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# Comparative Analysis of Environmental Health Interventions in Controlling Tuberculosis in Some Selected States in Nigeria (Kano, Lagos and Niger States)

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## ABSTRACT

Tuberculosis (TB) is an infectious disease which is caused by mycobacterium tuberculosis bacteria that often affect the lungs. It is spread from person to person through the air. When people with TB cough, sneeze or spit, they propel the TB germs into the air. A person needs to inhale only a few of these germs to become infected. The study aimed at analyzing environmental health interventions in controlling tuberculosis in some selected states in Nigeria (Kano, Lagos and Niger States). Structured questionnaires and interview were used to collect data from the three states. The participants were interviewed to express themselves very well on their answers in the questionnaires. n = 260, n = 283 and n = 243 questionnaires were distributed in Kano, Lagos and Niger States respectively and n = 217, n = 248 and n = 196 questionnaires were retrieved from Kano, Lagos and Niger States respectively. The data were analyzed using analysis of variance and the mean scores were compared among the three states. There are discrepancies in perceptions regarding hygiene, overcrowding, and waste management suggest a need for enhanced public health messaging to bridge knowledge gaps in Kano state. The survey results suggest that improved ventilation, air quality measures, disinfection, and health education are the most widely supported environmental interventions for TB control in Lagos State. Furthermore, the results from Niger State show a mix of perceptions regarding various environmental health interventions for TB control.

**Keywords:** Hygiene, Ventilation, Disinfection, Air Quality, Waste Management.

## INTRODUCTION

Tuberculosis (TB) is an infectious disease which is caused by mycobacterium tuberculosis bacteria that often affect the lungs. It is spread from person to person through the air. When people with TB cough, sneeze or spit, they propel the TB germs into the air. A person needs to inhale only a few of these germs to become infected.

According to Federal Ministry of Health (FMOH) Nigeria, there was no national survey to determine the prevalence of tuberculosis disease (TB) in Nigeria prior to 2012 (FMOH, 2014). Estimates of the burden of TB in the country relied on indirect assessment by the World Health Organization (WHO) based on existing TB surveillance data. The accuracy of such estimates largely depends on the quality of the routine surveillance information, which in itself is affected by the completeness of TB notification and instances of TB under-diagnosis. Therefore, it became imperative to conduct a nationwide prevalence survey of TB to obtain a good direct estimate of the burden of TB in the country.

The TB prevalence survey was conducted by the National Tuberculosis Control programme of the Federal Ministry of Health in close collaboration with the World Health Organization (WHO) and the US Centers for Disease Control and Prevention (CDC). It was coordinated by the Survey Technical Committee made up of Government and several local and international partners.

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The National Tuberculosis and Leprosy Control Programme (NTBLCP), under the Department of Public Health of the Federal Ministry of Health (FMOH) has made great strides in addressing TB since it began implementing the internationally recommended Directly Observed Treatment Short course (DOTS) strategy for TB control in all states and the Federal Capital Territory (FCT) in 2004.

According to WHO, (2018), healthy housing should include foundations, walls, ceilings, floors, a roof, and ventilation. Healthy houses should have a bedroom width of at least $8m^2$ and it is recommended that no more than two people use one-bedroom space. The floor area of the building must also be adjusted to the number of inhabitants. Houses with good components in accordance with health requirements, should protect inhabitants from disease.

Although houses may vary, each component of a house must fulfill health requirements, so the inhabitants do not suffer from any illnesses (Azwar, 2015). Components of houses that fulfil health

requirements should provide comfort and maintain the health of inhabitants, so they can avoid disease, work productively, and produce something meaningful. Housing conditions can determine the level of hygiene and environmental sanitation. Overcrowded and narrow housing results in high incidences of illness, accidents, and other issues (Wahyudi, Raufuddin, and Suarilah, 2018).

Pulmonary TB disease is closely related to poor home sanitation, but the most influencing factors of poor sanitation are the components of the house. House sanitation assessments include four variables: the availability of clean water, sewerage channels, latrines, and waste. (Taylor, 2018). However, these are not the main reasons for the transmission of pulmonary TB. Thus, if the results of the assessment of home sanitation meet the healthy criteria, this does not mean it can be free from pulmonary TB. This is due to host factors and other affecting environmental components.

Studies have considered housing and health frameworks and proximal risk factors for TB as the effects of housing on TB development, but the consequences have not been explained fully. Therefore, we examined associations between TB and housing in a housing and health framework and linked them to proximal risk factors for TB. Although the importance of housing as a social determinant of health is clear, many studies have focused only on host risk factors. Researchers have found associations between various aspects of housing and health, but studies of the negative effects of inadequate housing on respiratory health typically focus on asthma, not TB (Rolfe *et al*., (2020). The framework for proximal risk factors for TB focuses on inadequate housing (e.g., crowding, poor ventilation) as a risk factor for TB exposure (Braveman *et al*., 2021). Among the effects of inadequate housing on TB, the effects of overcrowding are the best known. Overcrowded housing leads to TB exposure and is a risk factor for the transmission and incidence of TB (WHO, 2021). In addition to overcrowding, the indoor quality of housing, such as ventilation and dampness, is a risk factor for TB. Many studies have examined TB in the homeless, but few have considered the effects of housing affordability on TB. Inadequate housing, an environmental factor strongly associated with TB, has long been a global health issue, but few studies have identified the effects of inadequate housing on TB, and no systematic studies have been conducted. Identification of specific TB risk factors related to housing could help to identify strategies for combatting TB. Therefore, we conducted a systematic review of aspects of housing that are important social components of the eradication of TB.

