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DEVELOPMENT AND VALIDATION OF AN INTEGRATED RISK-BASED ENVIRONMENTAL HEALTH ASSESSMENT FRAMEWORK FOR CHILDCARE FACILITIES IN NIGERIA

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ABSTRACT

Background: Children in childcare settings may be exposed to multiple environmental health hazards, yet these risks are often assessed separately. This study developed and validated an integrated, multidomain, risk-based environmental health assessment framework for childcare facilities in Nigeria.

Methods: An initial set of 91 indicators was refined through a three-round modified Delphi process with a 16-member multidisciplinary expert panel. The final 72-item instrument covered six domains. Domain weights were derived using the Analytic Hierarchy Process. Content validity was assessed using item-level and scale-level content validity indices. Internal consistency was evaluated using Cronbach's alpha, and inter-rater and test-retest reliability were assessed using intraclass correlation coefficients. The framework was piloted in 30 childcare facilities across six states or regions and urban, peri-urban, and rural settings.

Results: The final framework included Water, Sanitation and Hygiene, Food Safety, Structural and Physical Safety, Indoor and Outdoor Air Quality, Chemical and Toxicant Exposure, and Biological and Vector Hazards. Scale-level content validity was 0.94. Overall internal consistency was high (alpha = 0.91), while inter-rater and test-retest reliability were good (ICC = 0.89 and 0.86). Composite risk scores ranged from 20.4 to 66.7; 20.0% of facilities were Low risk, 36.7% Moderate, 30.0% High, and 13.3% Critical.

Conclusion: The framework demonstrated strong content validity and reliability and provides a structured approach for integrated environmental health risk assessment in childcare facilities.

Keywords: Childcare Facilities; Environmental Health; Risk Assessment; Delphi Method; Content Validity; Nigeria

1 INTRODUCTION

Children under five spend a large part of their waking day in out-of-home childcare, making the quality of these environments especially important. Their physiology also increases their vulnerability to environmental exposures. Compared with adults, young children eat, drink, and breathe more in relation to their body weight. They also spend more time close to floors and frequently place their hands or objects in their mouths, increasing contact with dust and surface contaminants. In addition, early childhood includes important developmental periods when organ systems may be more sensitive to harmful exposures [1]. Young children may not recognize a hazard, explain what happened, or move away from it, so their protection depends heavily on caregivers and the conditions of the facility. Relevant exposure pathways include inadequate water, sanitation and hygiene; unsafe food handling; structural and physical hazards such as falls, unsafe electrical installations, and unsafe play equipment; poor indoor and outdoor air quality; chemical and toxicant exposure; and biological and vector-borne hazards. Studies in U.S. childcare settings have documented measurable concentrations of phthalates [2], volatile organic compounds and particulate matter [3,4], and bisphenol-A and phthalates from plastic toys [5]. Variation in disinfection practices has also raised health concerns [6]. These findings show that the types of hazards addressed by this framework are measurable and relevant to child health.

In Nigeria, responsibility for environmental health oversight in childcare facilities is spread across several regulatory bodies, and there is no widely used standardized assessment tool. The Child's Rights Act 2003 [7] gives government authority to register and inspect child-minding premises. However, the Act only applies in a state after it has been domesticated by the state House of Assembly, and recent reviews indicate that about one-third of Nigeria's 36 states had not yet done so. As a result, inspection and enforcement capacity varies across the country. Similar gaps have been reported elsewhere. Reviews of U.S. childcare regulations, for example, found that most jurisdictions address physical safety, but relatively few regulate environmental toxicant exposures beyond lead [8,9].

Where inspection tools are available, they often focus on one area at a time. A food hygiene checklist, for example, may be used separately from a structural safety inspection. These tools also rarely account for the relative contribution of each domain to overall child health risk. This makes it difficult to compare facilities, decide where limited inspection resources should be directed, or measure improvement over time using a common score. Environmental health hazards also rarely occur in isolation. A facility's overall risk reflects the combined effect of conditions across several domains, and those conditions may sometimes reinforce one another. For this reason, a composite, multidomain, risk-weighted approach may provide a more realistic picture of the burden experienced by children and a stronger basis for prioritizing corrective action.

