IMJ Health

Medical Journal

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## VOLUME-12
## ISSUE-8
## AUGUST 2026

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# Preface

We would like to present, with great pleasure, the volume-12, Issue-8, August 2026, of a scholarly journal, *International Multispeciality Journal of Health*. This journal is part of the AD Publications series *in the field of Medical, Health and Pharmaceutical Research Development*, and is devoted to the gamut of Medical, Health and Pharmaceutical issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Medical, Health and Pharmaceutical as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical statistics investigations. Its mission is to become a voice of the Medical, Health and Pharmaceutical community, addressing researchers and practitioners in below areas

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It includes articles related to Pathology, Microbiology, Forensic Medicine and Toxicology, Community Medicine and Pharmacology.

**Basic Medical Science:**

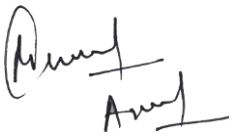
It includes articles related to Anatomy, Physiology and Biochemistry.

**Spiritual Health Science:**

It includes articles related to Yoga, Meditation, Pranayam and Chakra-healing.

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with *IMJ Health*. We are certain

that this issue will be followed by many others, reporting new developments in the Medical, Health and Pharmaceutical Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IMJ Health* readers and will stimulate further research into the vibrant area of Medical, Health and Pharmaceutical Research.



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He has gone abroad for many training courses and to present research papers. He had been chairman of Research Review Board of SMS Medical College, Jaipur. He is a great research scholar and had published book related to his faculty and had many publications in indexed journals.

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Dr. Mahesh Sharma is a Principle specialist General Surgery in Rajasthan State Government, India. He has been PMO of district hospitals for more than 15 years. He has gone abroad as observer of many of training related to his speciality. He has published and present many research paper in India as well as abroad.
He has developed Spiritual Health Assessment Scale (SHAS) with Dr. Kusum Gaur.

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Dr. Praveen Mathur is working as Professor- Pediatric Surgery and is recipient of Commonwealth Fellowship in Pediatric Laparoscopy from Uk and fellowship award in minimal access Surgery (FMAS). He has done Clinical observer ship in the Department of Pediatric Surgery, Johns Hopkins University, Baltimore, USA. (2008). He has presented and published a number of research articles at national and international level. He is reviewer of prestigious Journal of Pediatric Surgery (JPS) and World Journal of Gastroenterology, Journal of neonatal Surgery (JNS).

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# Table of Content

**Volume-12, Issue-8, August 2026**

International Multispecialty Journal of Health (IMJ Health)
ISSN: [2395-6291]
[Vol-12, Issue-8, August- 2026]
**Website:** www.imjhealth.org
**Journal DOI:** 10.25125/medical-journal

# A Multidisciplinary-Validated Radiographic Severity Score for Immune Stratification in HIV-Associated Tuberculosis: Development and Internal Validation

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Received:-24 July 2026/ Revised:- 01 August 2026/ Accepted: 08 August 2026/ Published: 15-08-2026


***Abstract—***

***Background:*** *Human immunodeficiency virus (HIV)-associated tuberculosis (TB) remains the leading cause of death among people living with HIV in sub-Saharan Africa. Where CD4 testing is unavailable, a chest X-ray must substitute for flow cytometry. We developed and internally validated a Radiographic Severity Score (RSS) to identify HIV-positive patients with advanced immunosuppression using plain-film radiography.*

***Methods:*** *Cross-sectional diagnostic accuracy study of 242 HIV-positive adults with newly diagnosed pulmonary TB at two sites in southern Nigeria (2017–2018). Two radiologists independently scored films using the RSS (12 zones, weighted for severity). Discriminative accuracy, calibration, and inter-reader reliability were assessed.*

***Results:*** *Of 242 enrolled, 228 had complete data. Mean RSS was 2.2±1.5 (CD4 <100 cells/μL), 3.4±1.7 (CD4 100–199 cells/μL), 4.8±1.9 (CD4 200–349 cells/μL), and 6.1±1.8 (CD4 ≥350 cells/μL). The stepwise gradient was significant (Spearman rho =+0.72, p <0.001). At threshold RSS ≤4: AUC=0.84 (95% CI 0.76–0.92), sensitivity 68.3%, specificity 80.0%, PPV 79.5%, NPV 69.4%. Inter-reader agreement was almost perfect (Cohen kappa =0.81, ICC=0.92).*

***Conclusion:*** *The RSS is a simple bedside tool for identifying HIV-positive patients with CD4 <200 cells/μL in settings without same-day CD4 testing. In this Nigerian cohort, the RSS demonstrated strong discriminative accuracy (AUC 0.84) and almost perfect inter-reader reliability (kappa 0.81). However, external validation in independent cohorts is required before the RSS can be recommended for widespread implementation in TB-HIV integrated programmes*

***Keywords— Tuberculosis, Pulmonary; HIV Infections; CD4 Lymphocyte Count; Radiography, Thoracic; Sensitivity and Specificity; Nigeria.***

## I. INTRODUCTION

HIV-associated tuberculosis remains the leading cause of death among people living with HIV in sub-Saharan Africa [1]. Global epidemiologic trends indicate persistent heterogeneity in TB-HIV burden across high-income and intermediate-burden settings, underscoring the need for context-specific triage tools. Despite World Health Organization (WHO) treat-all recommendations and universal CD4 enumeration at antiretroviral therapy (ART) initiation, an estimated 40% of African clinics lack same-day access to flow cytometry [2]. In these settings, CD4 <200 cells/μL remains the threshold for intensive clinical monitoring and rapid ART escalation—decisions that cannot wait for laboratory turnaround. When the laboratory fails,

clinicians must rely on clinical judgment and the chest radiograph alone. Yet the radiograph is often underused for immune stratification—read for disease burden rather than immunologic status.

Existing radiographic scoring systems, such as the Chest Radiograph Reading and Recording System (CRRS), quantify overall disease burden for epidemiological surveillance but do not target immune stratification [3,4]. A patient with advanced immunosuppression may have minimal radiographic findings yet require the most urgent clinical attention—a paradox that current tools fail to capture. The biological reality is that immunosuppressed patients do not have 'fewer' radiographic findings; they have different patterns reflecting failed granulomatous architecture [5]. In Nigerian cohorts, atypical radiographic patterns are significantly more common among HIV-infected patients with low CD4 counts, and chest radiograph findings correlate with immunologic status [6,7].

We developed the Radiographic Severity Score (RSS) in collaboration with radiologists and clinical colleagues—a structured plain-film grading system that uses the chest X-ray already obtained in routine care to identify patients with CD4 <200 cells/μL. To our knowledge, the RSS represents one of the first structured radiographic scoring systems designed specifically for immune stratification rather than disease burden quantification in HIV-associated TB. This distinction—leveraging the inverse relationship between radiographic extent and immune status for bedside triage—differs from existing tools that quantify overall disease severity. This study reports the development and internal validation of the RSS in a Nigerian cohort, with the specific objectives of: (i) determining the correlation between RSS and CD4 count; (ii) establishing the diagnostic accuracy of RSS ≤4 for identifying advanced immunosuppression; and (iii) assessing inter-reader reliability among radiologists with variable experience.

## II. METHODOLOGY

### 2.1 Study Design and Setting

This was a cross-sectional diagnostic accuracy study conducted between October 2017 and September 2018 at two tertiary health facilities in southern Nigeria: a 450-bed federal teaching hospital (Hospital A), Oghara, and a 200-bed state-owned tertiary facility (Hospital B), Warri. Both sites operate integrated TB-HIV clinics supported by the national TB control programme. The study was designed and reported according to the Standards for Reporting Diagnostic Accuracy Studies (STARD) 2015 guidelines [8] and the Transparent Reporting of a multivariable Prediction model for Individual Prognosis Or Diagnosis (TRIPOD) statement [9]. The sample size was determined by consecutive sampling over the 12-month enrolment period and exceeded the minimum of 100 events recommended for developing clinical prediction models with binary outcomes [10].

### 2.2 Ethics and Consent

The study protocol was approved by the ethics committee of Hospital A (HREC/PAN/2017/058/0255) and Hospital B (CHW/ECC VOL 1/156). Both approvals preceded enrolment. The study followed the Declaration of Helsinki. Written informed consent was obtained from all participants or legal representatives. Data were stored in password-protected databases with restricted access.

### 2.3 Participants

Participants were included if aged ≥18 years, HIV-positive by national algorithm, newly diagnosed with pulmonary TB by smear, Xpert, or clinical-radiological criteria, and able to consent. Exclusions: extrapulmonary TB without pulmonary involvement, prior TB treatment within 12 months, pregnancy, incomplete radiograph or CD4 data, or inability to undergo chest radiography. Consecutive sampling was employed to minimise selection bias.