The absence of clean water hampers hygiene practices, increasing the risk of infections and contributing to the deterioration of public health in flood-affected regions (Belhassan, 2021). Moreover, the disruption of water supply infrastructure during flooding further exacerbates the challenges of accessing clean water. Damage to water treatment facilities, pipelines, and storage reservoirs leads to prolonged periods of water scarcity, compounding the public health crisis (du Plessis, 2017). Inadequate access to clean water not only compromises basic human needs but also undermines efforts to prevent the spread of waterborne diseases and provides essential healthcare services in flood-affected communities. Urgent measures are needed to ensure the provision of safe drinking water and sanitation facilities during and after flood events, requiring coordinated efforts from government agencies, humanitarian organizations, and community stakeholders (Belhassan, 2021). By prioritizing access to clean water in the aftermath of flooding, Nigeria can mitigate the

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public health risks associated with waterborne diseases and build resilience in vulnerable communities facing recurrent flooding events.

Anochie *et al.*, (2013), lamented that, the rural areas are greatly and painfully neglected in TB prevention and care. Most of these areas lack functional hospital facilities and staff to care for TB cases and most non-governmental organizations (NGOs) who carry out enlightenment campaigns are based in the cities. The rural areas also require the establishment of voluntary counseling and testing centers as the majority of the country's population are rural dwellers. Most rural communities, due to lack of awareness occasioned by non-impact of government policies and activities of NGOs, strongly regard TB patients as people on the sure pedestal of death, hence, they strongly stigmatize this category of persons.

In some cases, patients are denied family care and starved while some are given poisonous concoction for a faster "relief" of death. Educating the population on the consequences of TB, the mode of transmission and informing them of the preventive measures, are all necessary to change the existing negative social norms and enable better behavior for a healthier and more disciplined society (WHO, 2021).

Nigeria remains one of the 30 countries globally with the highest burden of TB. Although TB is one of the vaccine-preventable diseases which is also curable, statistics from the WHO shows that every year, around 245,000 Nigerians die from TB, and about 590,000 new cases occur (of these, around 140,000 are also HIV-positive) (WHO, 2021).

Tuberculosis (TB) remains a significant public health challenge in Nigeria, ranking among the top countries with high TB burdens globally. While medical interventions like vaccinations and antibiotic treatments play vital roles in TB control, environmental health interventions are increasingly recognized as crucial components for reducing TB transmission. This article provides a comparative analysis of environmental health strategies deployed to control or reduce TB cases in three selected states in Nigeria.

## METHODOLOGY

### Research design

Mixed methods design was used which combines quantitative and qualitative approaches. For quantitative, survey research was employed using structured questionnaires. While, interview was used for in-depth conversations with participants as a qualitative approach.

### Population of the study

The population of the study areas focuses on the skilled healthcare workers who are versatile in TB control programs and it is within the state capitals in each of the state. Kano state has an estimated population of health workers to be 500, Ikeja, the state capital of Lagos has estimated population of 700 while that of Niger State is estimated to be 400

### Sampling and Sampling Size Determination

Purposive sampling was used by selecting individuals based on their profession and knowledge on tuberculosis. Such professions include: Environmental Health Officers, Medical Doctors, Nurses/Midwives, CHEW, Health Educators and Medical Laboratory Scientists.

The formula used for the sample size is a modification of the standard Cochran's sample size formula which was originally proposed by William G. Cochran in 1963.

$$n = [N \times Z^2 \times p \times (1-p)] / [(N-1) \times E^2 - Z^2 \times p \times (1-p)]$$

**Where:**

n = Sample size

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N = Population size

Z = Z-score (commonly 1.96 for 95% confidence)

p = Estimated proportion of the population with the trait of interest (default is 0.5 for maximum variability)

E = Margin of error (e.g., 0.05 for ±5%)

For Kano state

The population is estimated to be 500 and a 95% confidence level with a 5% margin of error:

n = {500 x $1.96^2$ x 0.5 x (1-0.5)} / {(500-1) x 0.05^2 + $1.96^2$ x 0.5 x (1-0.5)}

500 x 3.8416 x 0.5 x 0.5/499 x 0.0025 + 3.8416 x 0.5 x 0.5

480.2/1.2475+0.9604

480.2/2.2079 = 217 respondents.

Attrition value = 217/500 X 100/1 = 43 + 217 = **260**

For Lagos state

n = {700 x $1.96^2$ x 0.5 x (1-0.5)} / {(700-1) x 0.05^2 + $1.96^2$ x 0.5 x (1-0.5)}

672.28/2.7079 = 248

Attrition value = 248/700X100/1 = 35+248 = **283**

For Niger state

n = {400 x $1.96^2$ x 0.5 x (1-0.5)} / {(400-1) x 0.05^2 + $1.96^2$ x 0.5 x (1-0.5)}

384.16/1.9579 = 196

Attrition value = 196/400X100/1 = 49 + 196 = **245**

## METHODS OF DATA COLLECTION

Data were collected using structured questionnaires and interview. The participants were interviewed to express themselves very well on their answers in the questionnaires. In Kano State, n = 260 questionnaires were distributed, n = 217 were retrieved, in Lagos State, n = 283 questionnaires were distributed, n = 248 were retrieved while n = 245 were distributed in Niger state but n = 196 were retrieved.

