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Assessment Of Building Characteristics, Ventilation Openings and Natural Ventilation Performance in Community Health Centres in Ogbomoso, Nigeria

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Abstract- This study assessed the influence of natural ventilation on users' satisfaction in selected community health centres in Ogbomoso, Nigeria, with the findings intended to inform the design of a proposed community health centre in Aroje. A descriptive research design was adopted, combining questionnaire surveys with field observation and assessment of ventilation characteristics. Data were collected from 182 users, comprising patients, visitors, healthcare workers and other users of selected health centres. Descriptive statistics, including frequencies, percentages and mean weighted values, were used to analyse the data. The findings revealed that 55.5% of the respondents identified the facilities as Primary Health Centres, while 69.8% were government-owned and 87.9% were single-storey buildings. Regarding users' thermal responses, 72.0% reported feeling slightly warm or hot, while 66.5% preferred cooler indoor conditions and 75.9% experienced heat discomfort at least sometimes. The assessment of ventilation openings showed that 53.8% reported the absence of cross-ventilation, while 51.6% described windows as small and 39.6% rated existing openings as inadequate. Perceived ventilation performance was generally low, with cross-ventilation availability recording the lowest mean weighted value of 2.29, while ventilation effectiveness during hot periods recorded 2.30. These findings indicate that inadequate opening sizes, poor positioning, obstruction and limited cross-ventilation constrain natural ventilation performance. The study recommends climate-responsive design strategies incorporating effective cross-ventilation, adequately sized operable openings, shaded outdoor spaces and high-level ventilation openings for improved user comfort and satisfaction.

Keywords: natural ventilation; users' satisfaction; thermal comfort; community health centres; cross-ventilation; ogbomoso; healthcare facilities.

I. INTRODUCTION

Indoor environmental quality is an important consideration in building design because of its relationship with occupants' health, comfort and wellbeing. Ventilation is a major component of indoor environmental quality as it facilitates air movement, removes accumulated heat and pollutants, and influences occupants' perception of indoor comfort (Ogunnaike et al., 2025; Islam, 2025; Rodrigues et al., 2025). These functions are particularly important in healthcare facilities, where patients, healthcare workers and visitors may spend considerable periods within enclosed spaces. Poor ventilation can result in stuffiness, thermal discomfort and inadequate indoor air quality, thereby affecting the quality of the healthcare environment.

Natural ventilation is particularly relevant in warm-climate regions because it can provide air movement and heat removal without continuous dependence on mechanical cooling. Through wind-driven pressure and thermal buoyancy, appropriately designed openings can facilitate the exchange of indoor and outdoor air while reducing energy demand (Ahmed et al., 2021; Mba et al., 2022). However, the effectiveness of natural ventilation depends on more than the presence of windows and doors. Building orientation, form, spatial configuration, opening size, position, operability and surrounding conditions determine the extent to which airflow can penetrate and circulate within occupied spaces (Munonye and Ji, 2020; Mba et al., 2025; Ogochukwu and Ehisuoria, 2025).

This issue is particularly significant in Nigeria, where high outdoor temperatures and dependence on natural ventilation create a need for climate-responsive building design. Although natural ventilation remains an important strategy in many Nigerian public buildings, inadequate building configuration, poorly positioned openings, obstruction of airflow paths and insufficient cross ventilation can limit its effectiveness (Munonye and Ji, 2020; Mustapha et al., 2023; Uzuegbunam et al., 2024). Studies has also shown that occupants' thermal responses are influenced by both environmental conditions and personal factors, including age, clothing, activity level and duration of exposure. Consequently, assessment of ventilation should consider not only the physical characteristics of buildings but also how users perceive and experience the indoor environment.

Community health centres require particular attention because they accommodate users with different characteristics, activities and durations of stay. Patients and visitors may spend extended periods in waiting areas, while healthcare workers occupy consultation rooms, treatment spaces and offices for several hours. The thermal and ventilation conditions experienced by these groups may therefore differ. Previous Nigerian studies have examined thermal comfort and natural ventilation in residential, educational and other building types (Ibem et al., 2020; Munonye and Ji, 2020; Mba et al., 2022), but comparatively limited attention has been given to the combined assessment of building characteristics, ventilation openings and natural ventilation performance in community health centres.