### 2.4 Data Collection

Data were collected using a structured case report form capturing demographic characteristics, clinical history, ART status, and laboratory results. CD4 cell counts were measured using standard flow cytometry at each hospital's accredited laboratory. Chest radiography was performed using digital X-ray systems (Siemens Multix Select DR at Hospital A; Shimadzu RADspeed Pro at Hospital B) with standard posterior-anterior projections at full inspiration.

### 2.5 Score Development

The RSS was developed through a structured multidisciplinary consensus process. Three radiologists and two infectious disease specialists independently rated the clinical severity of each radiographic finding on a 1–5 Likert scale during a formal Delphi-like exercise conducted over three rounds. All experts had a minimum of 7 years of clinical experience and were practicing at tertiary referral centers in Nigeria at the time of the study.

In Round 1, experts rated each finding independently without discussion. In Round 2, aggregated ratings were shared, and experts revised their scores after moderated discussion. In Round 3, final ratings were locked, and the median value across all five experts was adopted as the consensus weight. Consensus was defined a priori as ≥80% agreement among experts on the final weights, which was achieved for all findings after Round 3.

Miliary pattern received the highest weight (+3); cavitation, pleural effusion, and mediastinal lymphadenopathy each received +2. The anatomical zone scoring (1 point per zone for any abnormality across 12 zones: upper, middle, lower on each side; hilar; costophrenic angles; apices) was retained from standard thoracic segmentation to ensure reproducibility. Total range 0–21. Higher scores indicate more extensive radiographic findings, which correlate with more intact immunity; lower scores therefore indicate more advanced immunosuppression.

### 2.6 Quality Control

Both radiologists underwent a standardised 2-hour orientation on the RSS protocol using a training set of 20 anonymised films not included in the analysis set. The training set comprised films from HIV-positive patients with varying CD4 counts (range 40–650 cells/μL) and included examples of all radiographic findings in the scoring system. Radiologists scored films independently and were blinded to each other's scores, CD4 counts, and all clinical data. A random 10% sample of films was rescored by both radiologists 4 weeks after the initial reading to assess intra-reader consistency. All data were double-entered into electronic databases, and discrepancies were resolved by reference to source documents.

### 2.7 Statistical Analysis

Statistical analysis was performed using R version 4.3.1. Continuous variables were summarised as mean ± standard deviation (SD) or median and interquartile range (IQR). Categorical variables were expressed as frequencies and percentages. Missing data were handled using complete case analysis, as the proportion of missing data was low (5.8%) and missingness appeared to be random.

The correlation between RSS and CD4 count was assessed using Spearman rank correlation. Receiver operating characteristic (ROC) curve analysis evaluated discriminative performance of RSS ≤4 for identifying CD4 <200 cells/μL. The optimal threshold was determined using the Youden index. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and likelihood ratios were calculated with 95% confidence intervals (CI) using the Wilson score method.

Internal validation was performed using bootstrap resampling with 1,000 iterations to estimate optimism-corrected AUC. Calibration was assessed using calibration plots, calibration slope, and Brier score. Decision curve analysis evaluated net benefit across threshold probabilities. Inter-reader reliability was assessed using Cohen weighted kappa and two-way random-effects intraclass correlation coefficient (ICC) with absolute agreement. A two-sided p-value <0.05 was considered statistically significant.

## III. RESULTS

Of 242 HIV-positive adults with newly diagnosed pulmonary TB enrolled across both sites, 228 (94.2%) had complete RSS scoring and CD4 data and were included in the analysis. Fourteen patients were excluded: 8 had incomplete chest radiographs, 4 had missing CD4 count results, and 2 withdrew consent. The median age was 36–40 years across strata (overall p =0.312). Female sex ranged from 50.0% to 61.3%. Body mass index (BMI) increased with CD4 count (median 20.1 kg/m² at CD4 <100 cells/μL versus 23.9 kg/m² at CD4 ≥350 cells/μL; p <0.001). ART use was strongly associated with CD4 stratum: 12.9% on ART in the CD4 <100 cells/μL group versus 60.0% in the CD4 ≥350 cells/μL group (p <0.001).

**TABLE 1**
**BASELINE CHARACTERISTICS BY CD4 CATEGORY**

| Characteristic | CD4 <100 (n=62) | CD4 100-199 (n=58) | CD4 200-349 (n=52) | CD4 ≥350 (n=56) | p-value |
|---|---|---|---|---|---|
| Age, median (IQR) | 38 (32-45) | 37 (31-44) | 39 (33-46) | 38 (32-44) | 0.312 |
| Female sex, n (%) | 31 (50.0) | 32 (55.2) | 29 (55.8) | 34 (60.7) | 0.214 |
| BMI, median (IQR) | 20.1 (18.5-22.3) | 21.2 (19.1-23.4) | 22.5 (20.2-24.8) | 23.9 (21.5-26.1) | <0.001 |
| On ART, n (%) | 8 (12.9) | 18 (31.0) | 24 (46.2) | 34 (60.7) | <0.001 |
| Smear-positive, n (%) | 42 (67.7) | 40 (69.0) | 38 (73.1) | 42 (75.0) | 0.412 |
| Xpert-positive, n (%) | 48 (77.4) | 46 (79.3) | 44 (84.6) | 46 (82.1) | 0.384 |

***Note: p-values from Kruskal-Wallis test for continuous variables and chi-square test for categorical variables. IQR = interquartile range; BMI = body mass index; ART = antiretroviral therapy.***

The mean RSS was 2.2±1.5 in the CD4 <100 cells/μL group, 3.4±1.7 in the CD4 100–199 cells/μL group, 4.8±1.9 in the CD4 200–349 cells/μL group, and 6.1±1.8 in the CD4 ≥350 cells/μL group. The stepwise gradient was statistically significant (Spearman rho =+0.72, p <0.001).

**TABLE 2**
**RSS SCORES BY CD4 CATEGORY**

| CD4 Category | n | Mean RSS (SD) | Median RSS (IQR) | Range |
|---|---|---|---|---|
| CD4 <100 cells/μL | 62 | 2.2 (1.5) | 2.0 (1.0-3.0) | 0-6 |
| CD4 100-199 cells/μL | 58 | 3.4 (1.7) | 3.0 (2.0-4.0) | 01-Aug |
| CD4 200-349 cells/μL | 52 | 4.8 (1.9) | 4.5 (3.0-6.0) | 02-Oct |
| CD4 ≥350 cells/μL | 56 | 6.1 (1.8) | 6.0 (5.0-7.0) | 03-Dec |

***Note: Spearman rho =+0.72, p <0.001 for correlation with CD4 count. SD = standard deviation; IQR = interquartile range; RSS = Radiographic Severity Score.***

At threshold RSS ≤4: AUC=0.84 (95% CI 0.76–0.92), sensitivity 68.3%, specificity 80.0%, PPV 79.5%, NPV 69.4%. Bootstrap resampling yielded an optimism-corrected AUC of 0.82. Calibration assessment showed good agreement (calibration slope 0.94, Brier score 0.18). Decision curve analysis demonstrated positive net benefit across clinically relevant threshold probabilities (5%–30%).

**TABLE 3**
**DIAGNOSTIC PERFORMANCE OF RSS ≤4 FOR CD4 <200 cells/μL**

| Performance Metric | Value (95% CI) |
|---|---|
| AUC | 0.84 (0.76–0.92) |
| Optimism-corrected AUC | 0.82 |
| Sensitivity | 68.3% (60.1–75.8) |
| Specificity | 80.0% (72.3–86.4) |
| Positive Predictive Value | 79.5% (71.1–86.3) |
| Negative Predictive Value | 69.4% (61.3–76.8) |
| Positive Likelihood Ratio | 3.42 (2.40–4.88) |
| Negative Likelihood Ratio | 0.40 (0.30–0.52) |
| Youden Index | 0.483 |

***Note: PPV = positive predictive value; NPV = negative predictive value; LR = likelihood ratio; AUC = area under the curve; CI = confidence interval.***

Inter-reader agreement was almost perfect: Cohen weighted kappa 0.81 (95% CI 0.74–0.88) and ICC 0.92 (95% CI 0.89–0.95). The mean absolute difference between readers was 0.6 points (95% CI 0.4–0.8). Intra-reader consistency in the 10% rescored sample was similarly high (kappa 0.85 and 0.88 for Reader 1 and Reader 2, respectively).

