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# APPLICATION OF AN INTEGRATED ENVIRONMENTAL HEALTH RISK ASSESSMENT FRAMEWORK IN SELECTED NIGERIAN CHILDCARE FACILITIES: RISK CHARACTERIZATION, CORRECTIVE ACTION PRIORITIZATION, AND A PROPOSED INSPECTION AND ENFORCEMENT SYSTEM

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## ABSTRACT

**Background**: Risk-based inspection can help regulators direct limited resources toward childcare facilities with the greatest environmental health concerns. This study applied a previously validated 72 item, six domain environmental health risk assessment framework to selected childcare facilities and developed a proposed corrective action and inspection prioritization system.

**Methods**: The framework was applied to 30 childcare facilities across six states or regions, three facility settings, and four ownership types. Composite and domain level scores were summarized descriptively. Each facility's highest scoring domain was identified as its priority domain. High- and Critical risk facilities were ranked for corrective action, and a provisional risk tiered inspection and escalation model was developed.

**Results**: Mean composite risk score was 44.7 (SD 11.3). Urban facilities had the highest mean score (47.2), followed by peri urban (45.4) and rural facilities (41.5). Community-owned facilities had the highest mean score (50.8), while faith based facilities had the lowest (40.6). Structural and Physical Safety was the most frequent priority domain (9 of 30 facilities). Thirteen facilities (43.3%) were classified as High or Critical risk.

**Conclusion**: The framework identified facility- and domain-specific priorities and offers a structured basis for corrective action prioritization. Because the analysis uses the same 30-facility sample as the validation study and the proposed inspection system has not been piloted, the findings and operational model should be treated as descriptive and provisional.

**Keywords:** Childcare Facilities; Environmental Health; Risk Characterization; Corrective Action; Risk Based Regulation; Nigeria

## 1 INTRODUCTION

Environmental health regulators often have more facilities to oversee than available staff and resources can support. This makes it important to identify which facilities need attention first. This constraint is well documented outside the childcare sector: risk based approaches to regulatory inspection, in which limited enforcement resources are deliberately targeted toward the facilities and hazards posing the greatest risk rather than distributed evenly or randomly, are now standard guidance among regulatory bodies internationally [3] and have been shown, in at least one large-scale evaluation of a targeted occupational safety inspection program, to avert substantially more harm than untargeted alternatives [4]. A validated risk assessment framework is a prerequisite for this kind of targeting: without a consistent, comparable risk metric, a regulator has no principled basis for deciding which facility to visit first, or what to do when a facility does not correct a flagged problem.

Adekola [1] developed and validated such a framework for Nigerian childcare facilities: a 72 item instrument spanning six domains (Water, Sanitation & Hygiene; Food Safety; Structural & Physical Safety; Indoor & Outdoor Air Quality; Chemical & Toxicant Exposure; and Biological & Vector Hazards), weighted by the Analytic Hierarchy Process and validated for content validity, internal consistency, and interrater and test to retest reliability. That paper established that the instrument measures what it is intended to measure, and does so consistently across assessors and over time. It did not, however, focus on what the resulting scores actually show about the facilities assessed, or on how those scores might translate into a practical prioritization and enforcement structure for regulators operating under real resource constraints.

This study builds on that work in two ways. First, using the validated framework, we characterize the risk profile of the facilities assessed, overall, and broken down by state or region, facility setting, and ownership type, and identify which domains most frequently drive risk at the facility level. Second, we build on that characterization to design a proposed risk tiered inspection and corrective action system: a structure that links each risk band to an inspection interval and, for facilities that do not correct flagged deficiencies within that window, a graduated escalation pathway toward stronger regulatory response. This second stage draws on responsive regulation theory [2], which argues that regulators achieve better compliance by starting with cooperative, corrective engagement and reserving punitive sanctions for facilities that fail to respond, rather than by treating every instance of noncompliance identically.

## 2 MATERIALS AND METHODS

### 2.1 Instrument

This study applies the 72 item, six domain environmental health risk assessment framework developed and validated by Adekola [1], without modification. Each indicator is scored 0 to 4 (0 = none, 1 = minor, 2 = moderate, 3 = serious, 4 = critical); domain scores are the sum of item scores normalized to a 0 to 100 scale; and the facility composite score is the AHP-weight-adjusted sum of the six domain scores (weights: WASH 0.20, Food Safety 0.17, Structural & Physical Safety 0.22, Air Quality 0.13, Chemical Exposure 0.15, Biological/Vector Hazards 0.13), also expressed on a 0 to 100 scale. Composite scores are classified into four risk bands (Low, Moderate, High, Critical) as established in Adekola [1]. Full item content, scoring rules, and validation statistics are reported there and are not repeated here.

