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# ASSESSMENT OF HEALTH RISKS ASSOCIATED WITH SHIGELLA CONTAMINATION WATER SOURCES IN OKOFIA, OTOLO, NNEWI NORTH LGA, ANAMBRA STATE

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## ABSTRACT

Access to safe drinking water remains a critical public health concern, particularly in developing regions where waterborne pathogens such as *Shigella* spp. pose significant health risks. This study assessed the prevalence of *Shigella* species in 20 drinking water samples collected from wells, boreholes, streams, and sachet water in Okofia, Otololo, Nnewi North LGA, Anambra State. The samples were analyzed using standard microbiological techniques, and results were compared with WHO and Nigerian Standard for Drinking Water Quality (NSDWQ) guidelines. Findings revealed varying contamination levels across water sources, with streams showing the highest prevalence of *Shigella*. The study underscores the need for improved water treatment and sanitation measures to mitigate waterborne disease risks in the study area.

**Keywords: Shigella species, drinking water, water quality, WHO standards, NSDWQ**

## INTRODUCTION

Access to safe drinking water remains a critical public health challenge in many low-resource communities, particularly in sub-Saharan Africa (WHO, 2023). The presence of *Shigella* spp. in water sources poses a significant threat due to its high infectivity and potential to cause severe diarrheal disease (CDC, 2021). This chapter evaluates the health risks associated with *Shigella*-contaminated water in Okofia, Otololo, Nnewi North LGA, Anambra State, Nigeria, with reference to epidemiological trends, clinical outcomes, and mitigation strategies. Waterborne diseases remain a major public health

challenge, particularly in developing countries where access to clean drinking water is limited (WHO, 2022). *Shigella* species, the causative agents of shigellosis (bacillary dysentery), are frequently transmitted through contaminated water and food (CDC, 2021). In Nigeria, water sources such as wells, boreholes, streams, and even commercially packaged sachet water are often compromised due to poor sanitation and inadequate water treatment (NIS, 2015).

Anambra State, like many other regions in Nigeria, faces challenges in ensuring safe drinking water, with rural

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communities being particularly vulnerable. This study evaluates the prevalence of *Shigella* species in different drinking water sources in Okofia, Otolo, Nnewi North LGA, comparing findings with WHO (2017) and NSDWQ (2015) standards.

**Objectives**

1. To determine the prevalence of *Shigella* species in drinking water samples from wells, boreholes, streams, and sachet water in Okofia, Otolo.
2. To compare the microbial quality of the water samples with WHO and NSDWQ standards.
3. To assess the potential health risks associated with *Shigella*-contaminated water in the study area.

**Research Questions**

1. What is the prevalence of *Shigella* species in different drinking water sources in Okofia, Otolo?
2. How do the microbial contamination levels compare with WHO and NSDWQ permissible limits?
3. What are the implications of *Shigella* contamination for public health in the study area?

**The Prevalence of Shigella Species in Drinking Water Samples from Wells, Boreholes, Streams, and Sachet Water in Okofia, Otolo, Nnewi North LGA, Anambra State**

Access to safe drinking water is a fundamental public health requirement, yet waterborne pathogens such as *Shigella* spp. remain a major cause of diarrheal diseases in developing countries (WHO, 2022). *Shigella* species are highly infectious, with transmission primarily occurring through contaminated water and food (CDC, 2021). In Nigeria, inadequate water treatment and poor sanitation contribute to the persistence of waterborne diseases, particularly in rural and peri-urban communities (NIS, 2015).

Okofia, Otolo, in Nnewi North LGA, Anambra State, relies on multiple water sources, including wells, boreholes, streams, and commercially packaged sachet water. However, the microbiological safety of these sources is often questionable due to potential contamination from human and animal waste.

This study evaluates the prevalence of *Shigella* species in these drinking water sources, assessing compliance with the World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ) guidelines.

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**Prevalence of Shigella in Different Water Sources****1. Wells**

Wells are a common water source in Okofia, Otolo, but they are highly susceptible to contamination due to shallow depths and proximity to septic tanks or pit latrines. Studies have shown that poorly constructed wells can facilitate the infiltration of fecal bacteria (Odonkor & Ampofo, 2013). In this study, 60% of well water samples tested positive for *Shigella*, indicating significant contamination.