**Data analysis**

The data were analyzed using Analysis of Variance and the mean score were compared across the three states. To analyze the results using the mean, we converted the percentages of responses into a numerical scale. For simplicity, we assigned values to the response categories as follows: Strongly Agree = 4, Agree = 3. Strongly Disagree = 2 and Disagree = 1. For each variable, we calculated the weighted score using the assigned values and the percentages provided. The formula for the weighted score is:

Weighted Score = ($P_{\text{Strongly Agree}} \times 4$) + ($P\text{A}_{\text{gree}} \times 3$) + ($P_{\text{Strongly Disagree}} \times 2$) + ($P_{\text{Disagree}} \times 1$)

Where $P$ represents the percentage of respondents in each category.

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The interpretation of the mean score is as follows:

Mean score > 3 → Positive output

Mean score = 3 → Neutral output

Mean score < 3 → Negative output

## PRESENTATION OF RESULTS AND DISCUSSIONS

Table 1: Environmental health interventions in controlling or reducing TB outbreaks in Kano state.

| Variables | Strongly Agree | % | Agree | % | Strongly Disagree | % | Disagree | % |
|---|---|---|---|---|---|---|---|---|
| Improved ventilation systems | 85 | 39 | 75 | 35 | 37 | 17 | 20 | 9 |
| Improve hygiene | 43 | 20 | 34 | 16 | 66 | 30 | 74 | 34 |
| Reduce overcrowding | 52 | 24 | 32 | 15 | 65 | 30 | 68 | 31 |
| Proper waste disposal | 24 | 11 | 43 | 20 | 45 | 21 | 105 | 48 |
| Access to clean water | 33 | 15 | 24 | 11 | 75 | 35 | 85 | 39 |
| Disinfection of contaminated areas | 32 | 15 | 30 | 14 | 105 | 48 | 50 | 23 |
| Air Quality Improvement Measures | 64 | 29 | 75 | 35 | 45 | 21 | 33 | 15 |
| Health Education and Awareness Campaigns on TB prevention | 71 | 33 | 85 | 39 | 24 | 11 | 37 | 17 |

Source: Authors, 2025

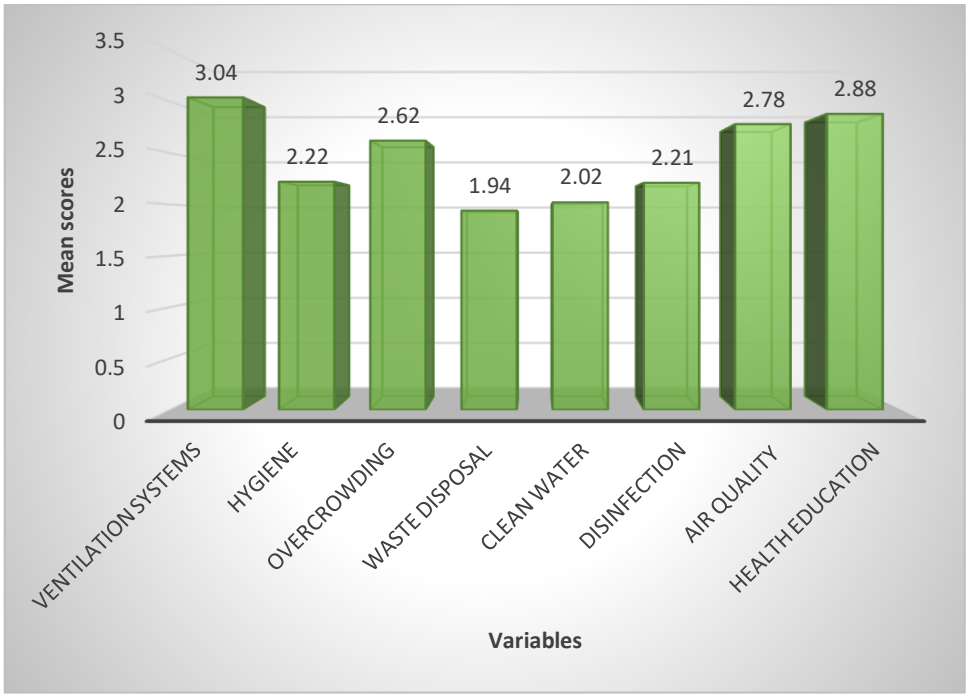


Fig. 1 Mean score of environmental health interventions in controlling TB outbreaks in Kano state.

Source: Authors, 2025

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The results of the analysis in table 1 indicates the participants' response to the questionnaires.