### 2.2 Study Sample

The sample comprises the same 30 childcare facilities assessed during the validation pilot reported in Adekola [1]: 5 facilities each in Lagos, Ogun, Oyo, FCT, Kwara, and Rivers; 10 facilities each in urban, peri urban, and rural settings; and 8 private, 8 faith based, 7 community, and 7 publicly owned facilities. No additional facilities were assessed for this paper. Because these strata are small (n = 5 per state; n = 7 to 8 per ownership type), no inferential statistical tests (e.g., ANOVA, chi-square) are reported; all comparisons below are descriptive, and readers should not treat between group differences as statistically confirmed.

### 2.3 Risk Characterization

Composite and domain level risk scores were summarized by state or region, facility setting type, and ownership type using means and standard deviations. For each facility, the single domain with the highest (worst) score was identified as that facility's priority domain, and the frequency with which each domain appeared as a priority domain was tabulated across the 30 facilities to identify system-level patterns in what drives risk.

### 2.4 Corrective Action Prioritization

Facilities were ranked in descending order of composite risk score to produce a proposed prioritization list for regulatory follow up. Facilities classified High or Critical risk were treated as the priority tier warranting near-term

corrective action; for each, the priority domain (Section 2.3) is reported alongside a proposed response timeline keyed to risk band (Table 1).

### 2.5 Inspection and Enforcement System Design

The response timelines in Table 1 were used to outline a recurring inspection cycle (Section 3.6.2) and a graduated, four-tier escalation pathway (Section 3.6.4) for facilities that do not correct flagged deficiencies within their assigned window. The escalation structure follows the "enforcement pyramid" logic developed in responsive regulation theory [2]: regulatory response begins with cooperative, corrective engagement and escalates in severity only when a facility fails to respond, with the most severe sanctions reserved for repeated or unresolved Critical risk cases. This design work is conceptual: no facility in this sample was actually taken through the proposed escalation pathway, and no outcome data exist on whether the pathway would improve compliance in practice.

**Table 1: Risk bands observed in this sample and proposed (not yet adopted) response timelines.**

| Risk band | Composite score range (this sample) | Proposed response timeline |
|---|---|---|
| Critical | ≥ 54 | Immediate / within 7 days |
| High | 47 to 54 | Within 30 days |
| Moderate | 38 to 47 | Within 90 days |
| Low | < 38 | Routine annual reinspection |

## 3 RESULTS

### 3.1 Overall Risk Profile

Across the 30 facilities, composite risk scores ranged from 20.4 to 66.7 (mean 44.7, SD 11.3). Six facilities (20.0%) were classified Low risk, 11 (36.7%) Moderate, 9 (30.0%) High, and 4 (13.3%) Critical, 13 facilities (43.3%) in total falling into the High or Critical priority tier for corrective action.

### 3.2 Risk Patterns by State/Region

Mean composite scores by state ranged from 38.2 (Rivers, SD 14.6) to 49.8 (Kwara, SD 4.5). Lagos showed the widest within-state spread (mean 47.5, SD 17.3, range 26.9 to 66.7), reflecting the presence of both the sample's two Critical risk facilities and one of its Low risk facilities within the same state. Kwara showed the narrowest spread (SD 4.5), with all five facilities clustered in the Moderate-to-High range. With only five facilities per state, these patterns should be read as descriptive rather than as confirmed state-level effects.

### 3.3 Risk Patterns by Facility Setting

Urban facilities showed the highest mean composite score (47.2, SD 12.0), followed by peri urban (45.4, SD 7.7) and rural facilities (41.5, SD 13.8) (Table 2; Figure 1). Risk classification followed a broadly similar pattern: urban facilities accounted for both of the sample's Critical risk facilities in this setting stratum's high end, while rural facilities had the largest share of Low risk facilities (3 of 10). This higher urban risk pattern runs counter to a simple assumption that rural facilities are uniformly under-resourced; it is consistent, however, with at least one other Nigerian health-facility comparison that found infrastructure more constrained in urban than rural sites in a different sector [5], suggesting urban facilities' higher exposure density, higher enrollment, and more intensive space use may offset the infrastructure advantages urban areas typically hold.