This study aimed to develop and validate an integrated, multidomain, risk-based environmental health assessment framework that can be used across the range of childcare settings found in Nigeria, including urban, peri-urban, and rural facilities, as well as private, public, faith-based, and community-managed facilities. The framework was designed with routine field use in mind. It needed to be scientifically defensible, but also practical for inspectors working with typical resource and training limitations.

1.1 Conceptual and Theoretical Framework

The framework is informed by two established environmental health models: the Source-Pathway-Receptor model and the World Health Organization's DPSEEA framework (Driving forces, Pressure, State, Exposure, Effect, Action) [10]. DPSEEA describes the pathway from broader driving forces and environmental pressures to the condition of the environment, human exposure, health effects, and possible actions. In this study, the 72 indicators focus mainly on the state and exposure stages because these are the conditions that can be observed and corrected most directly at the facility level.

Risk was defined as a function of how likely a hazard is to occur, how severe the health consequence could be, and how often or how long exposure may occur. Each of the 72 indicators is rated on the same 0 to 4 ordinal severity scale, where 0 indicates no observed concern and 4 indicates a critical concern. Item scores are then combined into domain and facility-level scores so that conditions can be compared using a common risk metric. The framework intentionally uses an integrated design because hazards in childcare settings often occur together. Water intrusion, for example, may create a physical safety problem while also contributing to mold and poor indoor air quality. Limited WASH infrastructure may increase both hygiene-related and biological or vector-related risk. Research in U.S. childcare settings has also shown that facility-level conditions can cluster and respond together to intervention [11]. Looking at each domain separately can therefore miss the broader pattern of risk within a facility.

The framework organizes indicators into six domains:

- Water, Sanitation & Hygiene (WASH)
- Food Safety / Handling

- Structural & Physical Safety
- Indoor & Outdoor Air Quality
- Chemical & Toxicant Exposure
- Biological & Vector-Borne Hazards

A seventh, psychosocial/ergonomic domain was considered during framework development but was not retained in the final instrument (see Section 3 and Section 7).

2 MATERIALS AND METHODS

2.1 Indicator Generation

The initial pool of indicators was developed by reviewing international guidance and assessment tools for childcare and school environmental health, including materials from WHO, EPA, and CDC. Nigerian regulatory provisions were also considered, particularly the child-minding registration and inspection requirements in the Child's Rights Act 2003 [7]. The peer-reviewed literature on childcare-related environmental exposures was used to identify additional items [2-6]. Indicators were adapted to reflect conditions that are relevant in Nigeria, including intermittent water and electricity supply, differences in waste management access, tropical and humid conditions that affect mold and vector risk, and the local regulatory environment. This process produced an initial pool of 91 candidate indicators across six main domains, with a psychosocial/ergonomic domain also considered during early development.

2.2 Expert Consultation

A 16-member multidisciplinary expert panel was formed, with two representatives from each of eight disciplines: environmental health, pediatrics, public health research, childcare regulation, environmental toxicology, food safety, and epidemiology. The panel size and mix of disciplines are consistent with published Delphi studies, where panels in the mid-teens are common and multidisciplinary representation is considered an important feature of methodological quality [12]. The indicators were reviewed through three rounds of a modified Delphi process. In each round, panelists rated the indicators and provided structured feedback that was used to retain, revise, combine, or remove items. The process followed published recommendations for defining and reporting consensus in Delphi studies [13].

2.3 Indicator Weighting

Domain weights were established using the Analytic Hierarchy Process (AHP) [14]. Panel members compared the six domains in pairs based on their relative contribution to child health risk. The standard Saaty 1 to 9 comparison scale was used, and the pairwise judgments were converted into normalized domain weights. These weights, shown in Table 1, were then used to calculate each facility's composite risk score as a weighted combination of the six domain scores.