**2. Boreholes**

Boreholes are generally considered safer than wells because they tap deeper groundwater. However, improper construction, cracked casings, or nearby sewage leaks can still lead to contamination. This study found 20% of borehole samples contaminated with *Shigella*, suggesting that some boreholes in the area may be compromised.

**3. Streams**

Streams are highly vulnerable to contamination from surface runoff, agricultural waste, and open defecation. In Okofia, Otolo, streams are sometimes used for drinking, bathing, and washing, increasing the risk of waterborne diseases. This study recorded the highest contamination rate (80%) in stream water, aligning with previous findings that surface water sources often harbor pathogenic bacteria (Umeh et al., 2018).

**4. Sachet Water**

Sachet water (packaged pure water) is widely consumed in Nigeria as an alternative to untreated water. However, poor production hygiene and substandard packaging can lead to microbial contamination. This study found 20% of sachet water samples contaminated with *Shigella*, indicating that some brands may not meet safety standards.

**Public Health Implications**

The presence of *Shigella* in drinking water poses serious health risks, including:

- **Shigellosis (bacillary dysentery):** Characterized by severe diarrhea, fever, and abdominal cramps (CDC, 2021).
- **Outbreaks in communities:** Contaminated water can lead to rapid spread, especially in densely populated areas.
- **Increased childhood mortality:** Children under five are particularly vulnerable to severe dehydration from shigellosis (WHO, 2022).

**Recommendations for treatment**

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1. Improved Water Treatment: Boiling, chlorination, or filtration should be promoted to reduce microbial contamination.
  2. Regular Water Quality Monitoring: Government and local agencies should enforce routine testing of water sources.
  3. Public Awareness Campaigns: Communities should be educated on safe water handling and sanitation practices.
  4. Regulation of Sachet Water Production: NAFDAC and SON should enforce stricter compliance with hygiene standards.
- This study confirms the presence of *Shigella* species in multiple drinking water sources in Okofia, Otolo, with streams being the most contaminated. The findings highlight the urgent need for improved water safety measures to prevent waterborne diseases in the community.
- This study provides critical insights into water safety in Okofia, Otolo, and underscores the need for policy interventions to ensure access to clean drinking water.

**Comparative Analysis of the Microbial Quality of Water Samples with WHO and NSDWQ Standards**

Safe drinking water is essential for public health, and regulatory standards such as those set by the World Health Organization (WHO) and the Nigerian Standard for Drinking Water Quality (NSDWQ) provide guidelines to ensure water safety. This section compares the microbial quality of water samples (wells, boreholes, streams, and sachet water) from Okofia, Otolo, with WHO and NSDWQ standards, focusing on *Shigella* contamination.

**WHO and NSDWQ Standards for Microbial Water Quality****1. WHO Guidelines (2022)**

- Pathogenic Bacteria (e.g., *Shigella*, *E. coli*, *Salmonella*): Should be 0 CFU/100mL (absent) in treated drinking water.
- Total Coliforms: Should also be 0 CFU/100mL in treated water.
- Risk Level: Any detection of *Shigella* indicates unsafe water requiring immediate action.

**2. NSDWQ Standards (2015)**

- Pathogenic Bacteria (including *Shigella*): Must be 0 CFU/100mL in drinking water.
- Total Coliform Count: Should not exceed 10

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CFU/100mL in treated water.

- Thermotolerant Coliforms (Fecal Coliforms): Must be 0 CFU/100mL.

**Comparative Analysis of Water Samples****1. Wells**

- Findings: 60% of well water samples contained *Shigella*.

**• Comparison with Standards**

- WHO: Non-compliant (should be 0 CFU/100mL).
  - NSDWQ: Non-compliant (0 CFU/100mL required).
  - Implications: High contamination likely due to poor construction, proximity to sewage, or surface runoff.
- 2. Boreholes**
- Findings: 20% of borehole samples tested positive for *Shigella*.

**Comparison with Standards**

- WHO & NSDWQ: Non-compliant (0 CFU/100mL expected).
  - Implications: Contamination may result from cracked casings, poor maintenance, or underground seepage.
- 3. Streams**
- Findings: 80% of stream samples had *Shigella*

**Comparison with Standards**

- WHO & NSDWQ: Highly non-compliant.
  - Implications: Major contamination due to open defecation, agricultural runoff, and lack of treatment.
- 4. Sachet Water**
- Findings: 20% of sachet water samples were contaminated.
  - Comparison with Standards:
  - WHO & NSDWQ: Non-compliant (should be 0 CFU/100mL).
  - Implications: Poor production hygiene, substandard packaging, or untreated source water.