**Table 2: Composite risk score and risk classification by facility setting type.**

| Setting | n | Mean composite | SD | Critical | High | Moderate | Low |
|---|---|---|---|---|---|---|---|
| Urban | 10 | 47.2 | 12.0 | 2 | 3 | 4 | 1 |
| Peri-urban | 10 | 45.4 | 7.7 | 1 | 4 | 3 | 2 |
| Rural | 10 | 41.5 | 13.8 | 1 | 2 | 4 | 3 |

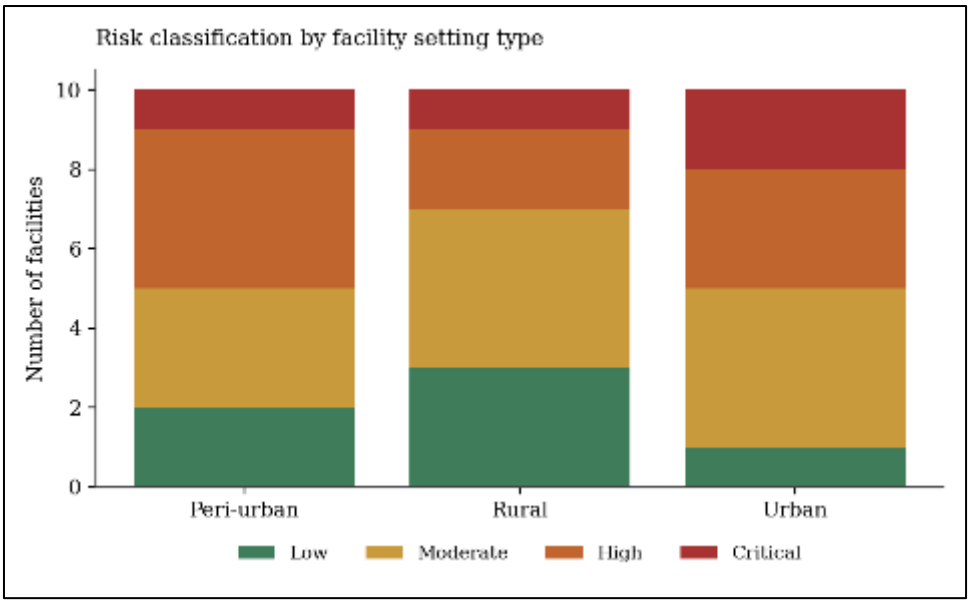


**Figure 1: Risk classification counts by facility setting type.**

### 3.4 Risk Patterns by Ownership Type

Community-owned facilities showed the highest mean composite score (50.8) and the widest spread (SD 15.0) of any ownership category, and accounted for 3 of the sample's 4 Critical risk facilities despite comprising only 7 of the 30 facilities overall. Faith-based facilities showed the lowest mean composite score (40.6, SD 11.6). Private and publicly owned facilities were similar to one another and closer to the sample mean (44.3 and 43.6, respectively), with both categories concentrated in the Moderate band (5 of 8 private facilities; 4 of 7 public facilities) (Figure 2). These differences are descriptive only and should not be interpreted as confirmed ownership effects.

