.S; Writing, review and editing – Y.C.K, G.K, S.A, H.S.K.

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Data availability
The dataset supporting the findings of this article is available from the corresponding author on request.

Declarations

Ethics approval and consent to participate
The Human Research Ethics Committee, Ministry of Health, Jigawa State, Nigeria granted ethical approval for the study [JGHREC/2023/151]. The participants were informed about the research aim and methods before signing the informed consent form. The investigation conforms to the principles outlined in the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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