2.4 Scoring and Classification System Design

Each indicator is scored from 0 to 4, where 0 = none, 1 = minor, 2 = moderate, 3 = serious, and 4 = critical. A domain score is calculated by adding the item scores within that domain, dividing the total by the maximum possible score for the domain, and multiplying by 100. This produces a score from 0 to 100. The facility composite score is calculated by applying the AHP weights to the six domain scores and summing the weighted values. The final composite is also expressed on a 0 to 100 scale. Facilities are grouped into four risk categories: Low, Moderate, High, and Critical. These categories form the basis for the corrective-action timelines.

Table 1: Final domain structure and AHP-derived domain weights.

Domain	Final items	AHP weight
Water, Sanitation & Hygiene	14	0.20
Food Safety	12	0.17
Structural & Physical Safety	14	0.22
Indoor & Outdoor Air Quality	10	0.13
Chemical & Toxicant Exposure	10	0.15
Biological & Vector Hazards	12	0.13
Total	72	1.00

2.5 Validation

2.5.1 Content Validity

Content validity was assessed using the content validity index [15,16]. Each of the 16 panelists rated the relevance of every retained indicator on a 1 to 4 scale. The item-level content validity index (I-CVI) was calculated as the proportion of panelists who rated an item 3 or 4. The scale-level content validity index (S-CVI/Ave) was calculated as the average of the item-level values. For a panel of this size, an I-CVI of 0.78 or higher is commonly considered acceptable [15].

2.5.2 Face Validity

Face validity was considered during framework development because the instrument is intended for routine use by environmental health inspectors and other personnel assessing childcare facilities. Formal face validity assessment would ideally involve review by intended end users to determine whether the indicators are understandable, relevant to field conditions, and practical to score during routine inspections.

However, a structured end-user face validity assessment was not available in the dataset used for the present validation study. Face validity should therefore be evaluated formally in a subsequent field application involving environmental health inspectors and childcare facility operators. Such an evaluation should assess item clarity, relevance, ease of use, scoring interpretation, administration time, and perceived feasibility of incorporating the instrument into routine inspection practice.

2.5.3 Construct Validity

Construct validity was explored using exploratory factor analysis (EFA) of the item-level pilot data. Six factors were extracted to reflect the six proposed domains. Because the pilot included only 30 facilities for a 72-item instrument, the EFA is underpowered by common sample-size standards. The findings should therefore be treated as preliminary and confirmed in a future study using a larger, independent sample before they are presented as confirmatory evidence of construct validity.

2.5.4 Reliability

Internal consistency was assessed using Cronbach's alpha [17] for each of the six domains and for the complete 72-item instrument. These calculations used item-level ratings from the 30-facility pilot. Inter-rater reliability was assessed with a two-way random-effects, absolute-agreement intraclass correlation coefficient, ICC(2,1), using paired composite scores from 12 facilities that were independently assessed by two raters. Test-retest reliability was assessed using the same ICC(2,1) model, based on scores from 10 facilities that were assessed twice by the same rater. ICC model selection and interpretation followed published guidance [18], where values below 0.50 are considered poor, 0.50 to 0.75 moderate, 0.75 to 0.90 good, and values above 0.90 excellent.

2.5.5 Field Pilot Testing

The instrument was piloted in 30 childcare facilities across six states or regions: Lagos, Ogun, Oyo, FCT, Kwara, and Rivers, with five facilities from each location. The sample also included 10 urban, 10 peri-urban, and 10 rural facilities and covered private, faith-based, community, and public ownership. This 30-facility sample was used for framework validation and was not intended to represent childcare facilities nationally.