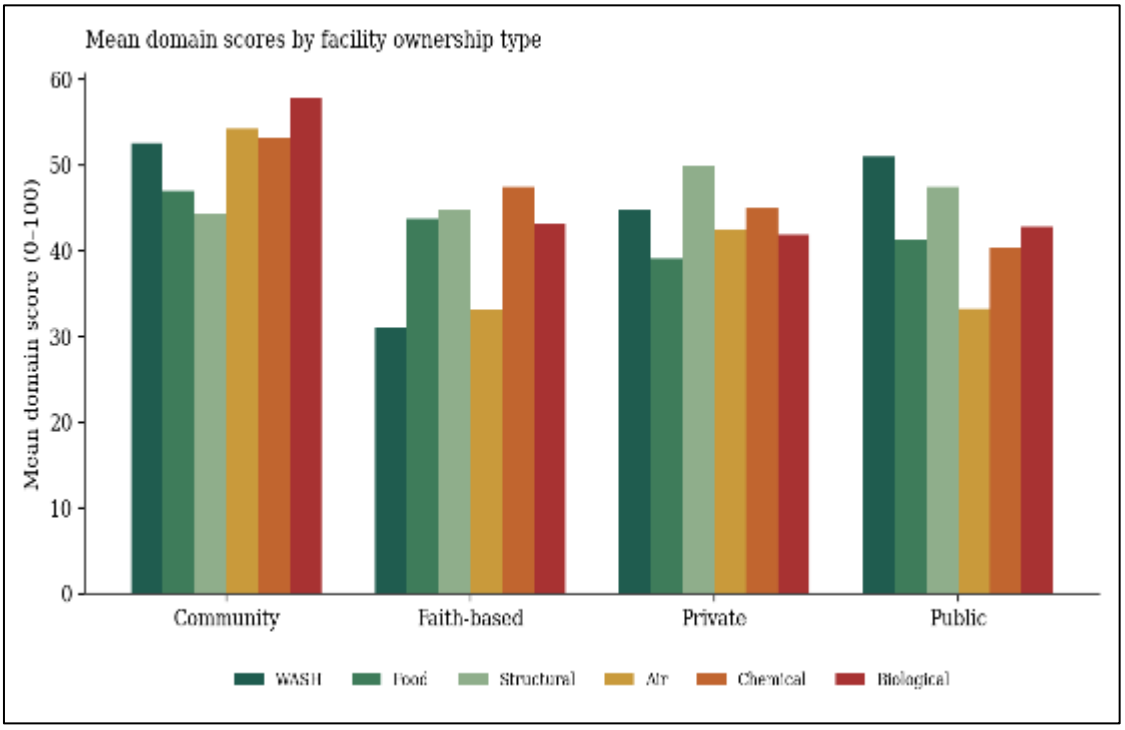


**Figure 2: Mean domain scores by facility ownership type.**

Domain-level patterns underlying these ownership differences varied: community owned facilities scored comparatively poorly on Biological/Vector Hazards and WASH, while faith based facilities' lower composite scores were driven primarily by weak WASH scores specifically (mean 31.0, the lowest domain to ownership combination observed in this sample).

### 3.5 Domain-Level Drivers of Risk

Structural & Physical Safety was the single highest scoring domain for 9 of the 30 facilities (30.0%), more than any other domain, followed by WASH (6 facilities, 20.0%), Chemical & Toxicant Exposure and Biological/Vector Hazards (5 facilities each, 16.7%), Food Safety (4 facilities, 13.3%), and Air Quality (1 facility, 3.3%) (Figure 3). Because Structural & Physical Safety also carries the highest AHP-derived domain weight (0.22), a facility's structural condition has an greater influence on its composite score whenever it is the weak domain, reinforcing the case for treating it as a first-order screening domain in any abbreviated or rapid-assessment version of the instrument.

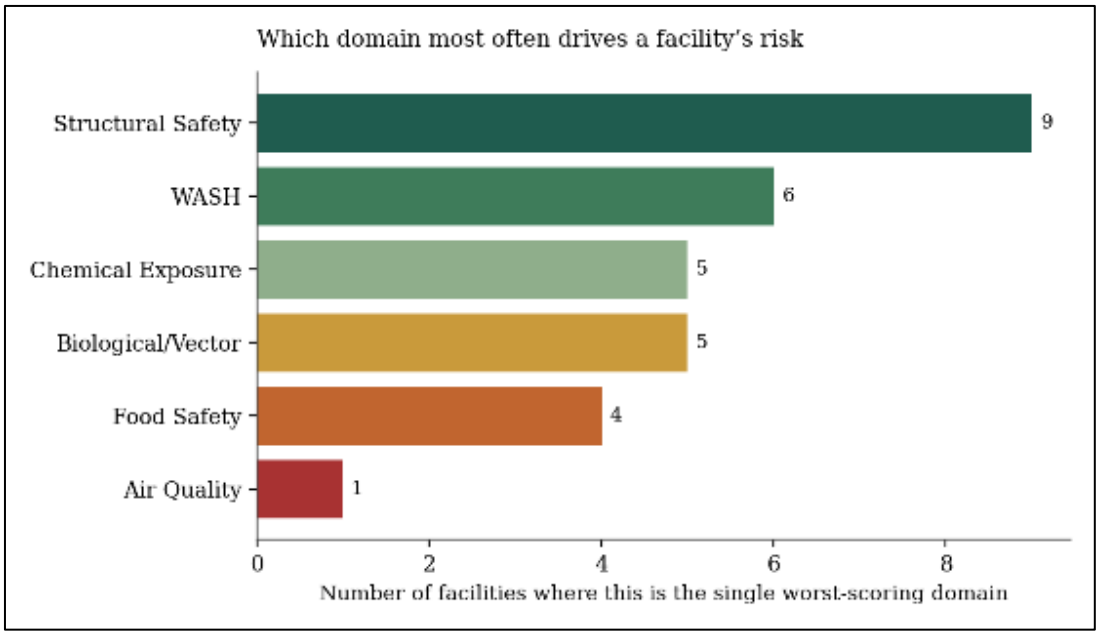


**Figure 3: Frequency with which each domain was a facility's single highest scoring domain.**

### 3.6 Corrective Action Priority List

Table 3 lists the 13 facilities classified High or Critical risk, ranked by composite score, together with each facility's priority domain and the proposed response timeline from Table 1. The two highest-priority facilities (CF-019 and CF-007), both Critical risk, urban, community owned facilities in Lagos, illustrate the framework's compounding logic: each carries a severe score in a different domain (Air Quality and Biological/Vector Hazards, respectively) layered onto elevated scores across several other domains, producing a composite score well above the Critical threshold even though no single domain alone would necessarily have triggered the same level of regulatory concern under a single-domain assessment approach.

