Examining the Influence of Environmental Characteristics on Health of Residents of Akure South LGA, Ondo State, Nigeria

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Abstract
The environmental challenges in Nigeria are severe, widespread, and rapidly increasing. It is on this premise that this research examines the influence of environmental characteristics on health of residents in Akure South LGA, Nigeria. A multi-stage sampling technique was used, such that 50% of the 9 urban political wards were selected. The selected 4 urban political wards comprised of 38,606 household heads. Also, 10% of the 40 rural settlements were randomly selected making 4 rural settlements with 2,066 household heads. In all, 1.5% of the total household heads in both urban and rural area consisting of 579 and 31 household heads respectively were interviewed using systematic random sampling techniques. Findings revealed that majority of the buildings experience insufficient airspace; considerable portion of the buildings situated in the central area violate the physical planning regulations of 3 meters' setback between buildings; non-compliance with the World Health Organization's guideline of 30 meters' between water sources and septic tanks in some areas; unhygienic practices of wastewater among residents. In the light of these findings, the following recommendations are proposed: environmental protection organizations and experts, especially urban planners, should be authorized to penalize individuals who occupy buildings with inadequate ventilation, residents with less than 3 meters of air space between buildings, residents who disregard the 30-meter distance between water sources and septic tanks and residents who engage in inappropriate wastewater management methods that could pose a significant health risk in the study area. By so doing, the influence of environmental characteristics on health of residents will be mitigated in the study area.
Keywords: Wastewater, Airspace, Ventilation, Health, Residents

Introduction

The health of individuals is determined by various environmental elements that play pivotal roles in shaping their identity and to a significant extent determine their well-being. Health is a state that arises from the comprehensive functioning of an individual within their environment, empowering them to lead a personally fulfilling and socially beneficial life (Olugbamila, 2016). Based on the premise that good health is a prerequisite for socio-political and economic development, it can be said that health is indeed wealth. Hence, the achievement of good health and well-being necessitates a clean and harmonious environment where physical, psychological, social, and aesthetic factors are all accorded their due importance.

Developing countries experience a significantly higher number of losses of lives each year due to environmental risk factors, with the total being 15 times greater than in other countries (WHO, 2019). Worldwide, 1.1 billion individuals lack access to potable water, leading to approximately 2 million children succumbing annually to preventable waterborne illnesses (Olatunde, Sarumi, Abdulsalaam, Bada & Oyebanji, 2021). Furthermore, as outlined by Ufoegbune, Oluwadare, Layi-Adigun, Olagoke, Ilevbaoje, and Ufoegbune (2021), the Water and Sanitation Programmes Africa (WSP-AF) disclosed that 440 children perish each week due to waterborne diseases. The underlying causes of these environmental problems can be attributed to factors such as poverty, weak institutional frameworks, population growth, and industrial expansion, as well as inadequate governmental response to environmental concerns, among others. Disturbingly, between 35% and 50% of urban dwellers in Africa lack access to safe drinking water, while approximately 60% lack adequate sanitation facilities (WHO/UNICEF, 2017; USAID, 2018).

Urbanization is a significant global trend of the 21st century that has a profound impact on health (WHO, 2016). Prasad, Kano, Dagg, Mori, Senkoro, Ardakani, and Armada (2015) argue that rapid urbanization affects human lives by influencing the natural environment, as a result of the intertwined history of humanity and disease. The aforementioned points clearly demonstrate the growing recognition of how social, physical, and built environments can influence the mental and physical health of individuals. The prevalence of diseases and negative health outcomes varies significantly based on factors such as age, ethnicity, income level, education status, physical layout, environmental planning, region, and other population characteristics that differ across different area (Muiruri, Wahome, Karatu, 2020). Of particular concern lies in the notion that socioeconomically disadvantaged, less prosperous, and more susceptible sectors of the population are frequently subjected to a greater degree of exposure to environmental hazards.

Many of the urban cities in Nigeria are rapidly deteriorating (Collins & Duffy, 2021). This has led to the proliferation of unsanitary and slum-like conditions, such as poor environmental sanitation, inadequate housing conditions, overcrowded housing units, improper waste disposal, pollution, and insufficient water supply (Centers for Disease Control and Prevention, 2022). These conditions also have detrimental effects on the built environment and serious implications for the health of city residents. These consequences vary in terms of solid waste disposal practices, cooking habits of residents, sources of water, inadequate housing conditions, indoor pollution, overcrowded housing units and distance of water to septic tanks across different geographical locations, which can contribute to poor health condition. It is on this premise that this study examines the influence of environmental characteristics on health of residence in Akure South LGA, Nigeria.