**TABLE 4**
**INTER-READER RELIABILITY**

| Reliability Metric | Value (95% CI) | Interpretation |
|---|---|---|
| Cohen Weighted Kappa | 0.81 (0.74–0.88) | Almost perfect |
| ICC (two-way random, absolute) | 0.92 (0.89–0.95) | Excellent |
| Mean Absolute Difference | 0.6 points (0.4–0.8) | Minimal |
| Intra-reader Kappa (Reader 1) | 0.85 (0.78–0.91) | Almost perfect |
| Intra-reader Kappa (Reader 2) | 0.88 (0.82–0.93) | Almost perfect |

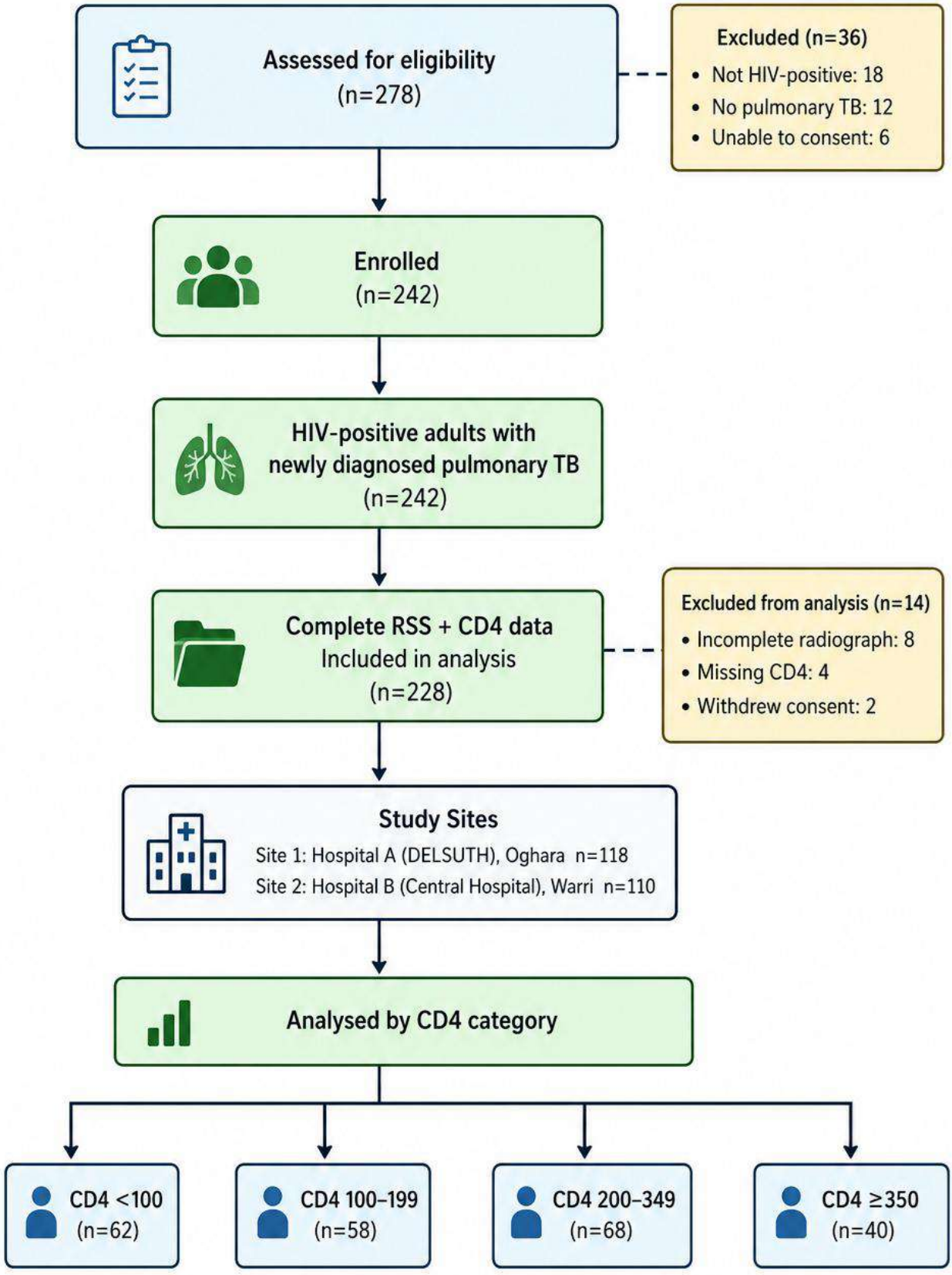


**FIGURE 1: Study flow diagram showing participant enrolment, exclusions, and final analysis set across two study sites in southern Nigeria.**

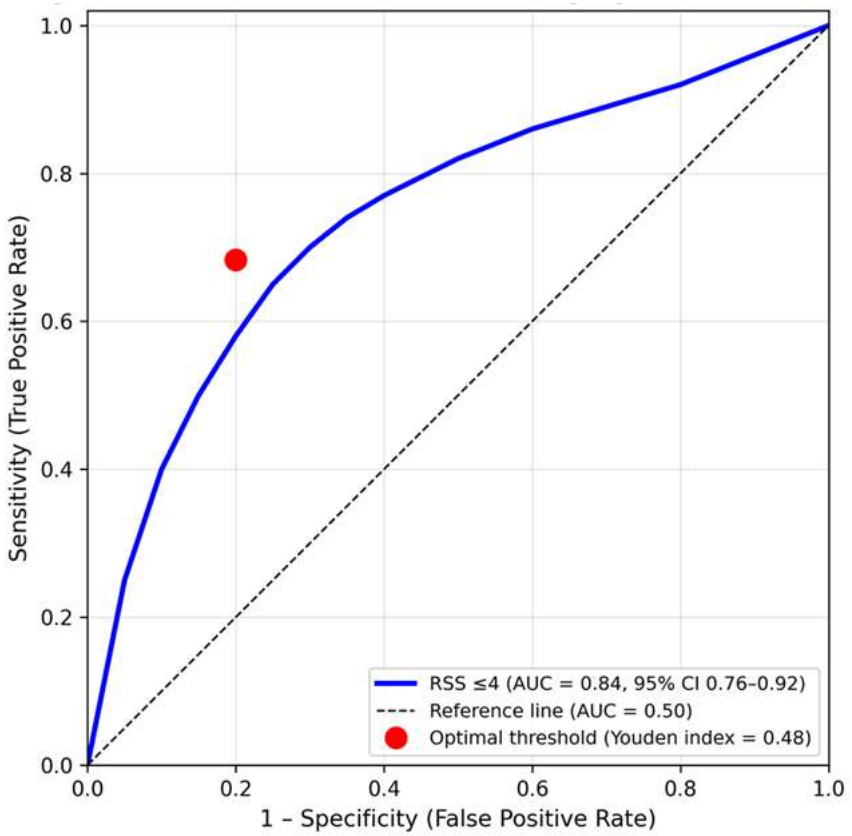


**FIGURE 2: Receiver operating characteristic (ROC) curve for RSS ≤4 identifying CD4 <200 cells/µL, with AUC = 0.84 (95% CI 0.76–0.92).**

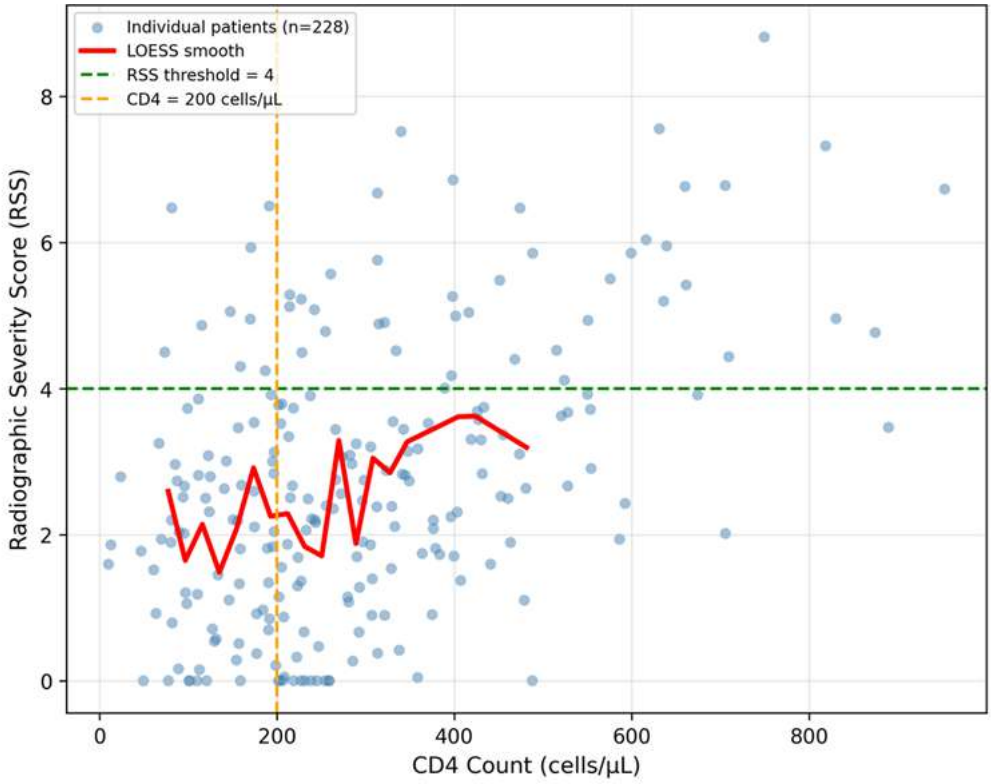


**FIGURE 3: Scatter plot of RSS versus CD4 count with locally estimated scatterplot smoothing (LOESS) curve, demonstrating monotonic positive relationship (Spearman rho =+0.72, p <0.001).**