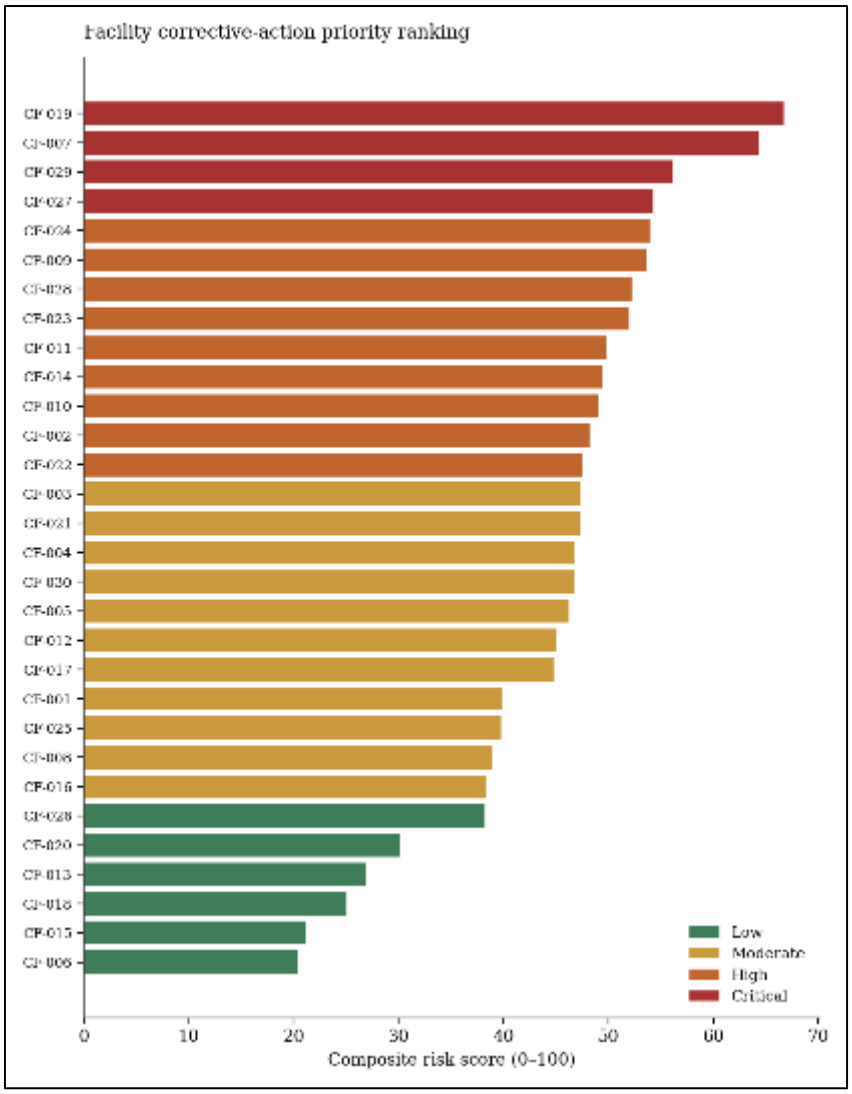


**Figure 4: All 30 facilities ranked by composite risk score, colored by risk classification.**

**Table 3: Proposed corrective action priority list: all High- and Critical risk facilities, ranked by composite score.**

| Facility | State | Setting | Ownership | Score | Risk band | Priority domain | Timeline |
|---|---|---|---|---|---|---|---|
| CF-019 | Lagos | Urban | Community | 66.7 | Critical | Air Quality | 7 days |
| CF-007 | Lagos | Urban | Community | 64.4 | Critical | Biological/Vector | 7 days |
| CF-029 | Kwara | Peri-urban | Private | 56.1 | Critical | Structural Safety | 7 days |
| CF-027 | Oyo | Rural | Community | 54.3 | Critical | Chemical Exposure | 7 days |
| CF-024 | Rivers | Rural | Public | 54.0 | High | WASH | 30 days |
| CF-009 | Oyo | Rural | Private | 53.6 | High | Structural Safety | 30 days |
| CF-028 | FCT | Urban | Public | 52.2 | High | Chemical Exposure | 30 days |
| CF-023 | Kwara | Peri-urban | Community | 52.0 | High | WASH | 30 days |
| CF-011 | Kwara | Peri-urban | Community | 49.9 | High | Food Safety | 30 days |
| CF-014 | Ogun | Peri-urban | Faith-based | 49.4 | High | Structural Safety | 30 days |
| CF-010 | FCT | Urban | Faith-based | 49.1 | High | Structural Safety | 30 days |
| CF-002 | Ogun | Peri-urban | Faith-based | 48.2 | High | Chemical Exposure | 30 days |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CF-022 | FCT | Urban | Faith-based | 47.5 | High | Food Safety | 30 days |

### 3.7 Proposed Risk-Tiered Inspection and Corrective-Action System

Sections 3.1 to 3.6 describe the risk patterns observed in the assessed facilities. This section considers how regulators could use that information in practice. The system below translates the four risk bands and the priority list into (a) a recurring inspection interval per band, (b) a standard structure for the corrective action notice a facility receives, and (c) a graduated escalation pathway for facilities that do not correct flagged deficiencies within their assigned window. The design is offered as a starting framework for review and adaptation by a regulatory partner, not as an adopted or validated system, see Section 3.8 for the limitations this carries.