3 RESULTS AND DISCUSSION

3.1 Final Indicator Set and Domain Structure

Across the three Delphi rounds, the candidate pool was reduced from 91 items to a final 72-item, six-domain instrument (Table 2). Most of the reduction occurred in Round 2, when overlapping items were combined and indicators with lower expert-rated relevance were removed. The psychosocial/ergonomic domain considered during early development was not included in the final six-domain instrument.

Table 2: Indicator attrition across the three-round modified Delphi process.

Domain	Initial items	After Round 1	After Round 2	Final items
Water, Sanitation & Hygiene	17	16	14	14
Food Safety	15	15	13	12
Structural & Physical Safety	18	17	14	14

Indoor & Outdoor Air Quality	13	13	11	10
Chemical & Toxicant Exposure	13	13	11	10
Biological & Vector Hazards	15	14	12	12
Total	91	88	75	72

3.2 Domain Weights

Structural & Physical Safety received the highest AHP weight (0.22), followed by WASH (0.20) and Food Safety (0.17). Indoor & Outdoor Air Quality and Biological & Vector Hazards had the lowest weights, at 0.13 each (Figure 1; Table 1).

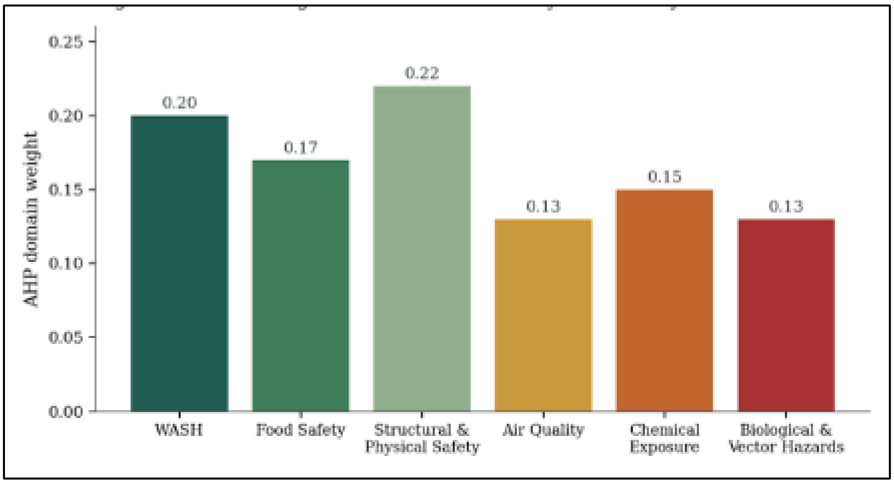

Figure 1: AHP-derived domain weights.

3.3 Validity Statistics

Scale-level content validity was high, with an S-CVI/Ave of 0.94. Item-level I-CVI values ranged from 0.75 to 1.00 across the 72 retained indicators. Most items met or exceeded the conventional 0.78 threshold for a panel of this size, although a small number of borderline items may need to be identified and discussed individually. The six-factor EFA solution explained 67.4% of the cumulative variance, and each factor corresponded to one of the six proposed domains (Table 3). Given the small pilot sample, this finding should be viewed as preliminary support for the proposed domain structure and confirmed in a larger sample.

Table 3: Exploratory factor analysis summary (preliminary; see Section 4.3 and Section 7).

Factor	Interpreted domain	Variance explained (%)	Cumulative (%)
Factor 1	Water, Sanitation & Hygiene	18.7	18.7
Factor 2	Food Safety	13.2	31.9
Factor 3	Structural & Physical Safety	10.8	42.7
Factor 4	Indoor & Outdoor Air Quality	9.4	52.1
Factor 5	Chemical & Toxicant Exposure	8.1	60.2
Factor 6	Biological & Vector Hazards	7.2	67.4

3.4 Reliability Statistics

Internal consistency ranged from acceptable to good across the six domains, with Cronbach's alpha values from 0.763 to 0.816. The overall 72-item instrument had high internal consistency (alpha = 0.91) (Figure 2). Structural & Physical Safety had the highest domain value (alpha = 0.816), while Indoor & Outdoor Air Quality had the lowest (alpha = 0.763), which was still within an acceptable range.