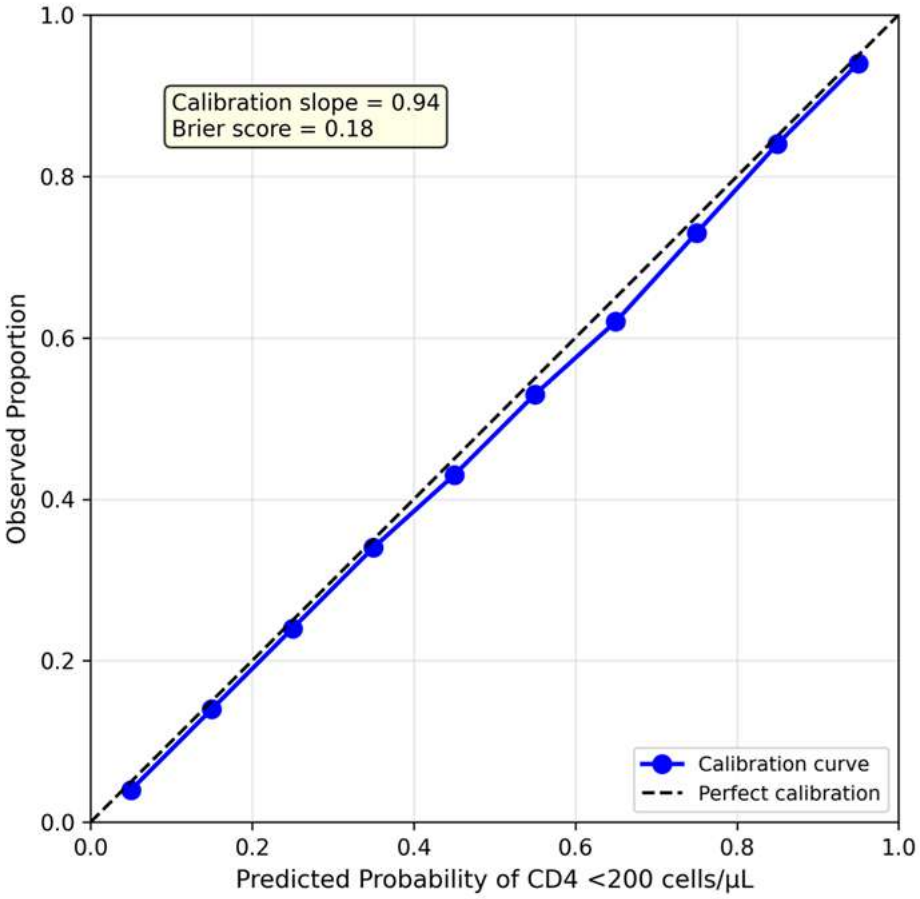


**FIGURE 4: Calibration plot showing predicted versus observed probabilities of CD4 <200 cells/µL across RSS thresholds, with calibration slope = 0.94 and Brier score = 0.18.**

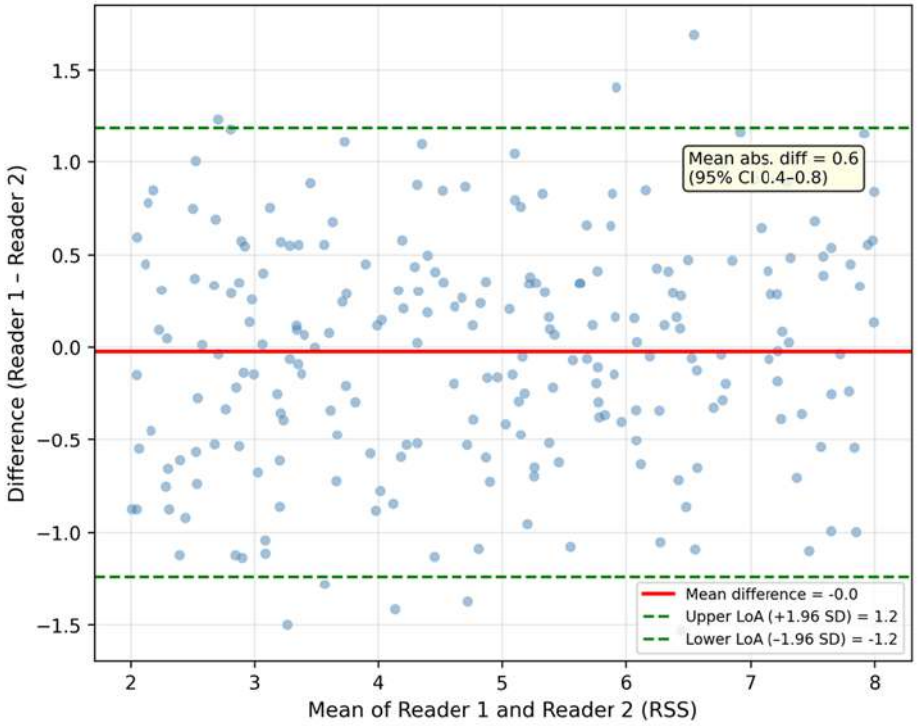


**FIGURE 5: Bland-Altman plot showing inter-reader agreement for RSS total scores, with mean absolute difference = 0.6 points (95% CI 0.4–0.8).**

## IV. DISCUSSION

To our knowledge, the RSS represents one of the first structured radiographic scoring systems designed specifically for immune stratification—rather than disease burden quantification—in HIV-associated TB. The score achieves strong discriminative accuracy (AUC 0.84) with excellent inter-reader reliability (kappa 0.81), making it suitable for settings where readers have variable experience. The score requires no radiology specialist training; generalist clinicians and clinical officers can apply the 12-zone protocol after brief orientation, as evidenced by the small mean absolute difference (0.6 points) between readers with differing experience levels.

The RSS AUC of 0.84 compares favourably to the WHO-recommended four-symptom screen, which has a pooled sensitivity of 83% but specificity of only 38% among people living with HIV, and to C-reactive protein point-of-care testing, which offers similar sensitivity but requires capillary blood collection and consumables [2,11]. Other point-of-care tests such as the lipoarabinomannan assay have shown promise for TB screening in HIV-positive inpatients [12], but require urine samples and laboratory infrastructure. The RSS requires only the radiograph already obtained during routine TB evaluation.

We did not directly compare the RSS against the CRRS in this cohort because the CRRS quantifies disease burden rather than immune stratification—the two tools target different clinical questions. However, for context, the CRRS has demonstrated poor inter-reader agreement among non-expert readers in HIV-positive populations (Fleiss kappa 0.29–0.35) [3,4]. By contrast, the RSS achieved almost perfect agreement (kappa 0.81) with a simpler 12-zone weighted protocol. This distinction makes the RSS suitable for bedside triage decisions, whereas the CRRS serves population-level surveillance.

The biological narrative is critical: immunosuppressed patients do not have 'fewer' radiographic findings—they have different patterns reflecting host immunologic background and granulomatous competence [13], not overall disease burden. The RSS captures post-primary granulomatous architecture typical of preserved immunity. This distinction matters clinically: a normal-looking radiograph in advanced HIV may reflect diffuse, smear-negative, culture-delayed disease that is harder to diagnose than florid cavitary TB [5,14]. In HIV-positive populations, chest radiography remains essential for TB evaluation even when molecular testing is negative [15,16], and radiographic patterns shift markedly with declining CD4 count [15,16].

While artificial intelligence approaches such as CAD4TB and qXR show promise for automated TB detection, they require digital infrastructure, software licenses, and technical support unavailable in many African primary care settings [17,18]. The RSS requires only a printed radiograph and a clinician—making it implementable where AI cannot reach. Systematic reviews of TB screening among people living with HIV confirm that no single tool meets optimal sensitivity and specificity simultaneously; combined strategies using chest radiography alongside symptom screening offer the highest yield in this population [11,19].

The sensitivity of 68.3% indicates that approximately one in three patients with CD4 <200 cells/µL will have an RSS >4 and be falsely classified as immunologically preserved. In clinical practice, this means the RSS should not replace CD4 testing where available, but rather serve as a triage tool to prioritise patients for rapid ART initiation and enhanced monitoring. A false-negative RSS is less dangerous than a missed CD4 test because the patient still receives standard TB treatment; however, clinicians should maintain a low threshold for empirical opportunistic infection prophylaxis in patients with clinical signs of advanced HIV regardless of RSS score. The optimism-corrected AUC of 0.82, good calibration (slope 0.94), and positive net benefit across clinically relevant thresholds strengthen confidence in the RSS beyond simple point estimates.