#### 3.7.1 Design Principles

- Risk-proportionate effort: inspection frequency and intensity should scale with assessed risk rather than apply uniformly across all facilities, consistent with international risk based regulatory guidance [3].

- Start cooperative, escalate only on lack of response: following responsive regulation theory's "enforcement pyramid" [2], the system begins every facility at the least severe response, a corrective action notice, and escalates only when a facility fails to correct flagged deficiencies within its assigned window, rather than treating a single instance of noncompliance the same as a repeated or unresolved one.

- Domain-targeted, not just facility-targeted: because the framework identifies a specific priority domain per facility (Section 3.5), corrective notices and reinspections can focus verification on the flagged domain rather than requiring a full 72 item re-assessment every cycle, reducing the burden of frequent follow up.

- Evidentiary basis, not automatic authority: the framework and this proposed system are intended to provide the risk evidence a registering authority would use in deciding on suspension or closure; they are not proposed as a substitute for that authority's own legal process. Legal review would be required before operational use to confirm consistency with the registration and inspection powers established under the Child's Rights Act 2003 [6].

### 3.8 Risk-Tiered Inspection Frequency

Table 1 (Section 2.4) proposed a response timeline for corrective action by risk band. Extending this into a recurring inspection cycle (Table 4) gives every facility, regardless of current risk band, a defined point at which its risk status is reassessed, not only the facilities currently in the High or Critical priority tier.

**Table 4: Proposed recurring inspection cycle by risk band.**

| Risk band | Corrective notice issued? | Mandatory reinspection | Next routine full assessment |
|---|---|---|---|
| Critical | Yes, immediate | 7 days (priority domain) | At reinspection; full 72 item if unresolved |
| High | Yes, within 5 days | 30 days (priority domain) | 6 months |
| Moderate | Yes, within 14 days | 90 days (priority domain) | 12 months |
| Low | No | Not required | 12 months (routine cycle) |

A "priority domain" reinspection (Section 3.5) verifies the specific indicators that drove the facility's highest scoring domain, rather than the full 72 item instrument, on the logic that this is where remediation is most urgent and most tractable to confirm quickly. A full 72 item re-assessment is reserved for the next routine cycle, or triggered early if a Critical facility fails its 7 day priority-domain reinspection (Section 3.6.4).

#### 3.8.1 Corrective Action Notice Structure

Each corrective action notice proposed under this system would include:

- The facility's composite score, risk band, and all six domain scores, so the facility can see its full profile rather than only the flagged issue.
- The priority domain and the specific indicators within it that scored 3 (serious) or 4 (critical), described in plain language rather than only as an item code.

- The required corrective action for each flagged indicator and the evidence the facility would need to provide or make available at reinspection (e.g., a repaired handwashing station, a documented pest-control schedule).
- The mandatory reinspection date, drawn from Table 4, and a plain statement of what happens if the deficiency is not corrected by that date (Section 3.6.4).
- A named contact and process for the facility to request clarification or an extension before the reinspection date, consistent with the cooperative starting posture in Section 3.6.1.

### 3.8.2 Escalation Pathway for Non-Compliance

*Figure 5 outlines the proposed four-tier escalation pathway. A facility enters at Tier 1 regardless of risk band; it moves to a higher tier only if it fails its mandatory reinspection (Table 4) with the flagged deficiency still unresolved. A facility that corrects the deficiency at any tier exits the pathway and returns to its routine inspection cycle (Table 4) at its newly rescored risk band.*

- Tier 1, Corrective-action notice: the standard response for any facility scoring above Low risk (Section 3.6.3). No punitive consequence attaches at this tier; the facility is given the timeline in Table 4 to correct the flagged deficiency.
- Tier 2, Formal warning and shortened reinspection window: issued if a facility fails its Tier 1 reinspection with the priority domain still deficient. The reinspection window is shortened (proposed: half the original interval) and a formal written warning is entered into the facility's compliance record.
- Tier 3, Conditional operating status: proposed for a facility that fails its Tier 2 reinspection, or that enters the pathway already at Critical risk and fails its initial 7 day reinspection. Conditions might include a temporary cap on enrollment or a requirement for more frequent internal reporting to the regulator, pending verified correction. The specific conditions and legal mechanisms available at this tier would require confirmation against applicable Nigerian childcare regulations before implementation.
- Tier 4, Suspension or closure referral: reserved for a facility that fails to achieve compliance under conditional status, or that shows a repeated pattern of Critical risk findings across cycles. This tier does not itself suspend or close a facility; it refers the facility's compliance record and risk history to the registering authority for a decision under its existing legal powers (Section 3.6.1).