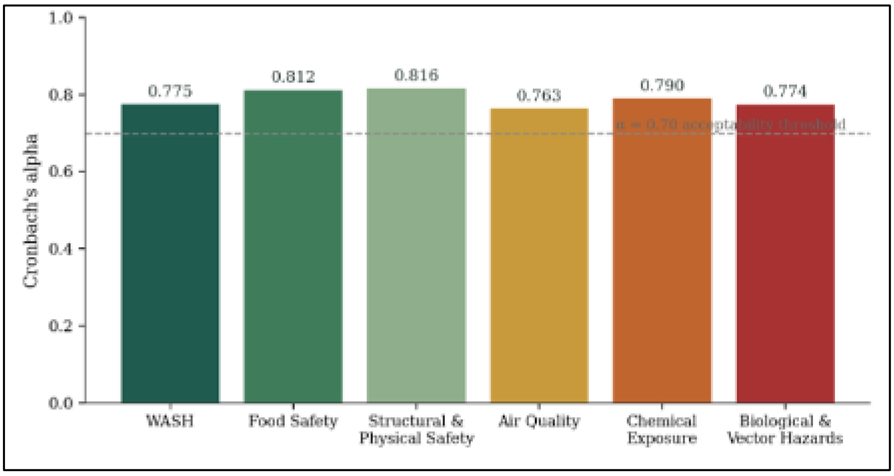

Figure 2: Internal consistency (Cronbach's alpha) by domain.

Inter-rater reliability was good among the 12 facilities that were independently scored by two assessors, with ICC(2,1) = 0.89. Test-retest reliability was also good among the 10 facilities assessed twice by the same assessor, with ICC(2,1) = 0.86 (Table 4).

Table 4: Inter-rater and test-retest reliability.

Reliability metric	Basis	ICC(2,1)
Inter-rater reliability	12 facilities, 2 independent assessors	0.89
Test-retest reliability	10 facilities, same assessor, 2 time points	0.86

3.5 Pilot Application and Risk Classification

Composite risk scores in the 30-facility pilot ranged from 20.4 to 66.7, with a mean of 44.7 (SD 11.3). Based on the four risk categories, 6 facilities (20.0%) were classified as Low risk, 11 (36.7%) as Moderate, 9 (30.0%) as High, and 4 (13.3%) as Critical (Figure 3). No facility fell within the lowest 10% of the possible score range, and none approached the theoretical maximum. This suggests that the pilot captured a broad but realistic range of facility conditions rather than only extreme examples.

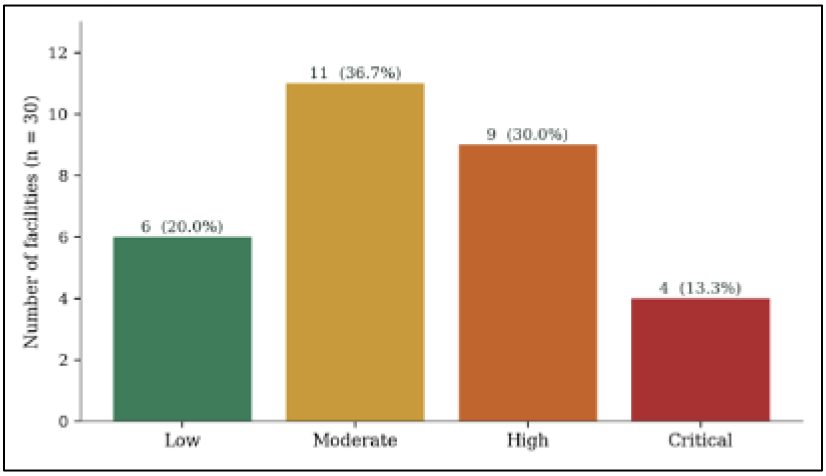

Figure 3: Distribution of composite risk classification across the 30-facility pilot sample.