Literature Review

Environmental Characteristics and Health Interlinks

The ecological characteristics of residential area encompass the constructed surroundings of dwelling units that provide the backdrop for human activities. However, the living environment is heavily contaminated due to social misconduct such as indiscriminate littering, improper disposal of domestic wastewater, and inadequate sewage management. These behaviors contribute to unhygienic living conditions, resulting in the spread of communicable diseases (Olay-Romero, Turcott-Cervantes, del Consuelo et al., 2020).

Water, in its true sense, serves as the fundamental source of sustenance on our planet by fulfilling a crucial role in ensuring the survival of humanity. The availability of a sufficient quantity of uncontaminated and pure water stands as the paramount requirement for the preservation of human life, the protection of ecosystems that sustain all living organisms, and the realization of sustainable progress (Ogbozige & Toko, 2020). Nevertheless, if tainted, water can also present a substantial threat in terms of facilitating the spread of various diseases and ailments. Instances of waterborne illnesses are uncommon in industrialized nations owing to the existence of effective water distribution and sewage systems. This scenario contrasts starkly with that of developing nations, where a considerable portion of the population lacks access to safe water sources and proper sanitation facilities (Ibeje, Nwoke & Ibearugbulem, 2018).

It is widely recognized that solid waste management is a global problem (Hettiarachchi, Meegoda, Ryu, 2018). This problem is particularly severe in developing countries like Nigeria, where solid waste management is a major concern. Karshima (2016) stated that effective solid waste management poses a significant challenge for environmental organizations within the nation. Almazán-Casali, Alfaro and Sikra (2019) highlighted a breakdown in law and order linked to waste management as a consequence of these challenges. They pointed out that urban area is experiencing a rise in environmental degradation due to the unregulated disposal of solid waste. Addo, Adei and Acheampong (2015) expressed concerns about the environmental hazards posed by heaps of waste being carelessly discarded along roadsides and in various open area.

The contamination of underground water, which refers to water found beneath the Earth's surface in soil pores and fractures of rock formations, has occurred due to the process of industrialization and urbanization, which has progressed over time without considering the environmental consequences. Consequently, this leads to the deterioration of the physical, chemical, and biological properties of water (Ali & Ahmad, 2020). The scarcity of piped water has forced communities to seek alternative sources, and groundwater has become a readily available option (Brockett, Wolfe, Hamot, Appiah, Mintz & Lantagne, 2020). Furthermore, the absence of a centralized wastewater treatment system in urban area necessitates landlords to install septic tanks or soak-away for the disposal of domestic wastewater. However, in their desperate pursuit of potable water, these landlords have also drilled boreholes to access groundwater, without taking into account the proximity of these boreholes to septic tanks or soak-away. It should be noted that boreholes can be contaminated through other means as well. This according to Ugbebor and Ntesat (2022), the primary cause of underground water pollution is often attributed to the close proximity of septic tanks to boreholes, particularly when the adjoining geological formation is fissured. Akinbamijo (2019) conducted a study and established a noteworthy correlation between the health status of individuals and the quality of their housing, as measured by factors such as the age of the building, waste disposal methods, frequency of waste collection, management of wastewater, type of toilet, use of toilet, walling materials, type of roofing materials, adequacy of electricity, type of kitchen, and state of repairs of the buildings. As a result of this correlation, the author recommended several interventions to address the issue, including a public health campaign, expanded coverage of waste removal agencies, and public sector involvement to improve access to housing funds for rehabilitation, renovations, and redevelopment.

Methods

The Study Area

Akure South Local Government Area is located in Ondo State in the South-Western geopolitical zone of Nigeria. It occupies a land area of 37,134 hectares (35sq.km). It lies between latitude 70 17’ 0” and 70 15’ 0” North on the Equator and longitude 50 15' 42” and 50 18’ 42” East of the Greenwich Meridian; it is about 370m above the sea level (Macmillan, 2006). The study area is bounded by Owo Local Government Area in the East, Akure North and Ifedore Local Government Area to the North, Ile-Oluji/Okeigbo Local Government Area in the West and Idanre Local Government in the South.