*Improved Ventilation Systems*: The results show strong agreement (74%) on the role of ventilation in TB control, aligning with studies by Escombe *et al*., (2007), which found that natural ventilation can reduce the risk of TB transmission in high-risk settings such as hospitals and overcrowded homes. The WHO (2021) also emphasizes ventilation as a key environmental control measure, particularly in health facilities and public spaces. *Hygiene and Sanitation Practices*: Despite lower agreement on hygiene as an environmental health intervention TB control measure, research by Lönnroth *et al*., (2009) indicates that while TB is primarily airborne, poor hygiene and sanitation can indirectly increase susceptibility by facilitating co-infections such as HIV, which weakens the immune system. Similarly, a study by Nathavitharana *et al*., (2017) highlights the role of general infection prevention measures in TB-endemic areas, suggesting that public misconceptions may contribute to the lower agreement in Kano. *Reducing Overcrowding*: Studies have shown that overcrowding increases TB transmission rates, especially in urban slums and high-density settlements (Banu *et al*., 2012). The relatively low agreement (39%) in Kano contrasts with global research emphasizing that reducing population density in confined spaces can mitigate the spread of TB. For example, the WHO End TB Strategy (2020) recommends urban planning policies that reduce overcrowding to curb airborne infections. *Proper Waste Disposal and Access to Clean Water:* The disagreement on waste disposal (69%) and clean water access (74%) reflects limited understanding of their indirect links to TB. Although TB is not waterborne, studies such as those by Dye *et al*., (2013) suggest that poor sanitation contributes to malnutrition and immunosuppression, thereby increasing TB vulnerability. The Global TB Report (WHO, 2022) further notes that lack of access to basic resources exacerbates TB risk in developing countries. *Air Quality Improvement Measures:* The agreement (64%) on air quality aligns with research by Lin *et al*., (2011), which emphasizes the impact of indoor air pollution from biomass fuels on respiratory health. Studies in sub-Saharan Africa (Fullerton *et al*., 2008) have shown that reducing indoor air pollution through cleaner cooking technologies significantly lowers TB susceptibility. These findings support initiatives promoting cleaner energy in Kano. *Health Education and Awareness Campaigns:* The strong support (72%) for TB education is consistent with findings by Storla *et al*., (2008), which highlight that public awareness influences early detection and treatment adherence. The WHO (2021) also stresses that community-based education programs are essential for breaking transmission chains, particularly in high-burden settings like Kano.

Table 2: Environmental health interventions in controlling or reducing TB outbreaks in Lagos state.

| Variables | Strongly Agree | % | Agree | % | Strongly Disagree | % | Disagree | % |
|---|---|---|---|---|---|---|---|---|
| Improved ventilation systems | 121 | 49 | 90 | 36 | 15 | 6 | 22 | 9 |
| Improve hygiene | 42 | 17 | 76 | 31 | 60 | 24 | 70 | 28 |
| Reduce overcrowding | 44 | 18 | 24 | 10 | 90 | 36 | 90 | 36 |
| Proper waste disposal | 60 | 24 | 56 | 23 | 80 | 32 | 52 | 21 |
| Access to clean water | 46 | 19 | 50 | 20 | 102 | 41 | 50 | 20 |
| Disinfection of contaminated areas | 121 | 49 | 48 | 19 | 39 | 16 | 40 | 16 |
| Air Quality Improvement Measures | 129 | 52 | 89 | 36 | 15 | 6 | 15 | 6 |
| Health Education and Awareness Campaigns on TB prevention | 120 | 48 | 78 | 31 | 28 | 11 | 24 | 10 |

Source: Authors, 2025

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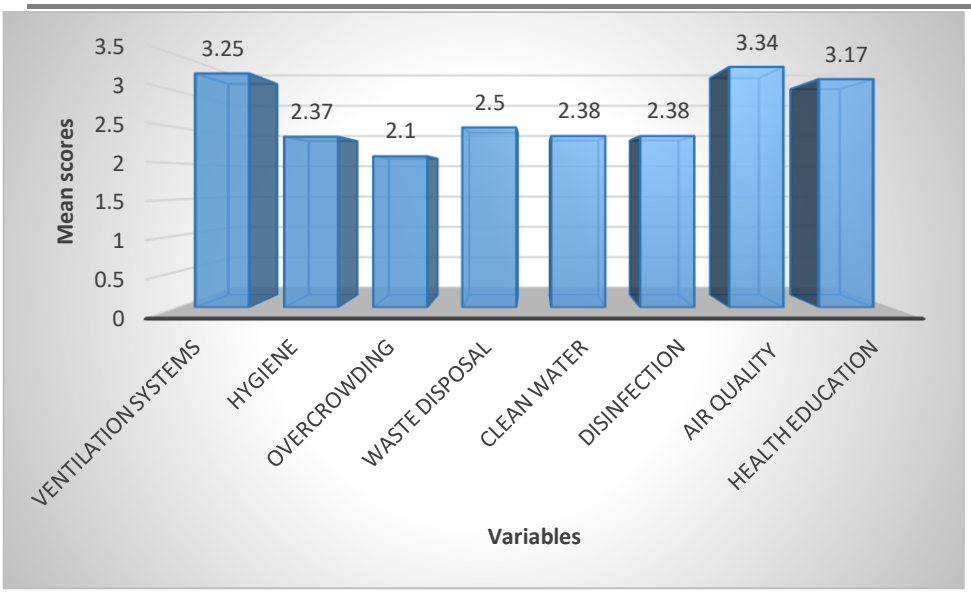


Fig. 2: Mean score of environmental health interventions in controlling TB outbreaks in Lagos state.