Domain scores also differed across states and regions (Figure 4). Chemical & Toxicant Exposure and Structural & Physical Safety showed the largest variation between locations, while Food Safety scores were more consistent. These patterns are descriptive because the pilot was designed mainly for validation and should not be interpreted as confirmed geographic differences.

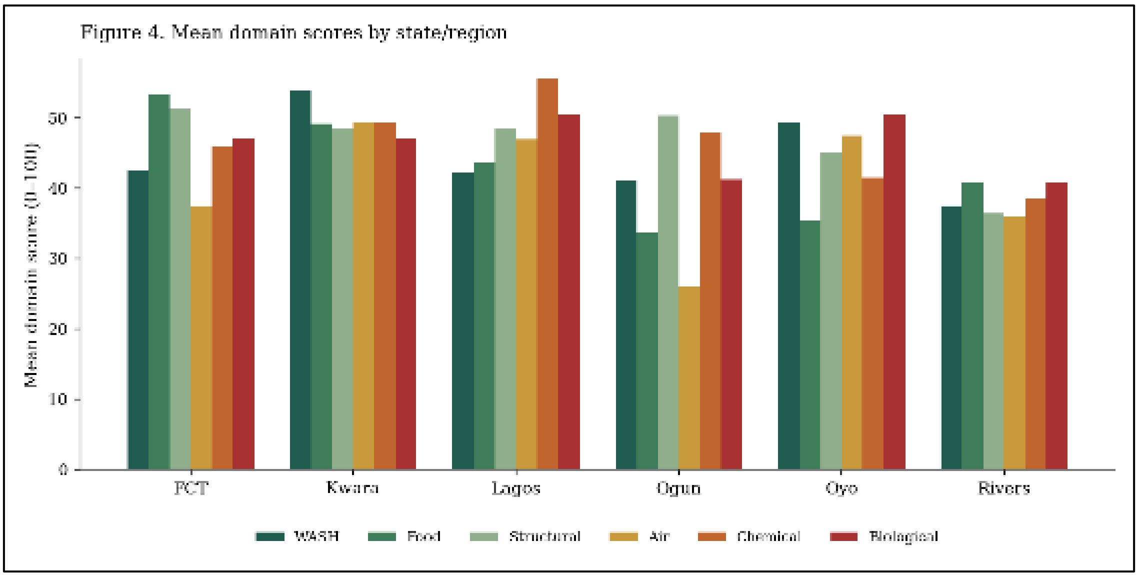

Figure 4: Mean domain scores by state/region (interactive version available in the companion dashboard).

4 DISCUSSION

The findings provide encouraging evidence that the framework performs consistently. Content validity was high (S-CVI/Ave = 0.94), internal consistency ranged from acceptable to good across the six domains (alpha = 0.763 to 0.816) and was high overall (alpha = 0.91), and both inter-rater and test-retest reliability were good (ICC = 0.89 and 0.86, respectively). Together, these results suggest that the 72 indicators were judged relevant by a multidisciplinary expert panel and can be scored with reasonable consistency. That consistency is important for a tool intended for routine use by inspectors with different levels of experience and training.

Indoor & Outdoor Air Quality had the lowest internal consistency of the six domains (alpha = 0.763), although the value remained within an acceptable range. One possible explanation is that air quality conditions vary more widely across urban, peri-urban, and rural childcare settings. It is also possible that some air-quality indicators need further refinement. Targeted feedback from assessors could help identify items that are difficult to interpret or score consistently.