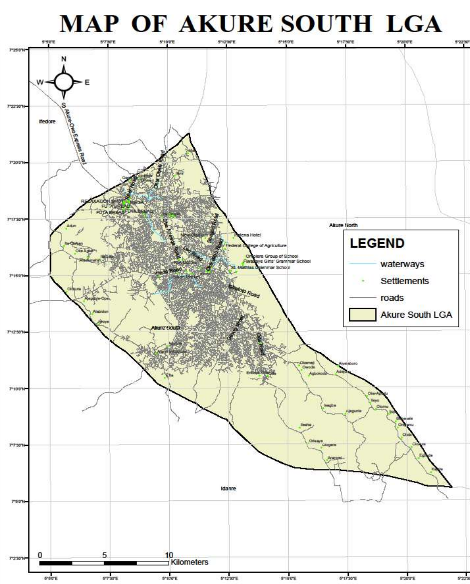

Figure 1: Ondo State in the National Context
Source: Ministry of Physical Planning and Urban Development, Ondo State, 2023

Figure 2: Akure South LGA
Source: Ministry of Physical Planning Urban Development, Ondo State, 2023

The city has a population of about 360,268 (National Population Commission, 2006). Using a 3.77% projection rate, it is expected that by 2023, the city population would have risen to about 74,400. The urban core which happens to be the oldest residential area of the city, consists of the city's oldest structures and is bounded by Oba Adesida Road to the North, Oke-Aro Road to the West and Hospital Road to the East.

Research Method

A multi-stage sampling technique was used. The initial stage encompassed the purposeful selection of one local government area (LGA) from the existing 6 LGAs in Ondo Central Senatorial District. Akure South LGA was selected based on the premise of greater number of healthcare facilities and the most urbanized local government area within Ondo Central Senatorial District. Akure South LGA consist of 9 political wards, 50% of it was selected namely: Gbogi/Isinkan I, Odopetu, Ijomu/Obanla, Oshodi/Isolo. The selected 4 political wards comprised of 38,606 household heads. Also, 10% of the 40 rural settlements were randomly selected making 4 rural settlements with 2,066 household heads. This according to NPC, (2006), settlements containing a population exceeding 20,000 individuals are categorized as urban, whereas those with a population below 20,000 are designated as rural settlements. In all, 1.5% of the total household heads in both urban and rural area consisting of 579 and 31 household heads respectively were interviewed using systematic random sampling techniques. This was in order to reduce the population of the identified urban and rural area to a manageable size and to capture the interest of the population of the different residential area. However, the first residential building with household head in each settlement was randomly selected, and subsequently, every 50th residential building in the selected settlements was sampled for the study (Table 1).

Table 1: Settlements and number of household heads selected for interview in the study area

LGA (i)	Settlement Category (ii)	No. of Settlement (iii)	Selected Rural Settlement (10% of iii) (iv)	Selected Urban Settlement (50%of iii) (v)	Household Population (vi)	Total No. of House hold head (vii)	Sample Size (1.5%of vii) (viii)
Akure South	Urban	9		5	193,030	38,606	579
	Rural	40	4		10,330	2,066	31
TOTAL		**49**	**9**		**203,360**	**40,672**	**610**

Source: NPC, 2006; Authors' fieldwork, 2024

As previously specified, a total of 610 households were subjected to interviews. However, only 578 survey was collected due to the reluctance of certain respondents to reveal the health condition of their families, particularly when the household head was unavoidably absent. Additionally, some individuals perceived such disclosure as a taboo and contrary to their beliefs and traditions.

Multivariate regression techniques were used to establish a cause-effect relationship between some research variables and the health condition (HLTCOND) of the residents. The purpose behind this was to assess the contributions made by these research variables in enhancing health and reducing its effect among the residents in the study area. In this study, six (6) research variables were carefully selected for the purposes of conducting multivariate analysis. Through the process of data transformation, the mean score of the HLTCOND variables was obtained for each respondent. The mean score was then utilized as the outcome variable, serving as a concise representation of the health condition index within the study area. The six explanatory variables were identified in order to determine their influence on HLTCOND in the study area. They are: air space between buildings (AIRSPAC), the occupancy ratio per room (OCUPAN), the ventilation level of the buildings (VENTLEV), the sources of water (SOWAT), the method of water treatment (WATTRET), and the distance of the sources of water to the septic tanks (DISEPTA). For clarity, the specification and justification for the choice of the explanatory variables were presented in Table 2.