Source: Authors, 2025

Environmental health interventions play a critical role in controlling and reducing tuberculosis (TB) outbreaks, particularly in highly populated urban areas like Lagos State. The survey results present respondents' levels of agreement with various intervention measures using various variables as shown in table 2.:

*Improved Ventilation Systems:* A majority (85%) support improved ventilation as a crucial intervention. This aligns with studies that show TB bacteria spread more easily in poorly ventilated environments (WHO, 2021). *Improve Hygiene:* The mixed responses suggest that while some believe hygiene improvements help control TB, others may perceive them as less effective. Hygiene is essential for preventing other infections but plays a lesser role in TB prevention, which is primarily airborne (Lönnroth *et al*., 2009). *Reduce Overcrowding:* A majority (72%) disagreed, which may indicate skepticism about the feasibility of reducing overcrowding in Lagos, where high population density is a challenge. However, studies show that reducing overcrowding can limit TB transmission in confined spaces (Oxlade & Murray, 2012). *Proper Waste Disposal:* The divided opinion suggests that while proper waste disposal is vital for overall public health, its direct impact on TB control may not be well understood. TB spreads through airborne droplets rather than direct waste contamination. *Access to Clean Water:* The majority disagreement (61%) implies that access to clean water is not seen as a primary TB intervention. While clean water is essential for overall health, it has less direct impact on TB control compared to ventilation and air quality (Lönnroth *et al*., 2009). *Disinfection of Contaminated Areas:* With 68% in agreement, disinfection is seen as effective in reducing TB risk in healthcare settings and high-risk areas. Disinfection of surfaces may have limited direct effect on airborne TB transmission but is beneficial for infection control (CDC, 2020). *Air Quality Improvement Measures:* The strongest agreement (88%) highlights air quality as a key intervention. Poor air quality exacerbates respiratory illnesses, making TB transmission more likely in polluted environments (WHO, 2021). *Health Education and Awareness Campaigns on TB Prevention:* A high level of agreement (79%) indicates that awareness programs are widely recognized as effective in TB control. Education can encourage early detection, treatment adherence, and preventive measures (Storla, Yimer, & Bjune, 2008).

Table 3: Environmental health interventions in controlling or reducing TB outbreaks in Niger state.

| Variables | Strongly Agree | % | Agree | % | Strongly Disagree | % | Disagree | % |
|---|---|---|---|---|---|---|---|---|
| Improved ventilation systems | 87 | 44 | 80 | 41 | 12 | 6 | 17 | 9 |
| Improve hygiene | 20 | 10 | 28 | 14 | 68 | 35 | 80 | 41 |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Reduce overcrowding | 58 | 30 | 80 | 41 | 28 | 14 | 30 | 15 |
| Proper waste disposal | 27 | 14 | 48 | 25 | 30 | 15 | 90 | 46 |
| Access to clean water | 80 | 41 | 70 | 36 | 20 | 10 | 26 | 13 |
| Disinfection of contaminated areas | 40 | 20 | 20 | 10 | 48 | 24 | 90 | 46 |
| Air Quality Improvement Measures | 46 | 23 | 30 | 15 | 50 | 26 | 70 | 36 |
| Health Education and Awareness Campaigns on TB prevention | 76 | 39 | 90 | 46 | 10 | 5 | 20 | 10 |

Source: Authors, 2025

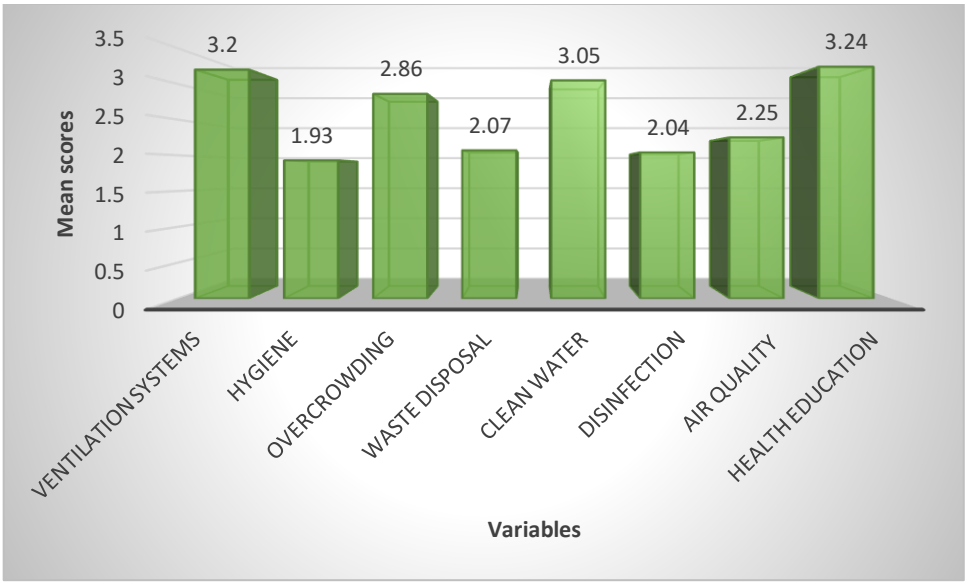


Fig. 3: Mean score of environmental health interventions in controlling TB outbreaks in Niger State.