Studies have often examined either physical environmental conditions or occupants' perceptions independently. This limits understanding of whether the architectural provision of ventilation actually produces satisfactory conditions for users. Assessing building characteristics alongside opening configuration and perceived ventilation performance can therefore provide a more comprehensive understanding of ventilation deficiencies within healthcare facilities. Such an approach is particularly relevant in Ogbomoso, where community health centres operate within a warm climatic context and where passive design strategies can provide an important means of improving indoor environmental conditions.

II. LITERATURE REVIEW

Community Health Centres and the Indoor Environmental Context

Community health centres (CHCs) constitute an important component of primary healthcare delivery, providing first-contact services such as outpatient care, maternal and child healthcare, immunization, health education and treatment of common illnesses (Aregbeshola and Khan, 2020; World Health Organization [WHO], 2021). In Nigeria, primary healthcare facilities are particularly important because they provide essential services to populations that may have limited access to secondary and tertiary healthcare institutions. However, the effectiveness of these facilities depends not only on the availability of healthcare services but also on the quality of their physical environments (Onwujekwe et al., 2019; Abimbola et al., 2021).

The physical characteristics of healthcare buildings can influence indoor environmental conditions and, consequently, the comfort and wellbeing of patients, healthcare workers and visitors. Community health centres commonly contain waiting areas, consultation rooms, treatment spaces, pharmacies, offices and other service areas, creating different occupancy patterns and ventilation requirements. Inadequate spatial planning, overcrowding and poorly coordinated building layouts can restrict air movement and contribute to thermal discomfort (Oladokun et al., 2014; Okafor and Okolie, 2021). Thus, the assessment of building characteristics provides an important basis for understanding the natural ventilation performance of community health centres.

Building Characteristics and Natural Ventilation

Building characteristics are important determinants of natural ventilation because they establish the pathways through which outdoor air enters, moves through and leaves an indoor space. Building orientation, form, spatial configuration, internal layout, occupancy and the relationship between indoor and outdoor spaces can either facilitate or obstruct airflow. In naturally ventilated buildings, these characteristics interact with prevailing wind conditions and temperature differences to determine ventilation effectiveness (Zaniboni and Albatici, 2022; Jiang et al., 2023).

Building orientation is particularly important because the location of façades and openings relative to prevailing wind directions affects the pressure differences responsible for wind-driven airflow. Buildings that are appropriately oriented can make better use of available wind, whereas poorly oriented buildings may experience limited airflow even where adequate openings are provided (Ogunsote and Prucnal-Ogunsote, 2020; Mba et al., 2022). Similarly, internal spatial configuration influences whether air can move continuously between openings. Excessive compartmentalization, poorly positioned partitions and enclosed spaces may interrupt airflow and reduce the effectiveness of cross ventilation.

The relationship between building characteristics and ventilation is particularly significant in warm climates such as southwestern Nigeria. High temperatures and humidity increase the need for air movement as a passive means of improving thermal comfort. However, studies have reported that many Nigerian buildings are not sufficiently adapted to local climatic conditions, resulting in poor indoor environmental performance and increased dependence on mechanical cooling (Ogunsote and Prucnal-Ogunsote, 2020; Munonye and Ji, 2020; Mustapha et al., 2023).

Ventilation Openings and Airflow Performance

Ventilation openings represent the principal connection between the indoor and outdoor environments in naturally ventilated buildings. Windows, doors, wall ventilators, clerestory windows, skylights and roof vents determine the amount and direction of air entering and leaving a building. Their effectiveness depends not simply on their presence but also on their size, location, orientation, height, distribution and operability (Awbi, 2021; Jiang et al., 2023).

Windows are particularly important because they are commonly the primary means of achieving natural ventilation in buildings. Casement, louvered, sliding and awning windows provide different opportunities for controlling airflow. Their performance depends on the relationship between opening area, wind direction and the internal arrangement of spaces (Awbi, 2021). Doors can also contribute to airflow, particularly where they provide additional pathways between spaces; however, privacy, security and functional requirements in healthcare environments may limit their use as ventilation openings (Atkinson et al., 2009).