Table 2: Definition of health condition variables

Variable code	Specification of variable code	Mean*	SD
HLTCOND	Health condition index	.6940	.62265
AIRSPAC	Air space between buildings	.6671	.54248
OCUPAN	Occupancy ratio per room	.6015	.52743
VENTLEV	Ventilation level of buildings	.8275	.60257
SOWAT	sources of water	.6961	.62425
WATTRET	Method of water treatment	.7425	.60926
DISEPTA	Distance of sources of water to septic tanks	1.42	.493^{+}

Source: Author's fieldwork, 2024

The selection of predictor variables in the study follows a thorough analysis of multi-co linearity, which was performed using the correlation matrix table. Hauser's (1974) assertion, in Noora (2020), posits that there should not be any correlation coefficient exceeding 0.8 between two predictors, while Field (2018) suggests that the correlation coefficient between predictors should not surpass 0.9. In this study, the issue of multi-co linearity did not arise, as the highest correlation coefficients among the predictors is 0.719 (Table 3).
This study uses the double-log models as against the linear models because of

a. high explanatory power of R2
b. possibility of presenting regression coefficient directly as elasticity estimates and
c. reduction in homoscedasticity-errors which are distributed over the estimate parameters uniform

Table 3: Zero – order correlation matrix for the study area

Akure South	Y	X_1	X_2	X_3	X_4	X_5	X_6
HLTCOND (Y)	1.000	.758	.772	.744	.723	.850	.541
AIRSPAC (X_1)		1.000	.647	.610	.555	.674	.307
OCUPAN (X_2)			1.000	.602	.507	.719	.456
VENTLEV (X_3)				1.000	.532	.615	.346
SOWAT (X_4)					1.000	.606	.447
WATTRET (X_5)						1.000	.473
DISEPTA (X_6)							1.000

Dependent Variable: HLTCOND

Predictors: AIRSPAC, OCUPAN, VENTLEV, SOWAT, WATTRET, DISEPTA

Source: Author's fieldwork, 2024

The utilization of the double log functional form in multiple regression models is customary for the purpose of applying the natural logarithm to both the outcome and explanatory variables, with the exception of the variable measured on a dichotomous scale, prior to subjecting them to multiple regression analysis (Noora, 2020). The preference for the double logistic model, as opposed to other functional forms, stems from its capacity to yield a high level of explanatory power, as indicated by Akinbamijo (2019). Additionally, it possesses the ability to decrease the variability of the dataset and enhance the probability of approximate normality. Furthermore, it has the capacity to diminish heteroscedasticity, which refers to the variance of the residual uniformly distributed across the estimates of the model parameters (Hizli, 2022). Moreover, it has the potential to directly present regression coefficients as elasticity estimates (Tırınk, Abacı & Önder, 2020). Specifically, in comparison to the semi-log function, the double log function does not necessitate the transformation of regression coefficients prior to interpretation. The predictors were systematically incorporated into the model using the forced entry option, based on their theoretical importance and the researcher's practical experience regarding health disparities in the study area, as supported by Field (2018). The double log functional form is represented as follows:

$\ln(Y) = \beta_0 + \sum_{i=1}^{n} \beta_1 \ln X_i$……………………………………………………………………Equation 1

Where:

ln ……….... is the natural logarithm,
'Y' ……….. is the outcome variable,
'βo' ………. is constant,
'βi'………...'βn' are regression coefficients,
'Xi'………..'Xn' are explanatory variables.

When the variables utilised in this empirical estimation are entered to equation 1, the model is interpreted as:

Ln (HLTCOND) = βo + β1 ln (AIRSPAC) + β2 ln (OCUPAN) + β3 ln (VENTLEV) + β4 (SOWAT) + β5 ln (WATTRET) + β6 (DISEPTA) ………………………... Equation 2

Results and Discussion

Ventilation Level of Buildings

As indicated in Table 4, respondents in both the urban and rural area of Akure South LGA revealed that the ventilation in buildings was in a fair condition, accounting for 48.4% and 87.1% respectively. Based on the findings, it is evidence that buildings with fair ventilation had dominance in the study area, accounting for 50.5%. This is primarily due to the prevalence of substandard buildings in the core of the study area. Similarly, the rural area is characterized by a proliferation of substandard buildings. These issues are noticeable in the quality of buildings and roofing materials, as well as in the inadequate size of windows and doors, and the close proximity of buildings to one another. The consequence of this situation is the accumulation of carbon dioxide and the depletion of oxygen. This can lead to respiratory problems, headaches, and asthma, among other health issues.