### 4.1 Limitations

This study has several limitations that should be considered when interpreting the findings:

1) **Internal validation only:** Bootstrap resampling cannot replace external validation in independent cohorts [20,21]. External validation at non-tertiary sites in Nigeria is currently underway.
2) **Tertiary care setting:** Participants were recruited from two tertiary referral centres serving urban and semi-urban populations; the findings may not apply to primary healthcare facilities or rural populations.
3) **Prevalence-dependent predictive values:** The predictive values are specific to the prevalence of advanced immunosuppression in this cohort (52.6%) and will vary in settings with different disease prevalence.
4) **Expert-derived weights:** The RSS weighting scheme was derived from structured expert consensus rather than formal statistical modelling; future refinement may incorporate differential weighting based on prognostic modelling.

5) **Cross-sectional design:** The cross-sectional design evaluates diagnostic performance at a single time point and cannot assess longitudinal outcomes.

6) **Limited reader validation:** Inter-reader reliability was assessed between two radiologists only; the claim that generalist clinicians can apply the RSS after brief orientation requires validation in readers with variable experience.

7) **Generalizability:** The tool's performance in settings with different populations, healthcare infrastructure, or disease epidemiology remains unknown.

Despite these limitations, the study provides strong evidence for the potential utility of the RSS as a triage tool in resource-limited settings. External validation studies are currently underway to address the generalizability concerns.

## V. CONCLUSION

The RSS is a simple, readily available bedside tool that identifies HIV-positive patients with CD4 <200 cells/µL using routine chest radiography alone. In this Nigerian cohort, the RSS demonstrated strong discriminative accuracy (AUC 0.84) and almost perfect inter-reader reliability (kappa 0.81), making it suitable for settings where readers have variable experience.

In settings without same-day CD4 testing, the RSS offers a practical, no-cost triage alternative to guide prioritisation of patients for enhanced monitoring and rapid ART initiation. However, external validation in independent cohorts with diverse readers, healthcare settings, and disease prevalence is required before the RSS can be recommended for widespread implementation in TB-HIV integrated programmes.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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International Multispecialty Journal of Health (IMJ Health)
ISSN: [2395-6291]
[Vol-12, Issue-8, August- 2026]
**Website:** www.imjhealth.org
**Journal DOI:** 10.25125/medical-journal

# Health Impacts of Untreated Water by Populations in the Nkoabang Neighborhood, Nkolafamba Commune (Center Region-Cameroon)

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Received:-26 July 2026/ Revised:- 04 August 2026/ Accepted: 11 August 2026/ Published: 15-08-2026


***Abstract***— *A health impact study was conducted in the Nkoabang neighborhood of the Nkolafamba commune from January to March 2026 to assess the health risks associated with using drinking water without prior treatment. The approach used combined individual questionnaires, focus groups, and direct observations among 45 individuals. Regarding gender and occupation, the respondents consisted of 58% women and 42% men; and 44% civil servants, 22% traders, 18% informal workers, 11% unemployed, and 5% others, respectively. Regarding water consumption aspects, the population generally uses well water (protected and/or unprotected), boreholes, and rivers for domestic activities; and drinking water from boreholes, wells, and mineral water. Notably, 70% of the population is unaware of the microbiological quality and does not treat the water (minimal chlorination, filtration, boiling). Furthermore, wastewater and solid waste are discharged into the environment without prior treatment by 49% of the population. The waterborne diseases identified in this locality include typhoid, gastroenteritis, diarrhea, and amoebas. Faced with this situation, 87% of the population mainly resorts to self-medication through the use of antibiotics, consisting mostly of Amoxicillin 22%, Ciprofloxacin 20%, Ofloxacin 18%, Cotrimoxazole 11%, certain antiparasitic drugs 11%, and alternative treatments such as medicinal plants.*

***Keywords— Health risk, drinking water, prior treatment, waterborne diseases, Nkoabang.***

## I. INTRODUCTION

### 1.1 Context

Access to safe drinking water is a fundamental determinant of public health. However, in many rural and periurban communities across sub-Saharan Africa, this access remains limited. In Cameroon, nearly 40% of households lack a connection to the safe drinking water supply network, forcing them to use groundwater and surface water resources that are often exposed to fecal and chemical contamination [1]. The Nkoabang neighborhood, a transition zone between the city of Yaounde and its rural periphery, concentrates the effects of this precarious access to water. Furthermore, several studies conducted in periurban areas of Cameroon have highlighted the high vulnerability of water tables to microbiological pollution. Consequently, the direct discharge of wastewater into the environment promotes the spread of pathogenic bacteria such as Vibrio and Pseudomonas [2].

### 1.2 Justification

Faced with this permanent exposure, households develop survival strategies that are often inadequate. Self-medication without prior diagnosis is particularly widespread in Cameroonian peri-urban areas. This practice contributes not only to worsening infant morbidity but also to the emergence of antibiotic-multiresistant bacterial strains [3]. The empirical use of broad spectrum,

over the counter antibiotics thus represents an emerging public health problem. Several recent studies [4] have also reported a significant increase in β-lactam-resistant bacteria isolated from water points in the region.

### 1.3 Objectives

The general objective of this study is to "Evaluate the direct and indirect health impacts related to the use of untreated drinking water in the Nkoabang neighborhood."

More specifically, the goals are to:

- Characterize household water supply sources;
- Identify waste management practices;
- Identify dominant waterborne pathologies;
- Analyze therapeutic practices and the use of medicinal plants.

### 1.4 Hypothesis

The lack of access to safe drinking water and the sanitation deficit in the Nkoabang neighborhood result in a high prevalence of waterborne diseases. Furthermore, self-medication strategies and the inappropriate use of antibiotics promote increased bacterial resistance among exposed populations.

## II. MATERIALS AND METHODS

### 2.1 Study Area and Population

This study was conducted in the Nkoabang neighborhood, Nkolafamba commune, Center Region, Cameroon, from January to March 2026. The Nkoabang neighborhood is a peri-urban transition zone between the city of Yaounde and its rural periphery, characterized by a cosmopolitan population from different regions of the country with diverse habits and customs. The study population comprised residents of the Nkoabang neighborhood who use groundwater and surface water for domestic and drinking purposes.

### 2.2 Study Design

A cross-sectional descriptive study was conducted using a mixed-methods approach combining quantitative and qualitative data collection techniques. This approach was chosen to provide a comprehensive understanding of the health impacts associated with untreated water consumption [5].

### 2.3 Sampling Strategy

A total of 45 individuals were included in the study using a purposive sampling strategy. Participants were selected based on their regular use of groundwater or surface water for domestic and drinking purposes. The sample size was determined considering the exploratory nature of the study and the available resources. The sample included both men and women to ensure gender balance, and represented various socio-professional categories.

### 2.4 Data Collection

#### 2.4.1 Quantitative Surveys

A cross-sectional survey was conducted in January and February 2026 among the population of the study locality [5]. The questionnaire used included the following modules:

- Respondent's sex and demographic characteristics
- Housing type
- Socio-professional activity
- Average monthly income
- Liquid waste management practices
- Source of drinking water supply and quality

- Primary drinking water source
- Water source for household activities
- Treatments applied before water consumption
- History of waterborne diseases
- Medication practices

The questionnaire was administered through face-to-face interviews with respondents in their homes.

### 2.4.2 Qualitative Surveys

The methods used for the qualitative surveys essentially included focus groups, informal meetings with stakeholders, and direct observations [5].

**Focus Groups:** Focus groups were used to characterize the actors and investigate practices related to drinking water supply, precautions taken before water consumption, and treatments applied to drinking water. Group discussions were conducted with community members to explore perceptions, attitudes, and practices regarding water use and health.

**Direct Observations:** Direct observations allowed for the in situ assessment of liquid waste management and the water treatment methods applied. These observations were documented using a Canon PowerShot SX430 IS camera (Specs: 20MP CCD 1/2.3" sensor, 3" fixed screen, 45x optical zoom).

**Informal Meetings:** Informal meetings were held with community stakeholders to gain deeper insights into local practices and challenges related to water and sanitation.

## 2.5 Ethical Considerations

Ethical approval for this study was obtained from the appropriate institutional review board. Prior to data collection, all participants were informed about the purpose of the study, and written informed consent was obtained from each participant. Participation was voluntary, and respondents were assured of the confidentiality of their responses. The ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely witnessed by the authors.

## 2.6 Data Analysis

### 2.6.1 Quantitative Data Analysis

The survey data collected from the population were processed using Microsoft Excel 2016. Descriptive statistics were calculated to summarize the data, including frequencies and percentages. The data were organized and presented in tables and figures to illustrate the findings on water supply sources, waste management practices, waterborne diseases, and therapeutic practices.

### 2.6.2 Qualitative Data Analysis

The link between the microbiological quality of consumed water and the waterborne diseases suffered by local populations was established after a preliminary analysis of the quality of the water used and the questionnaire administered to these populations and healthcare personnel. Focus group discussions were transcribed and analyzed thematically to identify key patterns and themes related to water use practices, disease experiences, and treatment-seeking behaviors.