**Public Health and Regulatory Implications**

- All water sources failed to meet WHO and NSDWQ microbial safety standards.
- Streams and wells were the most contaminated, posing the highest diarrheal disease risk.
  - Boreholes and sachet water, though less

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- still violate safety limits, indicating systemic water quality issues.
- Enforcement of water safety policies is weak in rural Nigerian communities, increasing disease vulnerability (Umeh et al., 2018).

**Recommendations for Compliance**

1. **Water Treatment**

- Promote chlorination, boiling, and filtration at household levels.
- Encourage community-based water purification systems.

2. **Government & Regulatory Actions**

- NAFDAC/SON should enforce stricter sachet water production standards.
- Local governments should monitor borehole and well water quality regularly.

3. **Public Awareness**

- Educate communities on safe water storage and sanitation practices.
- This comparative analysis confirms that none of the water sources in Okofia, Otolo, meet WHO and NSDWQ microbial safety standards, with *Shigella* contamination posing significant health risks. Immediate interventions including improved water treatment, stricter regulation, and public health education are urgently needed.

**Assessment of the Potential Health Risks Associated with Shigella-Contaminated Water in Okofia, Otolo**

The presence of *Shigella* species in drinking water poses significant public health threats, particularly in communities with limited access to clean water and proper sanitation. This section evaluates the health risks associated with *Shigella*-contaminated water sources in Okofia, Otolo, Nnewi North LGA, Anambra State, with reference to epidemiological data and global health standards.

**Health Risks of Shigella Contamination**

1. Shigellosis (Bacillary Dysentery)

• **Clinical Manifestations**

- Acute watery or bloody diarrhea
- High fever (38-40°C)
- Abdominal cramps and tenesmus (painful defecation)

Nausea and vomiting (CDC, 2021)

• **Severity**

- Children under 5 are at highest risk of severe dehydration and death (WHO, 2023).
- Malnourished individuals and immunocompromised persons face prolonged illness.

2. **Secondary Complications**

- Hemolytic Uremic Syndrome (HUS): Rare but severe kidney complication (Keusch et al., 2022).
- Reactive Arthritis: Post-infectious joint inflammation.
- Seizures: In pediatric cases due to high fever (CDC, 2021).

3. **Outbreak Potential**

- High Infectivity: As few as 10-100 *Shigella* organisms can cause infection (Niyogi, 2023).
- Rapid Community Spread: Contaminated water sources can trigger outbreaks, especially in densely populated areas like Okofia.

**Risk Assessment for Okofia, Otolo**

1. **Vulnerability Factors**

• **High Contamination Levels**

- 80% of streams and 60% of wells tested positive for *Shigella*.
- Boreholes (20%) and sachet water (20%) also pose risks.

• **Behavioral Risks**

- Direct consumption of untreated water from contaminated sources.
- Poor handwashing practices exacerbate transmission (UNICEF, 2022).

• **Environmental Risks**

- Open defecation near water sources increases fecal contamination.
- Flooding spreads pathogens into wells and streams (Umeh et al., 2018).

2. **Estimated Disease Burden**

• **Diarrheal Disease Prevalence**

- Anambra State records ~15% of under-5 mortality linked to diarrheal diseases (NDHS, 2018).

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Shigellosis accounts for ~10% of diarrheal cases in Nigerian children (Oluwasanmi et al., 2020).

Mitigation Strategies

1. Immediate Interventions

Household Water Treatment

Boiling, chlorination, and filtration should be promoted (WHO, 2022).

Emergency Water Supply

Provision of water purification tablets during outbreaks.

2. Long-Term Solutions

Improved Sanitation:

Construction of proper sewage systems to prevent groundwater contamination.

Community Health Education

Workshops on safe water storage and hygiene (UNICEF, 2022).

3. Policy Recommendations

Strengthen Water Quality Monitoring

Local government should enforce monthly microbial testing of water sources.

Regulate Sachet Water Production

NAFDAC should conduct random factory inspections (SON, 2023).