The position and distribution of openings are especially important for achieving cross ventilation. Openings positioned on opposite or suitably related façades can establish a continuous airflow path, whereas openings concentrated on one façade may produce weaker single-sided ventilation (Jiang et al., 2023). High-level openings, including clerestory windows and roof vents, can further facilitate the removal of warm air through buoyancy-driven airflow (Yang and Clements-Croome, 2012; Awbi, 2021).

The effectiveness of ventilation openings may also be reduced by physical obstructions. Internal partitions, furniture, enclosed rooms and poorly arranged circulation spaces can interrupt airflow between inlet and outlet openings. Similarly, external buildings, vegetation and other surrounding structures may obstruct wind before it reaches the openings. Consequently, the assessment of ventilation openings should consider not only their type but also their physical characteristics and relationship with the overall building layout.

Natural Ventilation Performance in Warm-Climate Buildings

Natural ventilation is the movement of outdoor air through a building using natural driving forces rather than mechanical equipment. The two principal mechanisms are wind-driven ventilation and buoyancy-driven ventilation. Wind-driven ventilation occurs because differences in wind pressure across building openings cause air to move through the building, while buoyancy-driven ventilation results from temperature and density differences between indoor and outdoor air (Yang and Clements-Croome, 2012; Jiang et al., 2023).

Natural ventilation is particularly relevant to developing countries where high energy costs and unreliable electricity supply can limit the continuous use of mechanical cooling systems. It can reduce dependence on air-conditioning while supporting thermal comfort and indoor air quality (Santamouris et al., 2020; Zaniboni and Albatici, 2022). In healthcare buildings, adequate ventilation is additionally important because air exchange contributes to the removal or dilution of airborne contaminants and supports healthier indoor conditions (Atkinson et al., 2009; WHO, 2021).

However, the presence of natural ventilation does not necessarily mean that adequate ventilation performance is being achieved. Research in warm-climate buildings has demonstrated that occupants may continue to experience thermal discomfort where airflow is insufficient, particularly during hot periods (Munonye and Ji, 2020; Abuhussain et al., 2024). The effectiveness of natural ventilation is therefore dependent on the interaction between building form, opening characteristics, climatic conditions and occupancy patterns.

Natural Ventilation and Indoor Environmental Quality

Natural ventilation contributes to indoor environmental quality through its influence on air movement, perceived air freshness and thermal conditions. Increased air movement can improve thermal comfort by enhancing convective and evaporative heat loss from the human body, allowing occupants to tolerate relatively high indoor temperatures in warm climates (Tamura et al., 2022; Mustapha et al., 2023).

Perceived air freshness is also strongly associated with ventilation. Adequate air exchange helps remove indoor heat, odours and accumulated pollutants, while insufficient ventilation may produce stagnant and stuffy conditions. Studies have therefore linked ventilation effectiveness with occupants' perceptions of indoor air quality and overall environmental satisfaction (Luo et al., 2022; Aydın and Yılmaz, 2023).

In healthcare environments, these relationships are particularly important because patients may remain in the facility for extended periods while healthcare workers may occupy the building throughout the working day. Poor ventilation can consequently affect both physical comfort and the perceived quality of the healthcare environment (Okafor and Okolie, 2021; Nimlyat et al., 2022).

Empirical Studies on Natural Ventilation in Nigeria

Studies have consistently identified challenges associated with natural ventilation and thermal comfort in buildings. Munonye and Ji (2020) found that occupants of naturally ventilated buildings in warm-humid environments experience varying thermal conditions influenced by environmental and personal factors. Similarly, Mustapha et al. (2023) reported that occupants in Nigerian naturally ventilated buildings can adapt to relatively high indoor temperatures, but effective air movement remains important to maintaining acceptable thermal comfort.

Mba et al,. (2022) demonstrated the importance of building characteristics in determining ventilation performance, particularly through factors such as building orientation, configuration and airflow pathways. Related research has emphasized that inadequate consideration of climatic conditions during building design can result in poor thermal performance and reduced effectiveness of passive ventilation strategies (Ogunsote and Prucnal-Ogunsote, 2020).