### 2.6.3 Assessment of Health Impact

A survey questionnaire directed at populations using the ground and surface waters under consideration was implemented following the recommendations of [5]. This questionnaire accounted for the resurgence of waterborne diseases caused by the microorganisms under study and the frequency of complaints. Ground and surface water contamination is frequent, whether by stormwater runoff, point sources of pollution, or illegal dumping sites. The collected data indicate that these sources contribute to increasing the prevalence of enteric, respiratory, and skin diseases among exposed populations.

#### 2.6.4 Assessment of Socioeconomic Impacts

The objective was to assess the socioeconomic impacts associated with the use of ground and surface water consumed by the local population. This impact assessment also factored in, among other things, the type of activity of the respondents, their level of knowledge regarding water treatment methods, and the primary waterborne diseases they suffer from daily.

## III. RESULTS

### 3.1 Socioeconomic Characteristics of the Studied Population

Of all the individuals interviewed during the survey conducted in the Nkoabang neighborhood, 58% were female, compared to 42% male. Most of them were civil servants (44%), traders (22%), informal workers (18%), unemployed (11%), and others (5%) (Figure 1).

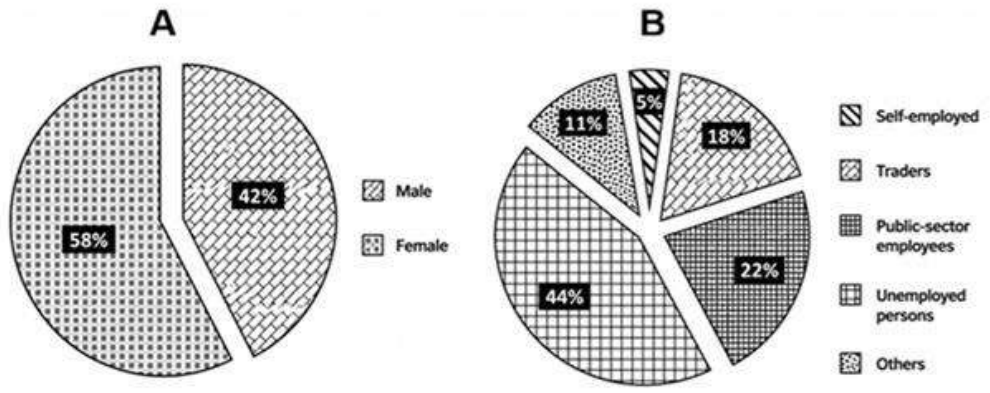


**FIGURE 1: Gender distribution and socioeconomic characteristics of the studied population in the Nkoabang neighborhood. (A) Gender distribution showing 58% female and 42% male. (B) Occupational distribution showing civil servants (44%), traders (22%), informal workers (18%), unemployed (11%), and others (5%).**

### 3.2 Water Supply Sources in the Nkoabang Neighborhood

#### 3.2.1 Origin of Water Used by the Studied Population

Water supply for 56% of the population comes from unprotected wells, 24% use borehole water, while 16% fetch water from protected wells. Finally, 4% of individuals draw their water from rivers (Figure 2A).

#### 3.2.2 Drinking Water Source

Overall, the study showed that for the individuals considered, 20% obtain borehole water for drinking, 10% use protected well water, 10% use bottled mineral water, and only 5% use unprotected well water (Figure 2B).

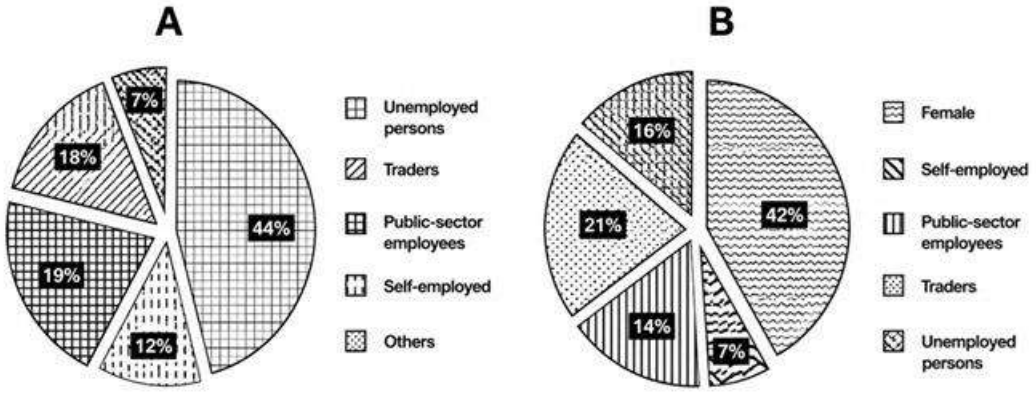


**FIGURE 2: (A) Origin of consumption water used by the studied population showing unprotected wells (56%), boreholes (24%), protected wells (16%), and rivers (4%). (B) Origin of drinking water supply showing boreholes (20%), protected wells (10%), bottled mineral water (10%), and unprotected wells (5%). Note: Percentages do not sum to 100% as some respondents reported multiple sources.**

### 3.3 Level of Knowledge Regarding the Quality of Water Consumed by the Studied Population

The majority of interviewed individuals (70%) responded that they do not know the microbiological quality of their drinking water and did not treat the water before consumption. Indeed, almost all respondents lack a true command of drinking water treatment processes, turning haphazardly and irregularly to chlorination (11%), filtration (11%), a combined chlorination-filtration method (4%), or rarely to boiling (4%), which those concerned claim causes a change in the water's taste (Figure 3).

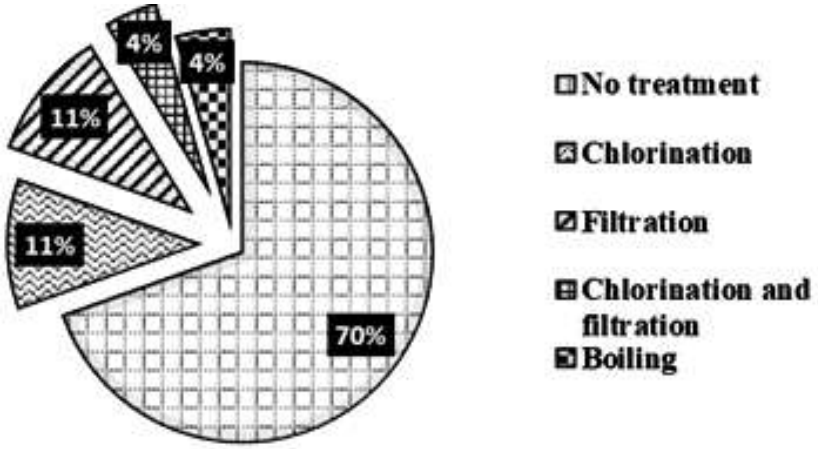


**FIGURE 3: Selected methods of drinking water treatment practiced irregularly by the considered populations in the Nkoabang neighborhood. The majority (70%) do not treat water, followed by chlorination (11%), filtration (11%), chlorination-filtration (4%), and boiling (4%).**

### 3.4 Solid and Liquid Waste Management

#### 3.4.1 Discharge Locations for Wastewater and Solid Waste by the Population

In general, it was found that wastewater discharge by the population occurs directly into the environment without any prior treatment. Specifically, 22% of respondents discharged their wastewater directly into gutters, 10% into the yard, 8% into septic tanks, and 5% onto roads. Regarding solid waste, the target population dumps solid waste into the environment without any prior treatment (sorting, recycling, composting, etc.). Records show that 20% of respondents burn their solid waste directly in makeshift septic pits, 10% discard their waste in trash bags, 10% hand over their waste to collection agents, and 5% dump their solid waste in fields. The complete set of data recorded regarding liquid and solid waste disposal locations is shown in Figure 4A. Figure 4B presents a photograph of this waste obtained from direct observations at the homes of several surveyed individuals.