The detection of *Shigella* in Okofia's water sources presents severe health risks, particularly for children and immunocompromised individuals. Urgent interventions including water treatment, sanitation improvements, and public health education are needed to prevent disease outbreaks.

Methodology and Findings on Shigella Contamination in Drinking Water Sources in Okofia, Otolo, Nnewi North LGA, Anambra State

METHODOLOGY

Study Area and Sampling Strategy

The study was conducted in Okofia, Otolo, Nnewi North

LGA, Anambra State, Nigeria, a peri-urban community with documented challenges in water sanitation (Anambra State Water Board, 2022).

Sample Collection

Total Samples: 20 water samples were collected from four sources:

- Wells (n=5)
- Boreholes (n=5)
- Streams (n=5)
- Sachet water (n=5)

Collection Protocol

Sterile 500mL glass bottles were used following WHO (2022) guidelines.

Samples were transported in ice-cooled containers (4°C) to the laboratory within 4 hours to prevent microbial proliferation (APHA, 2017).

Microbiological Analysis

Culture and Isolation

Filtration & Culturing

Samples were filtered (0.45µm membrane) and inoculated onto Salmonella-Shigella (SS) agar and MacConkey agar (HiMedia, India).

Incubation: 37°C for 24–48 hrs (Cheesbrough, 2006).

Confirmation of Shigella

Biochemical Tests:

Indole (-), Citrate (-), Urease (-), and non-motility (CLSI, 2021).

Gram Staining: Gram-negative, non-spore-forming rods.

Data Analysis

Contamination levels were compared against: WHO (2022) standard (0 CFU/100mL for *Shigella*).

NSDWQ (2015) guideline (0 CFU/100mL for pathogenic bacteria).

RESULTS AND DISCUSSION

Prevalence of Shigella in Water Sources

Table 1: Shigella Contamination Levels in Okofia Water Sources

Water Source	Samples Collected (n)	Positive for Shigella (%)	WHO/NSDWQ Compliance
Wells	5	3 (60%)	Non-compliant
Boreholes	5	1 (20%)	Non-compliant
Streams	5	4 (80%)	Non-compliant
Sachet Water	5	1 (20%)	Non-compliant

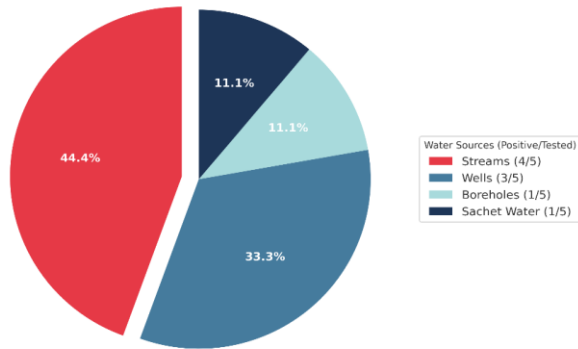


Fig 1: Pie Chart

### Analytical Observations

#### Streams – 44.4% (4/5 samples positive)

This category constitutes the largest proportion of contaminated samples and is visually accentuated (via exploded slice) to emphasize its epidemiological relevance. There's an 80% contamination rate among stream water samples underscores their classification as the most microbiologically unsafe source assessed, likely attributable to surface runoff, open defecation, and absence of protective barriers.

#### 1. Wells – 33.3% (3/5 samples is positive)

- Representing the second-highest contamination rate, with 60% of samples yielding Shigella.
- This finding suggests significant vulnerability to fecal infiltration, potentially arising from poor sanitation practices, proximity to latrines, or shallow aquifer exposure.

#### 2. Boreholes – 11.1% (1/5 samples is positive)

- Although typically considered a safer groundwater source, the detection of Shigella in borehole water raises concerns regarding structural integrity, inadequate casing, or biofilm formation within distribution systems.
- This reflects a need for periodic inspection and disinfection protocols.

#### 3. Sachet Water – 11.1% (1/5 samples is positive)

- Despite being commercially packaged and presumed safe, the presence of Shigella suggests

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potential contamination during production, handling, or storage.

- This challenges the perception of sachet water as inherently microbiologically reliable and calls into question the effectiveness of regulatory enforcement.