Studies highlighted the importance of ventilation openings. Ibem et al. (2020) identified building envelope and opening characteristics as important factors affecting indoor environmental conditions, while studies of naturally ventilated buildings have emphasized the role of window configuration, permeability and opening arrangement in determining airflow performance. More recent work has further indicated that simply providing windows does not guarantee effective natural ventilation because their location, size, operability and relationship with other

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openings determine the resulting airflow pattern (Abuhussain et al., 2024).

Within healthcare environments, Nimlyat et al., (2022) found that indoor environmental conditions influence patient wellbeing and satisfaction, while Okafor and Okolie (2021) highlighted the consequences of inadequate environmental conditions in healthcare facilities. These findings demonstrate the importance of evaluating ventilation within healthcare buildings rather than assuming that strategies developed for residential or educational buildings will perform similarly in healthcare settings.

III. METHODOLOGY

The study adopted a descriptive case study research design using a mixed-method approach that combined physical observation of selected community health centres with a structured questionnaire survey. The study was conducted in Ogbomoso, Oyo State, Nigeria, covering selected community health centres in Ogbomoso North and Ogbomoso South Local Government Areas. The approach enabled the assessment of the physical characteristics of the selected facilities, characteristics of ventilation openings, and the level of natural ventilation based on both physical observations and users' perceptions. The study population comprised patients, healthcare workers and visitors using the selected community health centres during the period of data collection. A multistage sampling technique was adopted, involving the identification of community health centres within the study area, purposive selection of suitable facilities based on functionality, accessibility, level of use and relevance to the study, and random selection of users for questionnaire administration. A total sample frame of 189 potential respondents was established, out of which 182 valid questionnaires were obtained and used for the analysis, representing a response rate of approximately 96.3%.

Primary data were collected through structured questionnaires and field observation. The questionnaire covered respondents' socio-characteristics, perceptions of ventilation openings, natural ventilation performance, and the relationship between users' characteristics and ventilation perception. A five-point Likert scale comprising Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), and Strongly Disagree (1) was used to obtain users' responses. The field observation involved the assessment of building characteristics, including building type, ownership, building height, spatial layout, occupancy level, building orientation and outdoor spaces, as well as ventilation-related characteristics such as window and door types, size, positioning, distribution, operability, high-level openings, cross-ventilation pathways and internal or external obstructions. Photographs, field notes and an observation checklist were used to support the physical assessment. The collected data were coded and analysed using frequency counts, percentages and Mean Weighted Values (MWV). Frequencies and percentages were used to describe building and user characteristics, while MWVs were used to assess and rank ventilation-opening characteristics and natural ventilation performance. The Mean Weighted Value was calculated based on the weighted responses to the five-point Likert scale. Natural ventilation performance was assessed using both physical and subjective measures, including airflow adequacy, cross ventilation, reduction of indoor heat, ventilation during hot periods, and ventilation conditions in waiting and consultation spaces. The relationship between users' characteristics and ventilation perception was examined through comparative descriptive analysis based on age, gender, duration of stay, frequency of use and user category.

IV. RESULTS AND DISCUSSION

Types and Characteristics of Selected Community Health Centres

The findings show that the selected community health centres were distributed almost equally between Ogbomoso South (50.5%) and Ogbomoso North (49.5%), providing balanced representation across the study area. Primary Health Centres constituted the largest facility type (55.5%), followed by maternity centres (19.2%), clinics (11.5%), and health posts (10.4%). Government-owned facilities

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dominated the sample (69.8%), indicating the major role of public healthcare facilities in community healthcare provision.

Most of the facilities were low-rise buildings, with 87.9% identified as bungalow or single-storey buildings and 85.7% having only one floor. Linear (33.0%) and compact (30.2%) layouts were the most common building forms, while courtyard layouts accounted for only 10.4%. Spatially, compartmentalized arrangements dominated (55.5%), reflecting the need for functional separation and privacy within healthcare facilities, although such arrangements may restrict airflow where ventilation openings are inadequate. East-West orientation was the most common (44.5%), while 22.5% of respondents were unsure of the orientation of their facilities.