Table 4: Ventilation level of buildings in the study area

Akure South	Poor	Fair	Good	Total
Urban	6 (1.1%)	265 (48.4%)	276 (50.5%)	**547 (100%)**
Rural	0 (0.0%)	27 (87.1%)	4 (12.9%)	**31 (100%)**
Total	**6 (1.0%)**	**292 (50.5%)**	**280 (48.5%)**	**578 (100%)**

Source: Author's fieldwork, 2024

Air Space between Buildings in the Study Area

The analysis on airspace between structures is disclosed in Table 5. In Akure South LGA, the airspace between buildings in the urban area indicated that 49.2% accounted for below 3 meters, while 50.8% constituted airspace above 3 meters. Also, in the rural area, the airspace between buildings below 3 meters was 48.4%, while above 3 meters constituted 56.1%. This reveals that 49.1% of the respondents in Akure South LGA did not complied with the physical planning standards for airspace between buildings. The implication is that it can escalate health risks and render the residents of such buildings susceptible to illness due to inadequate lighting and ventilation (Figure 3). These findings support the research conducted by Akinbamijo and Ayejugbagbe (2021), that insufficient airspace between buildings can negatively impact the well-being of the residents.

Table 5: Air space between buildings in the study area

Akure South	Below 3m	Above 3m	Total
Urban	269 (49.2%)	278 (50.8%)	**547 (100%)**
Rural	15 (48.4%)	16 (51.6%)	**31 (100%)**
Total	**284 (49.1%)**	**294 (50.1%)**	**578 (100%)**

Source: Author's fieldwork, 2024

Figure 3: Poor airspace of less than 3 meters between buildings at Oke-Ijebu

Occupancy Ratio per Room in the Study Area

The findings on Table 6 indicated that the occupancy ratio per room in urban area of Akure South LGA is distributed as follows: below 4 (24.5%), 4-6 (67.1%), 7-9 (8.4%), and above 9 (0.0%). In the rural area, the distribution is as follows: below 4 (35.5%), 4-6 (58.1%), 7-9 (6.4%), and above 9 (0.0%). The majority of the respondents fall within the range of 4-6 (66.6%) in terms of occupancy ratio. Some factors such as household size, low-income level among others can contribute to the high occupancy ratio observed among the respondents. The impact of a high occupancy ratio on the health of residents can lead to the transmission of contagious diseases such as tuberculosis, skin disease, and chicken pox, among others. These findings align with the assertion made by Bortolini, and Núria (2021) that a high occupancy ratio has a detrimental effect on the health of residents.

Table 6: Occupancy ratio per room in the study area

Akure South	Below 4	4 – 6	7 - 9	Above 9	Total
Urban	134 (24.5%)	367 (67.1%)	46 (8.4%)	0 (0.0%)	**547 (100%)**
Rural	11 (35.5%)	18 (58.1%)	2 (6.4%)	0 (0.0%)	**31 (100%)**
Total	**145 (25.1%)**	**385 (66.6%)**	**48 (8.3%)**	**0 (0.0%)**	**578 (100%)**

Source: Author's fieldwork, 2024

Distance of Source of Water to Septic Tank

The Analysis on Table 7 revealed the distance between the sources of water and the septic tanks. In the urban area of Akure South, 66.7% of the respondents had a distance below 30 meters, while 33.3% had a distance above 30 meters. Similarly, in the rural area, 31.5% of the respondents accounted for a distance below 30 meters and 64.5% had a distance above 30 meters. This indicates that 65.1% of the respondents in Akure South LGA did not adhere with the WHO recommended standard of 30 meters. These findings support Ugbebor & Ntesat (2022) that water from boreholes and hand dug wells can be contaminated, with the primary cause of water pollution being the close proximity of septic tanks to boreholes, particularly when the surrounding geological formation is fissured.