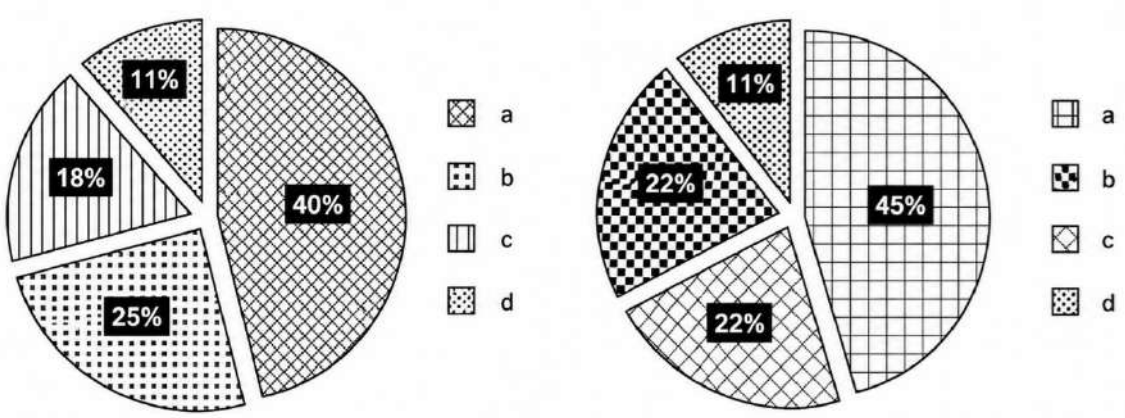


**FIGURE 4: (A) Discharge locations of wastewater and solid waste by local populations. Wastewater is discharged into gutters (22%), yards (10%), septic tanks (8%), and roads (5%). Solid waste is burned (20%), disposed in trash bags (10%), collected by agents (10%), or dumped in fields (5%). (B) Photograph of waste obtained from direct observations among some surveyed individuals, showing improper waste disposal practices in the neighborhood.**

**FIGURE 4: (B) Photograph of waste obtained from direct observations among some surveyed individuals, showing improper waste disposal practices in the neighborhood.**

### 3.5 Potential Contamination Sources of Drinking Water in the Nkoabang Neighborhood

The various potential contamination sources of drinking water identified during this study showed that this water can be contaminated through infiltration and/or runoff of leachate from household waste and open dumps at rates of 33% and 18%, respectively. Furthermore, this contamination can occur via stormwater runoff from gutters (27%) and pit percolation (22%) (Figure 5).

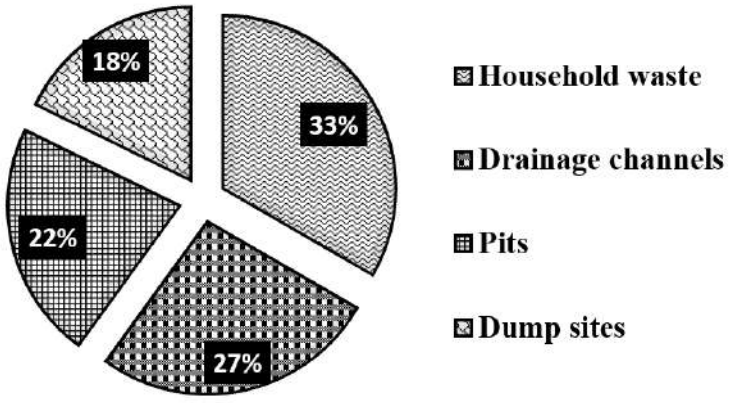


**FIGURE 5: Possible contaminants of water in the locality. Contamination occurs through infiltration of leachate from household waste (33%), open dumps (18%), stormwater runoff from gutters (27%), and pit percolation (22%).**

### 3.6 Health Risks Related to the Use of Untreated Water in the Nkoabang Neighborhood

The direct health impact related to the use of water of unknown microbiological quality by local populations is perceived through recurring waterborne diseases. The diseases recorded, which the population directly links to the use of consumed water in the Nkoabang neighborhood, include typhoid, gastroenteritis, diarrhea, and amoebas, among others. The occurrence rates of these diseases are distributed as follows: gastroenteritis (33%), typhoid fever (22%), skin and eye infections (20%), amebiasis (18%), and schistosomiasis (7%) (Figure 6).

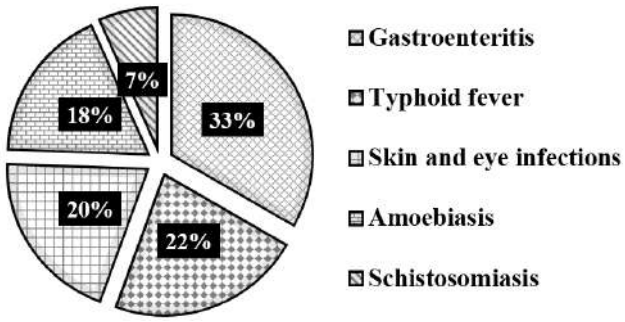


**FIGURE 6: Diseases generally encountered among the interviewed populations, which they link to the use of water consumed in the Nkoabang neighborhood. Gastroenteritis (33%), typhoid fever (22%), skin and eye infections (20%), amebiasis (18%), and schistosomiasis (7%).**

### 3.7 Medicine Procurement Methods and Treatment Procedures for the Target Waterborne Diseases

Across the entire surveyed population, it appears that 87% of respondents do not consult a doctor and procure medicines without a prescription, while only 13% consult a doctor and obtain their medication via prescription. The drugs used to treat their illnesses consisted primarily of antibiotics such as Amoxicillin (22%), Ciprofloxacin (20%), Chloramphenicol (18%), Ofloxacin (18%), and Cotrimoxazole (11%), compared to 11% for certain antiparasitic drugs, and alternative methods such as medicinal plants (Figure 7).

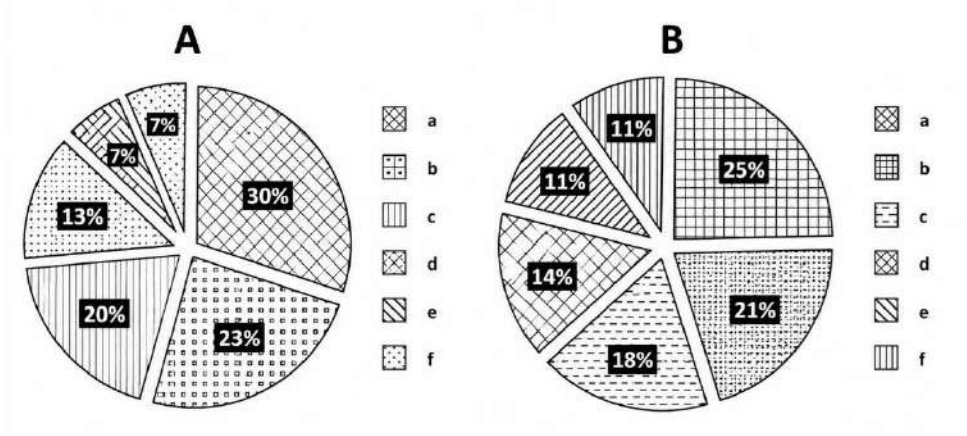


**FIGURE 7: Medication procurement channels and treatment procedures among local populations. (A) Healthcare-seeking behavior showing 87% self-medicate without prescription and 13% consult a doctor. (B) Types of medications used showing Amoxicillin (22%), Ciprofloxacin (20%), Chloramphenicol (18%), Ofloxacin (18%), Cotrimoxazole (11%), antiparasitic drugs (11%), and medicinal plants.**

## IV. DISCUSSION

This study assessed the health impacts associated with the use of untreated drinking water in the Nkoabang neighborhood of the Nkolafamba commune, Cameroon. The findings reveal significant challenges related to water quality, sanitation, waste management, and healthcare practices that collectively contribute to a high burden of waterborne diseases and inappropriate antibiotic use.

### 4.1 Socioeconomic Characteristics and Water Access

Among the respondents, civil servants represented 44%. This proportion of administrative workers could be explained by the fact that the study area is a peri-urban zone of Cameroon's capital (Central Africa), dominated by significant public services with a diversified economy. The predominance of civil servants may reflect the proximity to Yaoundé and the employment opportunities in the capital city, while the presence of traders (22%) and informal workers (18%) indicates a diverse economic base typical of peri-urban settlements.

### 4.2 Water Sources and Treatment Practices

The study found that 56% of the population relies on unprotected wells for their water supply, with only 20% using borehole water for drinking. This reliance on unprotected water sources is concerning, as these sources are highly vulnerable to contamination from surface runoff, improper waste disposal, and pit latrines. The finding that 70% of the population does not treat their water before consumption and is unaware of its microbiological quality represents a critical public health risk. This lack of awareness and treatment is consistent with findings from other peri-urban areas in Cameroon [2,5].

Among the small minority who do treat water, practices are irregular and inadequate, with only 11% using chlorination, 11% using filtration, and 4% boiling water. The reluctance to boil water, due to perceived taste changes, is a common barrier to effective water treatment in resource-limited settings. These findings highlight the urgent need for health education and behavior change communication to promote household water treatment as a key intervention for preventing waterborne diseases.

### 4.3 Waste Management and Environmental Contamination

It was reported that the populations of the Nkoabang neighborhood discharge domestic liquid and solid waste into the environment without prior treatment. These results match those of [2] in the locality of Ombessa, which showed that in the periurban neighborhoods of Yaoundé, direct discharge practices and the deficit of formalized collection are the primary drivers of environmental degradation. Yet, these wastes are capable of polluting the air, soil, subsoil, and subsequently receiving waters due to high levels of organic matter and microorganisms of fecal origin [6].

The study identified that 22% of respondents discharge wastewater directly into gutters, 10% into the yard, and 5% onto roads. Similarly, 20% burn solid waste in makeshift pits, 10% discard it in trash bags, and 5% dump it in fields. These practices create multiple pathways for contamination of water sources.