The facilities generally experienced moderate to high occupancy, with 44.5% reporting moderate occupancy and 35.2% high occupancy. During peak periods, 71.4% of the facilities accommodated between 20 and 100 users. Although outdoor spaces were available in many facilities, 44.0% reported that they were available but underutilized, while 24.7% had no outdoor spaces. Overall, the findings indicate that the selected health centres are predominantly government-owned, single-storey, compartmentalized facilities with linear or compact layouts and moderate-to-high occupancy levels. These characteristics provide an important basis for assessing their natural ventilation performance and users' satisfaction in subsequent sections.

Table 1: Types and Physical Characteristics of Community Health Centres in Ogbomoso, n = 182

Variable	Category	Frequency	Percentage (%)
LGA	Ogbomoso North	90	49.5
	Ogbomoso South	92	50.5
Ward Distribution	Sabo Taara	18	9.9
	Alapaata	17	9.3
	Osupa	15	8.2
	Ibapon	15	8.2
	Ijeru II	13	7.1
	Saja Isale Ora	11	6.0
	Ilogbo	11	6.0
	Akata	11	6.0
	Abogunde	10	5.5
	Isoko	10	5.5
	Jagun	9	4.9
	Lagbedu	9	4.9
	Alasa	8	4.4
	Isale Afon	7	3.8
	Oke Ola	6	3.3
	Okelerin	12	6.6
Type of Health Centre	Primary Health Centre	101	55.5
	Maternity Centre	35	19.2
	Clinic	21	11.5
	Health Post	19	10.4
	Others	6	3.3
Ownership of Facility	Government	127	69.8
	Private	23	12.6
	Faith-based	17	9.3
	NGO/Community	15	8.2

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Building Type	Bungalow, single-storey	160	87.9
	Multi-storey	22	12.1
Number of Floors	1 floor	156	85.7
	2 floors	16	8.8
	3 floors	10	5.5
	More than 3 floors	0	0.0
General Building Layout/Form	Linear	60	33.0
	Compact	55	30.2
	Cluster	36	19.8
	Courtyard	19	10.4
	Others	12	6.6
Spatial Arrangement of Key Areas	Compartmentalized	101	55.5
	Mixed	50	27.5
	Open-plan	31	17.0
Building Orientation	East-West	81	44.5
	North-South	60	33.0
	Not sure	41	22.5
General Occupancy Level	Low	37	20.3
	Moderate	81	44.5
	High	64	35.2
Typical Number of Users at Peak Periods	Less than 20	31	17.0
	20-50	67	36.8
	50-100	63	34.6
	Above 100	21	11.5
Availability of Outdoor Spaces	Available and functional	57	31.3
	Available but underutilized	80	44.0
	Not available	45	24.7

Personal and Socio-Characteristics of Users

Table 2 presents the personal and socio-characteristics of users of the selected community health centres in Ogbomoso. The results indicate that patients constituted the majority of respondents (54.4%), followed by visitors (21.4%), while nurses, administrative staff, doctors and other users made up the remaining proportion. Female respondents were slightly more represented (58.2%) than males (41.8%). The largest age group was 31–40 years (34.1%), indicating that the respondents were predominantly adults within the active age range.

In terms of facility use, 41.8% of respondents visited the health centres occasionally, while 39.6% visited weekly. Furthermore, 43.4% reported spending between 1 and 3 hours per visit, with 74.7% spending more than one hour in the facilities. This indicates considerable exposure to the indoor environmental conditions of the health centres. Most respondents reported an average body build (56.6%), while 50.5% indicated that they feel hot easily.

The clothing and activity characteristics show that light and moderate clothing were equally dominant (47.3% each), while 45.6% of respondents were sedentary and 38.5% engaged in light physical activity. The thermal responses further reveal that 42.9% felt slightly warm and 29.1% felt hot, meaning that 72.0% experienced some level of warmth within the facilities. Similarly, 66.5% preferred cooler conditions, while 84.7% were either moderately or very sensitive to heat. Heat discomfort was also common, with 75.9% experiencing it either sometimes or often.

The findings indicate that users of the selected community health centres are predominantly patients and adults who spend considerable periods within the facilities, with a strong tendency towards warmth,

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preference for cooler conditions, heat sensitivity, and recurring heat discomfort. These characteristics provide an important basis for assessing users' perception of natural ventilation and satisfaction with the indoor environmental conditions of the health centres.