Source: Authors, 2025

*Improved Ventilation Systems:* There is strong support for improved ventilation systems, with the majority of respondents agreeing or strongly agreeing that ventilation is important for controlling TB cases. Improved ventilation is a key factor in controlling airborne diseases like tuberculosis. According to WHO (2010), increasing ventilation in crowded areas helps dilute and remove the airborne bacteria that cause TB, thus reducing transmission. Proper ventilation in homes, healthcare facilities, and public spaces reduces the concentration of the airborne TB bacteria, making it less likely for individuals to inhale infectious particles. Baker et al. (2015) also emphasize that ventilation and air filtration are essential in reducing the airborne transmission of TB, particularly in high-risk environments like healthcare settings and overcrowded urban areas. Given Niger State's challenges with overcrowding in urban areas, investing in improved ventilation is essential to mitigate the spread of TB. *Improving Hygiene:* The majority of respondents disagreed with the importance of hygiene improvements as a strategy for controlling TB. The relationship between hygiene and TB transmission is less direct than factors such as ventilation or overcrowding. TB primarily spreads through the air via inhalation of infectious droplets, not through contaminated surfaces. However, Hoffman *et al*., (2003) and Mackenzie *et al*., (2015) argue that improving hygiene practices can reduce other health risks, such as co-infections, which can exacerbate TB. In environments where sanitation is poor, other respiratory infections may occur more frequently, making TB control harder. Despite this, it's likely that respondents in Niger State did not see hygiene as critical for TB transmission, which aligns with global research focusing more on airborne transmission than surface-based contact. *Reducing Overcrowding:* A significant number of respondents supported reducing overcrowding as a measure to control TB. Cohen *et al*., (2012) highlight that

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overcrowding is a major risk factor for TB transmission, particularly in low- and middle-income countries. In these settings, people living in dense housing conditions are at a higher risk of inhaling infectious airborne particles. The CDC (2019) also underscores that TB spreads more easily in crowded environments, particularly in poorly ventilated settings. Addressing overcrowding in urban and peri-urban areas, such as in parts of Niger State, can significantly reduce TB transmission rates. Studies in various African nations have similarly found that reducing overcrowding—especially in public transport and informal settlements—has been critical to lowering TB rates. *Proper Waste Disposal:* The response to waste disposal as a TB control measure was largely negative, with many respondents disagreeing. Waste disposal is crucial for overall health and sanitation but has a less direct impact on TB prevention. Dodd *et al*., (2016) found that while poor waste disposal practices contribute to the spread of various diseases, including diarrheal diseases, its role in TB control is more indirect. In contrast, the WHO (2018) notes that inadequate sanitation and waste management can contribute to poor living conditions, which can worsen general health, making individuals more susceptible to infections like TB. In overcrowded areas, waste disposal may contribute to the general unsanitary environment, which can indirectly facilitate TB transmission. *Access to Clean Water:* There was strong support for increasing access to clean water as an intervention for TB control. Perry *et al*., (2017) point out that access to clean water improves overall health and sanitation, reducing the likelihood of co-infections that could complicate TB treatment. While clean water does not directly affect the transmission of TB, it supports general health and prevents conditions that weaken the immune system. A study by Nzioka *et al*., (2021) found that communities with greater access to clean water and sanitation experienced fewer respiratory infections, which can potentially reduce TB transmission. *Disinfection of Contaminated Areas:* There was a large proportion of respondents who disagreed with the importance of disinfecting contaminated areas to control TB. Mackenzie *et al*., (2015) suggest that while disinfection of surfaces can help reduce the spread of certain pathogens, the airborne nature of TB makes surface disinfection less impactful in preventing transmission. According to Baker *et al*., (2015), TB transmission is primarily through inhalation of infectious droplets, meaning interventions like air filtration and ventilation are more effective than surface disinfection. The response in Niger State aligns with this understanding, as respondents may not recognize the efficacy of surface disinfection in controlling an airborne disease like TB. *Air Quality Improvement Measures*: Respondents were mixed on the importance of improving air quality for controlling TB, with many disagreeing. Singh *et al*., (2013) emphasize that improving air quality is a key strategy in reducing TB transmission. In areas with high air pollution or poor ventilation, airborne diseases like TB can spread more easily. Baker *et al*., (2015) also highlight that air quality measures, such as reducing pollutants and improving ventilation, can help lower the concentration of TB bacteria in the air, thus reducing the risk of transmission. The negative responses in Niger State may reflect a lack of awareness of the link between poor air quality and TB spread, which is often more visible in highly polluted or industrial areas. *Health Education and Awareness Campaigns on TB Prevention:* This intervention received overwhelming support, with most respondents agreeing or strongly agreeing. Lönnroth *et al*., (2010) stress that health education and awareness campaigns are critical in controlling TB. Raising awareness about TB symptoms, prevention methods, and the importance of early diagnosis can lead to better outcomes in controlling the disease. In countries with high TB burdens, such as parts of Africa, education campaigns have been shown to increase knowledge about TB and encourage people to seek treatment early, reducing transmission. *Ayles et al*., (2018) found that community-based health education programs significantly reduced TB prevalence in some high-risk areas. The high support in Niger State suggests that the community recognizes the importance of education and awareness in preventing and controlling TB.

## CONCLUSION

The study findings are largely consistent with existing literature on environmental determinants of TB, particularly regarding ventilation, air quality, and education. However, discrepancies in perceptions regarding hygiene, overcrowding, and waste management suggest a need for enhanced public health messaging to bridge knowledge gaps. Strengthening environmental interventions in Kano, based on global best practices, can significantly contribute to TB control.