### 3.8.3 Verification and Case Closure

A case is proposed to close, and a facility to return to its routine inspection cycle, when its rescored priority domain no longer contains an indicator rated 3 or 4 and its recomputed composite score has moved to a risk band at or below its band at the time of the original notice. Verification would be documented in the same facility record used to track compliance history and inform Tier 3/4 escalation decisions for any future noncompliance. A facility that closes a case but is re-flagged at its next routine assessment would be treated as a new Tier 1 case rather than as a continuation of the prior one, unless the same priority domain recurs, in which case the facility's compliance history (Section 3.6.4) would support consideration of a faster escalation.

### 3.8.4 Illustrative Application to the Priority List

To make the system concrete, Table 5 walks through how three facilities from Table 3 would move through the proposed structure under two scenarios: full compliance at first reinspection, and lack of response requiring escalation.

**Table 5 Illustrative, hypothetical application of the escalation pathway to three facilities from Table 3. No facility has actually been re-inspected under this system; both outcome columns are illustrative only.**

| Facility | Entry point | If compliant at reinspection | If non-compliant at reinspection |
|---|---|---|---|
| CF-019 (Critical, Air Quality, Lagos) | Tier 1: immediate notice, 7 day reinspection | Case closes; returns to Table 4 cycle at rescored band | Escalates to Tier 2: formal warning, reinspection shortened to ~3 to 4 days |
| CF-024 (High, WASH, Rivers) | Tier 1: notice within 5 days, 30 day reinspection | Case closes; returns to 6-month routine cycle | Escalates to Tier 2: formal warning, reinspection shortened to ~15 days |
| CF-022 (High, Food Safety, FCT) | Tier 1: notice within 5 days, 30 day reinspection | Case closes; returns to 6-month routine cycle | Escalates to Tier 2: formal warning, reinspection shortened to ~15 days |

## 4 DISCUSSION

Applying the validated framework to these facilities revealed two patterns that may be useful for environmental health practice. First, Structural & Physical Safety is the domain most often driving facility level risk (30.0% of facilities), and it is also the most heavily weighted domain in the composite score, meaning structural deficiencies deserve priority attention both because they are common in this sample and because they carry greater influence on a facility's overall classification. Second, ownership type appears to matter more than geography or urban/rural setting in this sample: community owned facilities, despite representing less than a quarter of the sample, accounted for three of the four Critical risk facilities, while faith based facilities' weaker performance was concentrated specifically in WASH. If this pattern holds in a larger sample, it would suggest that regulators may get more value from ownership-type-informed targeting than from purely geographic targeting, and, per Section 3.6, that community owned facilities in particular may need support alongside enforcement, not enforcement alone.

The proposed inspection and escalation system in Section 3.6 offers one practical way to apply risk proportionate regulatory practice [3] using this framework's output. Its graduated structure follows the logic of the responsive regulation "enforcement pyramid" [2]: most facilities are expected to correct flagged deficiencies at Tier 1 without further escalation, and progressively stronger responses are reserved for facilities that do not. This design choice matters for a resource-constrained regulator: treating every flagged facility identically, or reaching immediately for suspension, would either overwhelm inspection capacity or discourage the cooperative correction that the pyramid model is built to encourage. Responsive-regulation scholarship also emphasizes that escalation must be credible and consistently applied to work as intended [2], a requirement that has direct implications for the staffing and record-keeping capacity a regulator would need before adopting a system like the one proposed here.

The higher average scores observed among urban facilities are noteworthy because they differ from the common assumption that rural facilities would necessarily have the greatest environmental health risk. It did not hold here. A comparable rural to urban health-facility comparison in Rivers State similarly found infrastructure more constrained in urban than rural tuberculosis-care facilities [5], suggesting this may be a more general pattern in Nigerian facility-based services, plausibly linked to higher enrollment density and more intensive space use in urban childcare facilities offsetting their nominal infrastructure advantages, rather than an anomaly specific to this sample. This pattern may warrant further study, but the present dataset is too small to confirm it.