Table 2: Personal and Socio-Characteristics of Users in the Study Area, n = 182

Variable	Category	Frequency	Percentage (%)
Category of Respondent	Patient	99	54.4
	Visitor	39	21.4
	Nurse	20	11.0
	Administrative Staff	12	6.6
	Other	7	3.8
	Doctor	5	2.7
Gender	Female	106	58.2
	Male	76	41.8
Age Group	Below 20	16	8.8
	21–30	41	22.5
	31–40	62	34.1
	41–50	39	21.4
	Above 50	24	13.2
Frequency of Visit	Daily	34	18.7
	Weekly	72	39.6
	Occasionally	76	41.8
Average Duration per Visit	Less than 1 hour	46	25.3
	1–3 hours	79	43.4
	3–5 hours	39	21.4
	Above 5 hours	18	9.9
Body Build	Slim	44	24.2
	Average	103	56.6
	Heavy	35	19.2
Reaction to Heat	I feel hot easily	92	50.5
	I feel hot at a normal rate	71	39.0
	I rarely feel hot	19	10.4
Level of Clothing	Light	86	47.3
	Moderate	86	47.3
	Heavy	10	5.5
Physical Activity Level	Sedentary	83	45.6
	Light activity	70	38.5
	Moderate activity	27	14.8
	High activity	2	1.1
Thermal Sensation	Cold	3	1.6
	Slightly cool	12	6.6
	Neutral	36	19.8
	Slightly warm	78	42.9
	Hot	53	29.1
Thermal Preference	Prefer cooler conditions	121	66.5
	No change	51	28.0
	Prefer warmer conditions	10	5.5

Sensitivity to Heat	Very sensitive	66	36.3
	Moderately sensitive	88	48.4
	Not sensitive	28	15.4
Heat Discomfort Frequency	Often	50	27.5
	Sometimes	88	48.4
	Rarely	36	19.8
	Never	8	4.4

Types and Characteristics of Openings

This section presents the analysis of the types and characteristics of openings available in the selected community health centres in Ogbomoso. The analysis focuses on windows, doors, additional ventilation openings, transitional spaces, window height, window size, window-to-wall proportion, position of openings, cross-ventilation availability, functionality of openings, obstruction to airflow, and the general adequacy of openings for effective ventilation.

Openings are central to natural ventilation performance because they determine the movement of air into, within, and out of a building. In community health centres, effective ventilation is particularly important because such facilities accommodate patients, visitors, health workers, and administrative staff, many of whom spend extended periods indoors. Poorly designed or obstructed openings can lead to heat build-up, stuffiness, poor indoor air quality, and reduced user satisfaction.

The analysis for this section was conducted using descriptive statistics, frequency counts, percentages, mean scores, perception ranking, correlation analysis, and regression analysis. For the Likert-scale items under B2, the scoring system used was Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, and Strongly Disagree = 1.

Table 3: Types and Characteristics of Openings in the Study Area, n = 182

Variable	Category	Frequency	Percentage (%)
Types of windows available	Louvered	117	64.3
	Sliding	95	52.2
	Casement	64	35.2
	Fixed	45	24.7
	Awning	22	12.1
	Jalousie	14	7.7
	Others	5	2.7
Types of doors used	Single	116	63.7
	Double	78	42.9
	Others	24	13.2
	Perforated door	17	9.3
	Sliding	17	9.3
	Louvered door	12	6.6
Additional ventilation openings	Wall ventilators	63	34.6
	None	62	34.1
	Courtyard openings	41	22.5
	Fixed external louvers	26	14.3
	Clerestory windows	17	9.3
	Roof vents	15	8.2
	Skylights	6	3.3
Transitional/open spaces aiding ventilation	Corridors	111	61.0
	Verandas	101	55.5