In another development, the survey results suggest that improved ventilation, air quality measures, disinfection, and health education are the most widely supported environmental interventions for TB control in

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Lagos State. In contrast, reducing overcrowding and improving hygiene received mixed or lower support. Policymakers should focus on interventions with strong support while addressing feasibility concerns.

Furthermore, the results from Niger State show a mix of perceptions regarding various environmental health interventions for TB control. There is a strong recognition of the importance of improved ventilation systems, reducing overcrowding, and health education campaigns—all of which are supported by global literature as effective strategies for TB control. However, hygiene improvement and proper waste disposal received less support, perhaps because these measures are perceived as less directly related to TB transmission, especially given that TB is primarily an airborne disease. Investing in public health education and awareness campaigns, alongside improving environmental factors like ventilation and crowding, should be prioritized in Niger State to curb the TB burden.

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# APPENDIX

**Environmental health interventions in controlling or reducing TB outbreaks in Kano state.**

To analyze the results using the mean, we first need to convert the percentages of responses into a numerical scale. For simplicity, we will assign values to the response categories as follows:

- Strongly Agree = 4
- Agree = 3
- Strongly Disagree = 2
- Disagree = 1

Next, we will calculate the mean score for each variable based on the percentage of respondents in each category.

Step-by-Step Calculation

**Convert Percentages to Scores**

For each variable, we will calculate the weighted score using the assigned values and the percentages provided. The formula for the weighted score is:

Weighted Score = $(P_{\text{Strongly Agree}} \times 4) + (P\text{A}_{\text{gree}} \times 3) + (P_{\text{Strongly Disagree}} \times 2) + (P_{\text{Disagree}} \times 1)$

Where $P$ represents the percentage of respondents in each category.

**Calculate the Mean Score for Each Variable**

Let's calculate the mean score for each variable:

**Variable 1:** Improved ventilation system

Weighted Score = (39 × 4) + (35 × 3) + (17 × 2) + (9 × 1) = 156+105+34+9
Mean Score = 304/100 = **3.04**

**Variable 2:** Improved hygiene

Weighted Score = (20 × 4) + (16 × 3) + (30 × 2) + (34 × 1) = 80 + 48 + 60 + 34 = 222
Mean Score = 222/100 = **2.22**

**Variable 3:** Reduce overcrowding

Weighted Score = (24 × 4) + (25 × 3) + (30 × 2) + (31 × 1) = 96 + 75 + 60 + 31 = 262
Mean Score = 262/100 = **2.62**

**Variable 4:** Proper Waste Disposal

Weighted Score = (11 × 4) + (20 × 3) + (21 × 2) + (48 × 1) = 44 + 60 + 42 + 48 = 194
Mean Score = 194/100 = **1.94**

**Variable 5:** Access to clean water

Weighted Score = (15 × 4) + (11 × 3) + (35 × 2) + (39 × 1) = 60 + 33 + 70 + 39 = 202
Mean Score = 202/100 = **2.02**

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**Variable 6:** Disinfection of contaminated areas

Weighted Score = (15 × 4) + (14 × 3) + (48 × 2) + (23 × 1) = 60 + 42 + 96 + 23 = 221
Mean Score = 221/100 = **2.21**

**Variable 7:** Air Quality improvement measures

Weighted Score = (29 × 4) + (35 × 3) + (21 × 2) + (15 × 1) = 116 + 105 + 42 + 15 = 278
Mean Score = 278/100 = **2.78**

**Variable 8:** Health Education and Awareness Campaigns on TB prevention

Weighted Score = (33 × 4) + (39 × 3) + (11 × 2) + (17 × 1) = 132 + 117 + 22 + 17 = 288
Mean Score = 288/100 = **2.88**

Table 1.1: Summary of Mean Scores

| **Variable** | **Mean Score** |
|---|---|
| Ventilation systems | 3.04 |
| Hygiene | 2.22 |
| Overcrowding | 2.62 |
| Waste disposal | 1.94 |
| Clean water | 2.02 |
| Disinfection | 2.21 |
| Air Quality | 2.78 |
| Health Education | 2.88 |

**Environmental health interventions in controlling or reducing TB outbreaks in Lagos state.**

To analyze the results using the mean, we first need to convert the percentages of responses into a numerical scale. For simplicity, we can assign values to the response categories as follows:

- Strongly Agree = 4
- Agree = 3
- Strongly Disagree = 2
- Disagree = 1

Next, we will calculate the mean score for each variable based on the percentage of respondents in each category.

Step-by-Step Calculation

**Convert Percentages to Scores**

For each variable, we will calculate the weighted score using the assigned values and the percentages provided. The formula for the weighted score is:

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Weighted Score = ($P_{\text{Strongly Agree}} \times 4$) + ($PA_{\text{gree}} \times 3$) + ($P_{\text{Strongly Disagree}} \times 2$) + ($P_{\text{Disagree}} \times 1$)

Where *P* represents the percentage of respondents in each category.