The main unanswered question about the proposed system in Section 3.6 is whether it would be feasible in routine practice. Adekola [1] documented that environmental health oversight of Nigerian childcare facilities is already fragmented, with roughly a third of states not having domesticated the Child's Rights Act 2003 registration and inspection provisions at the time of that review. A system that requires 7 day and 30 day mandatory reinspections for 13 of 30 facilities in this sample, nearly half, presumes an inspection capacity that may not exist uniformly across states. The system as designed is therefore best read as a target structure to work toward and adapt, not a ready to use operational protocol, and its resourcing requirements would need to be assessed against actual state-level inspectorate capacity before adoption.

### 4.1 Limitations

- Same sample as Adekola [1]: this paper's 30 facilities are identical to the validation pilot in Adekola [1], not an independent or larger application sample. Any pattern reported in Section 3 should be treated as descriptive and hypothesis-generating.
- Small subgroup sizes: with 5 facilities per state and 7 to 8 per ownership category, none of the between group comparisons in Section 3 carry statistical power for formal hypothesis testing, which is why none was attempted.
- No causal inference: this paper reports associations between facility characteristics and risk scores, not causes. Ownership type, for instance, may be a proxy for funding level, staff training, or facility age not captured by this framework.
- The inspection and enforcement system (Section 4) is entirely a design proposal: no facility in this dataset has been taken through it, and no outcome data exist on whether it would improve compliance, reduce risk scores over time, or be administratively workable at scale. Table 5's illustrative application is a demonstration of the logic, not evidence that the system works.
- Legal authority is unconfirmed: Section 3.6.1 and 4.4 note that Tier 3 conditions and Tier 4 suspension/closure referral would need confirmation against Nigeria's actual childcare regulatory law and the the Child's Rights Act 2003 registration and inspection provisions specifically, ideally with legal counsel and a regulatory partner, before any operational use.
- Resourcing is unmodeled: the proposed 7/30/90 day reinspection cadence was not checked against actual inspectorate staffing or budget capacity in any Nigerian state; Section 5 flags this as the central open feasibility question.

- Equity and unintended consequences: a system that escalates enforcement against facilities scoring poorly, without a parallel support mechanism, risks disproportionately penalizing lower resourced ownership types (e.g., community owned facilities, Section 3.4) for conditions partly outside their control, rather than helping them improve; this tension is not resolved by the design proposed here.
- Cross-sectional snapshot: all scores reflect a single assessment per facility at one point in time and do not capture seasonal variation or any change following prior corrective action.

## 5 CONCLUSION

When applied to the 30 facilities included in this analysis, the validated framework identified Structural & Physical Safety as the most common single driver of facility level risk. Community owned and urban facilities were also more frequently represented in the Critical risk category within this sample, and the framework produced a clear priority list for corrective action. Building on that list, this paper proposes a risk tiered inspection cycle and a four-tier escalation pathway that translate the framework's risk bands into an operational structure a regulator could adapt: routine, risk proportionate reinspection intervals; a standardized corrective action notice; and a graduated response that starts cooperative and escalates only when a facility does not correct a flagged deficiency. Both the risk characterization and the proposed system rest on real but limited foundations, the same 30-facility sample used for the tool's own validation, and a system design that has not itself been piloted, and both should be treated as a working foundation for further, independent testing rather than as adopted findings or ready-to-implement policy. The next steps are an independent, larger-scale application of the framework, and a pilot of the proposed inspection and escalation system with a willing regulatory partner to test its feasibility, resourcing requirements, and effect on facility compliance over time.

## STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

### *Acknowledgments*

The authors acknowledge the contributions of the facility assessors and participating childcare facility operators.

### *Disclosure of conflict of interest*

The authors declare no conflict of interest.

### *Statement of ethical approval*

This study reanalyzes the facility level environmental assessment data described in Adekola [1] and collects no new data. As in Adekola [1], all indicators concern the physical and operational condition of the facility itself; no data were collected from or about individual children. Facilities are identified only by role-based code (e.g., CF-001) throughout, consistent with the approach in Adekola [1]. The illustrative escalation examples in Section 3.6.6 use only these existing facility codes and composite scores and do not involve any new data collection, contact with facility operators, or regulatory action; the same open items regarding facility-operator consent and IRB/exemption determination noted in Adekola [1] apply here and are not repeated in full (see Adekola [1], Ethical Considerations).

### *Statement of informed consent*

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 data underlying this paper are the same dataset described in Adekola [1] (Childcare_Environmental_Health_Data.xlsx), including the QA_Validation worksheet documenting independent recomputation of the underlying validity and reliability statistics. The corrective action priority ranking in Table 3, the setting/ownership breakdowns in Section 3, and the illustrative escalation examples in Table 5 were computed directly from that workbook and are reproducible from the facility level Composite_Score and domain-score columns. No dataset documenting actual inspection or enforcement outcomes exists at this time, as the system proposed in Section 4 has not been piloted.

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