The WASH findings are broadly consistent with evidence from other institutional settings in sub-Saharan Africa. A six-country study of rural schools in Ethiopia, Kenya, Mozambique, Rwanda, Uganda, and Zambia found that only 1% to 23% of schools met basic combined standards for water, sanitation, and handwashing [19]. A broader review of WASH services in the region also found substantial and uneven infrastructure gaps [20]. In the present pilot, WASH scores ranged from 16.1 to 66.1 across facilities, showing a similarly widespread. This suggests that the 14 WASH indicators are capturing meaningful differences in facility conditions. However, much of the existing research examines WASH as a standalone domain [21]. A key feature of this framework is that WASH is assessed alongside five other domains and incorporated into one AHP-weighted composite score.

The scoring system was also designed to be practical in the field. Inspectors rate each item from 0 to 4, scores are summarized at the domain level, and facilities are assigned to one of four overall risk categories. This approach is intended to support routine inspection without requiring inspectors to perform statistical calculations on site

4.1 Limitations

- Expert panel size and composition: The panel included 16 experts across eight relevant disciplines. Although this provided multidisciplinary input, a larger panel with broader geographic representation could strengthen the content validity findings.
- Pilot sample size and regional representativeness: The validation pilot included 30 facilities across six states and three types of settings. It was designed as a validation sample rather than a nationally representative sample. Future studies should evaluate the framework in larger and more geographically diverse samples that include a broader range of facility types.
- Construct validity: The EFA is likely underpowered because it used data from only 30 facilities for a 72-item instrument. Common guidance often recommends roughly 5 to 10 cases per variable, which would require approximately 360 to 720 observations for an instrument of this size. The six-factor solution

explaining 67.4% of the variance should therefore be treated as preliminary and re-examined in a larger, independent sample.
- Domain reliability: All six domains met conventional standards for acceptable internal consistency. Indoor & Outdoor Air Quality had the lowest alpha value (0.763) and may benefit from additional item review.
- Risk-band cut-points: The numeric boundaries used to separate Low, Moderate, High, and Critical risk should be confirmed as pre-specified thresholds rather than fitted to the observed pilot distribution before they are adopted as fixed classification thresholds for routine use.
- Scope: The final instrument does not include every possible childcare-related hazard. The psychosocial/ergonomic domain considered during early development was excluded, so these conditions are not represented in the composite risk score.
- Face validity: A formal end-user face validity assessment was not conducted as part of this validation study. Future field application should include structured review by environmental health inspectors and childcare facility operators to assess item clarity, relevance, ease of scoring, administration time, and practical feasibility.

5 CONCLUSION

This study developed and validated a 72-item, six-domain, risk-weighted environmental health assessment framework for childcare facilities in Nigeria. The framework showed high content validity, acceptable to good internal consistency across the six domains, and good inter-rater and test-retest reliability. It was also piloted across facilities representing different states, settings, and ownership types. The framework provides a structured basis for future environmental health assessment, risk prioritization, and the development of corrective-action systems. Further validation in larger and more geographically diverse samples, and eventually in comparable childcare settings in other low- and middle-income countries, would help establish its wider applicability.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

Data collection focused on the physical environment of participating facilities. The 72 indicators describe structural, infrastructural, and operational conditions observed by a trained assessor, such as the presence of a handwashing station, the condition of electrical wiring, and the storage of cleaning chemicals. Each condition was scored using the 0 to 4 severity scale described in Section 3.4. No information was collected directly from children. The study did not include interviews with children, individual child observations, photographs of children, health records, or other personally identifiable child information. The unit of assessment was the childcare facility, not the individual child.

Statement of informed consent

The expert panel described in Section 3.2 and the facility assessors described in Section 4.5 are identified in the dataset using role-based codes such as EXP-01 and CF-001 rather than names. Facility characteristics, including state or region, setting type, and ownership category, are reported in aggregate and do not identify individual facilities or operators in the manuscript. The facility operators or administrators gave informed consent for their premises to be assessed and for anonymized results to be published.

Data Availability

The facility-level pilot data, expert panel ratings, reliability datasets, and codebook used for this manuscript are available in the accompanying workbook, Childcare_Environmental_Health_Data.xlsx.