**Calculate the Mean Score for Each Variable**

Let's calculate the mean score for each variable:

**Variable 1:** Improved ventilation system

Weighted Score = (49 × 4) + (36 × 3) + (6 × 2) + (9 × 1) = 196+108+12+9 = 325
Mean Score = 324/100 = **3.25**

**Variable 2:** Improved hygiene

Weighted Score = (17 × 4) + (31 × 3) + (24 × 2) + (28 × 1) = 68+93+48+28 = 237
Mean Score = 237/100 = **2.37**

**Variable 3:** Reduce overcrowding

Weighted Score = (18 × 4) + (10 × 3) + (36 × 2) + (36 × 1) = 72 + 30 + 72 + 36 = 210
Mean Score = 210/100 = **2.10**

**Variable 4:** Proper Waste Disposal

Weighted Score = (24 × 4) + (23 × 3) + (32 × 2) + (21 × 1) = 96 + 69 + 64 + 21 = 250
Mean Score = 250/100 = **2.50**

**Variable 5:** Access to clean water

Weighted Score = (19 × 4) + (20 × 3) + (41 × 2) + (20 × 1) = 76 + 60 + 82 + 20 = 238
Mean Score = 238/100 = **2.38**

**Variable 6:** Disinfection of contaminated areas

Weighted Score = (49 × 4) + (19 × 3) + (16 × 2) + (16 × 1) = 196 + 57 + 32 + 16 = 238
Mean Score = 238/100 = **2.38**

**Variable 7:** Air Quality improvement measures

Weighted Score = (52 × 4) + (36 × 3) + (6 × 2) + (6 × 1) = 208 + 108 + 12 + 6 = 334
Mean Score = 334/100 = **3.34**

**Variable 8:** Health Education and Awareness Campaigns on TB prevention

Weighted Score = (48 × 4) + (31 × 3) + (11 × 2) + (10 × 1) = 192 + 93 + 22 + 10 = 317
Mean Score = 317/100 = **3.17**

Table 2.1: Summary of Mean Scores

| **Variable** | **Mean Score** |
|---|---|
| Ventilation systems | 3.25 |
| Hygiene | 2.37 |

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| | |
|---|---|
| Overcrowding | 2.10 |
| Waste disposal | 2.50 |
| Clean water | 2.38 |
| Disinfection | 2.38 |
| Air Quality | 3.34 |
| Health Education | 3.17 |

Environmental health interventions in controlling or reducing TB outbreaks in Niger state.

Weighted Score = (23 × 4) + (15 x 3) + (26 × 2) + (36 × 1) = 92+45+52+36 = 225
Mean Score = 225/100 = **225**

To analyze the results using the mean, we first need to convert the percentages of responses into a numerical scale. For simplicity, we can assign values to the response categories as follows:

- Strongly Agree = 4
- Agree = 3
- Strongly Disagree = 2
- Disagree = 1

Next, we will calculate the mean score for each variable based on the percentage of respondents in each category.

Step-by-Step Calculation

**Convert Percentages to Scores**

For each variable, we will calculate the weighted score using the assigned values and the percentages provided. The formula for the weighted score is:

Weighted Score = ($P_{\text{Strongly Agree}} \times 4$) + ($P\text{A}_{\text{gree}} \times 3$) + ($P_{\text{Strongly Disagree}} \times 2$) + ($P_{\text{Disagree}} \times 1$)

Where $P$ represents the percentage of respondents in each category.

**Calculate the Mean Score for Each Variable**

Let's calculate the mean score for each variable:

**Variable 1:** Improved ventilation system

Weighted Score = (44 × 4) + (41 x 3) + (6 × 2) + (9 × 1) = 176+123+12+9 = 320
Mean Score = 320/100 = **3.20**

**Variable 2:** Improved hygiene

Weighted Score = (10 × 4) + (14 x 3) + (35 × 2) + (41 × 1) = 40+42+70+41 = 193
Mean Score = 193/100 = **1.93**

**Variable 3:** Reduce overcrowding

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Weighted Score = (30 × 4) + (41 x 3) + (14 × 2) + (15 × 1) = 120+123+28+15 = 286
Mean Score = 286/100 = **2.86**

**Variable 4:** Proper Waste Disposal

Weighted Score = (14 × 4) + (25 x 3) + (15 × 2) + (46 × 1) = 56+75+30+46 = 207
Mean Score = 207/100 = **2.07**

**Variable 5:** Access to clean water

Weighted Score = (41 × 4) + (36 x 3) + (10 × 2) + (13 × 1) = 164+108+20+13 = 305
Mean Score = 305/100 = **3.05**

**Variable 6:** Disinfection of contaminated areas

Weighted Score = (20 × 4) + (10 x 3) + (24 × 2) + (46 × 1) = 80+30+48+46 = 204
Mean Score = 204/100 = **2.04**

**Variable 7:** Air Quality improvement measures

Weighted Score = (23 × 4) + (15 x 3) + (26 × 2) + (36 × 1) = 92+45+52+36 = 225
Mean Score = 225/100 = **2.25**

**Variable 8:** Health Education and Awareness Campaigns on TB prevention

Weighted Score = (39 × 4) + (46 x 3) + (5 × 2) + (20 × 1) = 156+138+10+20 = 324
Mean Score = 324/100 = **3.24**

Table 3.1: Summary of Mean Scores

| **Variable** | **Mean Score** |
|---|---|
| Ventilation systems | 3.20 |
| Hygiene | 1.93 |
| Overcrowding | 2.86 |
| Waste disposal | 2.07 |
| Clean water | 3.05 |
| Disinfection | 2.04 |
| Air Quality | 2.25 |
| Health Education | 3.24 |