Table 7: Distance of septic tank/soak-away to source of water

Akure South	Below 30metres	Above 30metres	Total
Urban	365 (66.7%)	182 (33.3%)	**547 (100%)**
Rural	11 (31.5%)	20 (64.5%)	**31 (100%)**
Total	**376 (65.1%)**	**202 (34.9%)**	**578 (100%)**

Source: Author's fieldwork, 2024

Management of Wastewater in the Study Area

As revealed in Table 8, in the urban area of Akure South, the management of wastewater Is as revealed: soak-away pits accounted for 47.9%, drains represented 11.3%, and open spills constituted 40.8%. In the rural area, the distribution is as follows: soak-away pits (9.7%), drains (25.8%), and open spills (64.5%). It is evident that the soak-away pit method of wastewater management exhibits dominance in certain parts of the urban area, accounting for 47.9%. However, 40.8% of respondents in other urban area practiced open spills, also, 64.5% of respondents in the rural area engaged in this same method. It is worth noting that the open spills of wastewater pose a significant risk to human health in the study area. As improper disposal of wastewater from bathrooms, laundries, and kitchens results in foul odors and creates breeding grounds for mosquitoes, as well as unsanitary environments.

Table 8: Management of wastewater in the study area

Akure South	Soak-away pit	Drains	Open spills	Total
Urban	262 (47.9%)	62 (11.3%)	223 (40.8%)	**547 (100%)**
Rural	3 (9.7%)	8 (25.8%)	20 (64.5%)	**31 (100%)**
Total	**265 (45.8%)**	**70 (12.1%)**	**243 (42.1%)**	**578 (100%)**

Source: Author's fieldwork, 2024

Environmental Factors and Health Condition of Residents in the Study Area

As indicated in Table 9, the study presented six parameters that influenced the health condition of the residents in the study area. These parameters are air space between buildings (AIRSPAC), the occupancy ratio per room (OCUPAN), the ventilation level of the buildings (VENTLEV), the sources of water (SOWAT), the method of water treatment (WATTRET), and the distance of the sources of water to the septic tanks (DISEPTA). These six parameters were significant at a 0.01 level. The coefficients for these parameters are 0.170, 0.154, 0.202, 0.195, 0.333, and 0.104, respectively. They were all significant at a 0.5 alpha level ($p < 0.01$). This means that, a 100% improvement in the management of AIRSPAC, OCUPAN, VENTLEV, SOWAT, WATTRET, and DISEPTA would results in 17.0%, 15.4%, 20.2%, 19.5%, 33.3%, and 10.4% increase in the health quality of the residents of the study area. It must be emphasized that water plays a major impact on health of residents in the study area, therefore, a qualitative change in the method of water treatment will improve the health of residents. It is evident that water is life and have a vital role in supporting human existence, and if contaminated, it has the potential to transmit a wide range of diseases (Ndaw, 2020; Popoola, 2020).

Table 9: Regression model on health conditions of residents in the study area

Independent variable	Reg. Coeff.	t-value	Level of sig
AIRSPAC	.170	7.710	.000
Ln (OCUPAN)	.154	6.684	.000
Ln (VENTLEV)	.203	9.965	.000
Ln (SOWAT)	.195	9.883	.000
Ln (WATTRET)	.333	13.517	.000
DISEPTA	.104	5.976	.000
Constant	-11.011		
R^2	.879		
F	691.684		
N	578		

Source: Author's fieldwork, 2024

Overall, it is revealed that each of the variables implemented on the health model in the study area exhibit a strong fit with R2 estimates of 0.879. The F values of Akure South LGA ($F = 691.684$, $p < 0.001$), signify that these specific model parameters accurately forecast health condition within the study area.

Conclusion and Recommendations

The potential for built environments to promote positive health outcomes is closely linked to their effectiveness in facilitating stress management and rejuvenation. The environment should strive to support and maintain residents' autonomy, acceptability, convenience, and controllability. The findings revealed that a large proportion of buildings lack sufficient airspace; a significant number of buildings in the core area fails to comply with the urban planning rules requiring a 3-meter setback between buildings; certain areas do not adhere to the World Health Organization's standard of 30 meters' distance between water sources and septic tanks; and the residents display unhygienic practices in managing wastewater. Given these results, it is recommended that environmental protection agencies and professionals, particularly urban planners, be given the authority to penalize individuals who inhabit buildings with inadequate ventilation, occupants living in spaces with less than 3 meters of air space between buildings, individuals who disregard the 30-meter distance requirement between water sources and septic tanks, and residents who adopt improper methods for handling wastewater that could pose significant health hazards in the research area. However, a qualitative change in the environmental characteristics used will enhance the health of residents in the study area.

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