REFERENCES

[1] Etzel RA, Landrigan PJ. Children's exquisite vulnerability to environmental exposures. In: Landrigan PJ, Etzel RA, editors. Textbook of Children's Environmental Health. Oxford University Press; 2014. p. 18-27.

[2] Gaspar FW, Castorina R, Maddalena RL, Nishioka MG, McKone TE, Bradman A. Phthalate exposure and risk assessment in California child care facilities. Environmental Science & Technology. 2014;48(13):7593-7601.

[3] Quirós-Alcalá L, Wilson S, Witherspoon N, Murray R, Perodin J, Trousdale K, et al. Volatile organic compounds and particulate matter in child care facilities in the District of Columbia: results from a pilot study. Environmental Research. 2016;146:116-124.

[4] Hoang T, Castorina R, Gaspar F, Maddalena R, Jenkins PL, Zhang Q, et al. VOC exposures in California early childhood education environments. Indoor Air. 2017;27(3):609-621.

[5] Andaluri G, Manickavachagam M, Suri R. Plastic toys as a source of exposure to bisphenol-A and phthalates at childcare facilities. Environmental Monitoring and Assessment. 2018;190:65.

[6] Holm SM, Leonard V, Durrani T, Miller MD. Do we know how best to disinfect child care sites in the United States? A review of available disinfectant efficacy data and health risks of the major disinfectant classes. American Journal of Infection Control. 2018;47(1):82-91.

[7] Federal Republic of Nigeria. Child's Rights Act, 2003 (Act No. 26 of 2003). 2003.

[8] Hudson G, Miller GG, Seikel K. Regulations, policies, and guidelines addressing environmental exposures in early learning environments: a review. Journal of Environmental Health. 2014;76(7):24-34.

[9] Environmental Law Institute. Reducing Environmental Exposures in Child Care Facilities: A Review of State Policy. Environmental Law Institute; 2015.

[10] Briggs D. Environmental Health Indicators: Framework and Methodologies (WHO/SDE/OEH/99.10). World Health Organization; 1999.

[11] Ward DS, Benjamin SE, Ammerman AS, Ball SC, Neelon BH, Bangdiwala SI. Nutrition and physical activity in childcare: results from an environmental intervention. American Journal of Preventive Medicine. 2008;35(4):352-356.

[12] Boulkedid R, Abdoul H, Loustau M, Sibony O, Alberti C. Using and reporting the Delphi method for selecting healthcare quality indicators: a systematic review. PLoS ONE. 2011;6(6):e20476.

[13] Diamond IR, Grant RC, Feldman BM, Pencharz PB, Ling SC, Moore AM, et al. Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies. Journal of Clinical Epidemiology. 2014;67(4):401-409.

[14] Saaty TL. The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation. McGraw-Hill; 1980.

[15] Lynn MR. Determination and quantification of content validity. Nursing Research. 1986;35(6):382-385.

[16] Polit DF, Beck CT. The content validity index: are you sure you know what's being reported? Critique and recommendations. Research in Nursing & Health. 2006;29(5):489-497.

[17] Tavakol M, Dennick R. Making sense of Cronbach's alpha. International Journal of Medical Education. 2011;2:53-55.

[18] Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. Journal of Chiropractic Medicine. 2016;15(2):155-163.

[19] Morgan C, Bowling M, Bartram J, Kayser GL. Water, sanitation, and hygiene in schools: status and implications of low coverage in Ethiopia, Kenya, Mozambique, Rwanda, Uganda, and Zambia. International Journal of Hygiene and Environmental Health. 2017;220(6):950-959.

[20] Ohwo O. Assessment of water, sanitation and hygiene services in Sub-Saharan Africa. 2018.

[21] Jasper C, Le TT, Bartram J. Water and sanitation in schools: a systematic review of the health and educational outcomes. International Journal of Environmental Research and Public Health. 2012;9(8):2772-2787.