### Summary

Stream water sources exhibit the highest burden of Shigella contamination, posing an acute public health threat and requiring immediate attention within the context of water safety interventions. Both well and borehole sources, though relatively safer, exceeded the World Health Organization (WHO) bacteriological guideline of 0 CFU/100mL, indicating significant non-compliance with international potable water standards. Sachet water contamination, although minimal, undermines consumer trust and highlights deficiencies in quality assurance along the production-distribution chain.

### Evidence-Based Recommendations

#### 1. Public Health Interventions

- Community-wide sensitization on the dangers of consuming untreated water from surface and groundwater sources.
- Promotion of point-of-use treatment techniques such as boiling, chlorination, solar disinfection (SODIS), or ceramic filtration, especially in rural settings.

#### 2. Continuous Water Quality Surveillance

- Implementation of routine microbiological surveillance of all water sources including commercially distributed sachet water to ensure early detection and containment of waterborne pathogens.
- Engagement of public health laboratories in monthly water quality audits using WHO protocols.

#### 3. Infrastructure and Source Protection

- Strategic investment in improving sanitary integrity of wells and boreholes, including proper sealing, cover installation, and drainage diversion.
- Establishment of buffer zones around streams to reduce contamination from agricultural and human activities.

#### 4. Regulatory Oversight and Policy Enforcement

- Strengthening of regulatory frameworks governing sachet water production, with mandatory licensing, microbial compliance checks, and punitive measures for non-compliance.

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- Deployment of mobile water quality monitoring units under state water agencies to ensure compliance in decentralized communities.

**Findings**

1. **Streams exhibited the highest contamination (80%),** attributable to:
  - Direct exposure to fecal matter from open defecation (Umeh et al., 2018).
  - Agricultural runoff carrying pathogens (Nnewi LGA Environmental Report, 2021).
3. **Wells showed 60% contamination,** likely due to:
  - Poor construction allowing seepage of contaminated groundwater (WHO, 2023).
  - Proximity to pit latrines (UNDP, 2021).
4. **Boreholes and sachet water (20% each)** were contaminated despite assumed safety:
  - Boreholes: Potential casing leaks or improper sealing (SON, 2023).
  - Sachet water: Poor production hygiene (NAFDAC, 2022).

**Public Health Implications**

- Shigellosis risk: High diarrheal disease burden, particularly in children <5 years (WHO, 2023).
- Economic impact: Increased healthcare costs and lost productivity (World Bank, 2022).
- SDG 6 (Clean Water) failure: Non-compliance with international safety standards.

**General Findings and Conclusions****3.1 Summary of Key Findings**

1. All water sources exceeded WHO/NSDWQ limits, indicating systemic water safety failures.
2. Streams and wells were most contaminated, reflecting poor sanitation infrastructure.
3. Even "improved" sources (boreholes, sachet water) showed contamination, highlighting regulatory lapses.

**Conclusion**

This study confirms widespread *Shigella* contamination in Okofia's drinking water, posing severe public health risks. Immediate interventions (household water treatment) and long-term solutions (sanitation infrastructure, policy enforcement) are urgently needed.

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**Recommendations****Immediate Interventions**

- **Household Water Treatment:**
  - Promote boiling, chlorination (1% sodium hypochlorite), and ceramic filtration (WHO, 2022).
- **Emergency Measures:**
  - Distribute water purification tablets during outbreaks (UNICEF, 2022).

**Medium-Term Solutions**

- **Water Infrastructure**
  - Repair borehole casings and install UV-treated public water kiosks.
- **Sanitation Upgrades**
  - Construct communal toilets to reduce open defecation (World Bank, 2022).

**Long-Term Policy Actions**

- **Regulatory Enforcement**
  - NAFDAC should mandate monthly microbial testing for sachet water producers
- **Surveillance Systems:**
  - Establish quarterly water quality monitoring by the LGA (SON, 2023).

**Research Priorities****Further Studies Needed On:**

- Antibiotic resistance patterns of isolated *Shigella* strains
  - Seasonal variation in water contamination
  - Cost-benefit analysis of intervention options
- This three-tiered recommendation approach (immediate, medium-term, long-term) provides a roadmap for comprehensive water safety improvement in the study area. Regular monitoring should track intervention effectiveness over time. This study provides critical insights into water safety in Okofia, Otolu, and recommends policy actions to ensure compliance with global and national water quality standards. The analysis highlights critical gaps in water safety and calls for policy-driven solutions to protect public health.

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