Furthermore, [5] confirmed, in a similar study conducted in Nkolafamba, that dump leaching and household wastewater infiltration constitute the main routes of water table contamination by fecal coliforms. [7] demonstrated that leachate from open dumps and poorly sealed septic tanks migrates vertically through the sandy soils of the periurban zone, carrying organic loads and fecal germs down to shallow water tables. [8] highlighted that sandy soils and the lack of impermeable lining on waste disposal sites, along with the use of gutters as outlets, accelerate the percolation of contaminated runoff water, making groundwater particularly vulnerable.

The potential contamination sources identified in this study—leachate infiltration from household waste (33%), stormwater runoff from gutters (27%), pit percolation (22%), and open dump runoff (18%)—are consistent with these previous findings. These contamination pathways underscore the need for integrated approaches to water and sanitation management that address both source water protection and safe disposal of waste.

### 4.4 Waterborne Diseases

The resurgence of ground and surface water contamination should drive populations to adopt various water treatment methods before consumption [9]. A small fraction of the population possesses a culture of short-term health risks associated with the consumption of water with poor microbiological quality; they feel they are already accustomed to this poor bacteriological water quality and note that it is children who suffer the most from waterborne diseases (gastroenteritis, typhoid, diarrhea, amebiasis, schistosomiasis, among others), likely due to their immature immune systems.

[10], in a similar study conducted in Nkolafamba, reported that this chronic exposure to contaminated water results in a high prevalence of digestive and parasitic pathologies in children under 5 years old, confirming the direct link between bacteriological water quality and disease burden in periurban areas without water piping. This chronic exposure correlates with a high prevalence of diarrhea and parasitic infections in children under five [11].

The diseases reported in this study—gastroenteritis (33%), typhoid fever (22%), skin and eye infections (20%), amebiasis (18%), and schistosomiasis (7%)—are consistent with waterborne disease patterns documented in other peri-urban areas of Cameroon. The high prevalence of gastroenteritis and typhoid fever is particularly concerning, as these diseases are directly linked to fecal contamination of water sources. The presence of skin and eye infections suggests that inadequate water quantity for hygiene may also be a contributing factor, in addition to water quality issues.

### 4.5 Self-Medication and Antibiotic Use

The empirical use of antibiotics without bacteriological diagnosis promotes the selection of multiresistant strains. This phenomenon is documented by [12], who report a significant increase in bacteria resistant to β-lactams and fluoroquinolones in the ground and rainwater of the region. Barriers to primary healthcare access and the financial burden of medical consultations explain why households resort to inappropriate and dangerous health practices.

In this study, 87% of respondents reported not consulting a doctor and procuring medicines without a prescription. The antibiotics most commonly used—Amoxicillin (22%), Ciprofloxacin (20%), Chloramphenicol (18%), Ofloxacin (18%), and Cotrimoxazole (11%)—are broad-spectrum antibiotics that are widely available over the counter in Cameroon. This pattern of antibiotic use is alarming, as it contributes to the selection of multidrug-resistant bacteria and undermines the effectiveness of these essential medicines.

The practice of self-medication with antibiotics without proper diagnosis is particularly concerning given the waterborne nature of the diseases being treated. Typhoid fever, for example, requires specific antibiotic treatment based on susceptibility testing, and inappropriate antibiotic use can lead to treatment failure and chronic carriage. Similarly, amebiasis requires specific antiparasitic treatment rather than antibiotics.

In parallel, a significant class of the population resorts to traditional pharmacopeia, where the use of local medicinal plants has shown that they contain numerous chemically and biologically active properties exerting various pharmacological actions: antioxidant, anti-inflammatory, analgesic, antiviral, antibacterial, and antifungal activities [13]. The use of medicinal plants (11%) represents an alternative treatment approach that may have cultural significance but requires further study to evaluate efficacy and safety.

### 4.6 Implications for Public Health Policy

The findings of this study have several important implications for public health policy and practice in Cameroon:

1) **Strengthening water quality monitoring:** Regular monitoring of groundwater and surface water sources in peri-urban areas is essential to identify contamination and guide interventions.
2) **Promoting household water treatment:** Health education programs should promote simple, effective, and acceptable water treatment methods, including chlorination, filtration, and solar disinfection.
3) **Improving waste management:** Investment in formal waste collection and disposal systems is needed to prevent environmental contamination of water sources.
4) **Enhancing healthcare access:** Improving access to primary healthcare services can reduce the reliance on self-medication and inappropriate antibiotic use.
5) **Regulating antibiotic sales:** Enforcement of regulations on antibiotic dispensing can help curb the misuse of antibiotics and reduce antimicrobial resistance.
6) **Integrating traditional medicine:** Further research is needed on medicinal plants used for treating waterborne diseases to evaluate their efficacy and safety, and to explore potential integration with conventional medicine.

### 4.7 Limitations of the Study

This study has several limitations that should be considered when interpreting the findings:

1) **Small sample size:** The study included only 45 respondents, which limits the generalizability of the findings to the broader population of Nkoabang or other areas.
2) **Purposive sampling:** The use of purposive sampling may have introduced selection bias, as participants were not randomly selected.
3) **Self-reported data:** Reliance on self-reported information may be subject to recall bias and social desirability bias, particularly regarding sensitive topics such as waste disposal and medication use.
4) **Lack of water quality testing:** The study did not include microbiological or chemical analysis of water samples, relying instead on reported perceptions of water quality.
5) **Lack of clinical confirmation:** Diseases were self-reported and not confirmed through clinical examination or laboratory testing, which may affect the accuracy of disease prevalence estimates.

6) **Seasonal limitations:** The study was conducted during a specific period (January to March), and water quality and disease patterns may vary seasonally.
7) **Single location:** The study was conducted in only one neighborhood, limiting the generalizability of findings to other areas.

Despite these limitations, the study provides valuable insights into the health risks associated with untreated water consumption in peri-urban Cameroon and highlights the urgent need for interventions to improve water quality, sanitation, and healthcare practices.

## V. CONCLUSION

The objective of this study was to evaluate the health risks associated with using ground and surface water intended for human consumption by populations in the locality of Nkoabang, Cameroon (Nkolafamba Commune). The survey of local populations identified the primary pollution factors, notably poor management of household waste, excreta, and wastewater, among others. Consequently, due to lapses in hygiene standards, these waters are contaminated with germs, presenting a major risk of gastroenteritis, typhoid, skin and eye diseases, amebiasis, and schistosomiasis for consumers.

The study found that 70% of the population does not treat water before consumption and is unaware of its microbiological quality. Furthermore, improper waste disposal practices create multiple pathways for contamination of water sources. The high prevalence of waterborne diseases and the widespread practice of self-medication with antibiotics without prescription represent significant public health concerns that require urgent attention.

Adhering to hygiene standards and promoting water treatment before usage by populations must be encouraged to prevent the occurrence of epidemics. Strengthening healthcare access, regulating antibiotic sales, and implementing integrated water and sanitation management approaches are essential for addressing the health impacts of untreated water in the Nkoabang neighborhood and similar settings.

## VI. RECOMMENDATIONS

Based on the study findings, the following recommendations are proposed:

1) **Health education:** Implement community-based health education programs to raise awareness about the risks of untreated water and promote simple, affordable household water treatment methods (chlorination, filtration, boiling, solar disinfection).
2) **Water quality monitoring:** Establish regular monitoring of groundwater and surface water sources in peri-urban areas to identify contamination and guide interventions.
3) **Sanitation infrastructure:** Invest in formal waste collection and disposal systems, including improved sanitation facilities and wastewater treatment.
4) **Healthcare access:** Strengthen primary healthcare services to reduce reliance on self-medication and ensure appropriate diagnosis and treatment of waterborne diseases.
5) **Antibiotic regulation:** Enforce regulations on antibiotic dispensing to curb misuse and reduce antimicrobial resistance.
6) **Medicinal plant research:** Conduct further research on medicinal plants used for treating waterborne diseases to evaluate their efficacy, safety, and potential integration with conventional medicine.
7) **Multisectoral approach:** Promote integrated approaches to water, sanitation, and hygiene (WASH) that address both source water protection and safe disposal of waste.
8) **Community participation:** Engage community members in the design and implementation of interventions to ensure ownership and sustainability.

## VII. FUTURE RESEARCH

Future studies should:

1) Conduct microbiological and chemical analysis of water sources to confirm contamination and identify specific pathogens.
2) Include clinical diagnosis and laboratory confirmation of waterborne diseases.

3) Employ larger, randomly selected samples to improve generalizability.
4) Assess seasonal variations in water quality and disease patterns.
5) Evaluate the effectiveness of different household water treatment methods in reducing disease burden.
6) Investigate the antimicrobial resistance patterns of bacteria isolated from water sources and clinical samples.
7) Explore the socio-economic and cultural factors influencing water treatment practices and healthcare-seeking behaviors.

## VIII. CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely witnessed by the authors.

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