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	Open waiting areas	90	49.5
	None	26	14.3
	Atrium	10	5.5
Approximate window height	Medium, 0.9 m to 1.5 m	95	52.2
	Low, below 0.9 m	42	23.1
	High, above 1.5 m	33	18.1
	Not sure	12	6.6
Approximate window size	Small	94	51.6
	Medium	61	33.5
	Not sure	15	8.2
	Large	12	6.6
Window-to-wall proportion	Less than 25%	89	48.9
	25-50%	60	33.0
	Not sure	17	9.3
	Above 50%	16	8.8
Window position in relation to airflow	Same wall only	86	47.3
	Adjacent walls	55	30.2
	Opposite walls, cross ventilation	41	22.5
Condition of doors during use	Occasionally open	79	43.4
	Mostly closed	57	31.3
	Frequently open	35	19.2
	Always closed	11	6.0
Location of ventilation openings	High level	79	43.4
	Both high and low	64	35.2
	Low level	39	21.4
Availability of cross-ventilation	No	98	53.8
	Not sure	45	24.7
	Yes	39	21.4
Functionality of ventilation openings	Partially functional	111	61.0
	Fully functional	53	29.1
	Not functional	18	9.9
Obstruction to ventilation openings	Furniture blocking openings	70	38.5
	External blockage, nearby buildings	66	36.3
	Internal partitions	66	36.3
	No obstruction	48	26.4
General adequacy of openings	Inadequate	72	39.6
	Fairly adequate	61	33.5
	Adequate	37	20.3
	Not sure	12	6.6

Note: Window types, door types, additional ventilation openings, transitional spaces, and obstruction to ventilation openings were multiple-response items. Therefore, their percentages exceed 100% when combined.

Findings on Types and Characteristics of Ventilation Openings

The findings indicate that the selected community health centres use a variety of ventilation openings, with louvered windows (64.3%) and sliding windows (52.2%) being the most common. However, the presence of fixed windows (24.7%), predominantly small window sizes (51.6%), and low window-to-

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wall proportions (48.9% below 25%) suggests that the available openings may not provide sufficient effective ventilation. Similarly, single doors were predominant (63.7%), while ventilated door types such as louvered and perforated doors were less common, limiting their contribution to continuous airflow when doors are closed.

Additional ventilation strategies were also limited. Although wall ventilators (34.6%), corridors (61.0%), verandas (55.5%), and open waiting areas (49.5%) were relatively common, 34.1% of respondents reported having no additional ventilation openings. Roof vents, clerestory windows, skylights, and atriums were comparatively uncommon, indicating limited use of high-level and vertical ventilation strategies. Window placement was another major limitation, as 47.3% reported openings on the same wall, compared with only 22.5% having openings on opposite walls capable of supporting cross ventilation.

The effectiveness of existing openings was further constrained by their operation and physical condition. 53.8% of respondents reported that cross ventilation was not available, while 61.0% indicated that ventilation openings were only partially functional. Obstructions from furniture (38.5%), nearby buildings (36.3%), and internal partitions (36.3%) further reduced airflow. Consequently, 39.6% rated the available openings as inadequate and 33.5% as fairly adequate, with only 20.3% considering them adequate.

The findings reveal that the major ventilation challenge in the selected health centres is not simply the absence of openings, but the inadequate size, positioning, operability, functionality, and obstruction of existing openings. The limited availability of cross ventilation and high-level outlets may contribute to the warm indoor conditions reported by users. Therefore, the proposed Aroje community health centre should adopt a more deliberate ventilation strategy involving adequately sized and operable windows, openings on opposite or adjacent walls, high- and low-level ventilation points, ventilated transitional spaces, courtyards or verandas, and unobstructed airflow paths.

Characteristics of Ventilation Openings

The section evaluates users' perception of the performance of ventilation openings using Likert-scale statements. The analysis is divided into four subsections: windows, doors, other ventilation openings, and general performance of openings.

Table 4: Characteristics of Ventilation Openings, n = 182

S/N	Statement	SA (5)	A (4)	N (3)	D (2)	SD (1)	TWV	MWV	AWV	Rank
1	Windows are adequate in number for effective ventilation	13	37	53	54	25	505	2.77	101.00	5th
2	Windows are properly sized to allow sufficient airflow	9	30	38	81	24	465	2.55	93.00	9th
3	Window types enhance ventilation	13	39	51	60	19	513	2.82	102.60	3rd
4	Windows are well positioned to promote cross ventilation	5	19	46	71	41	422	2.32	84.40	13th
5	Doors contribute effectively to airflow within spaces	11	28	46	65	32	467	2.57	93.40	8th
6	Door positions support cross ventilation within the building	7	19	44	80	32	435	2.39	87.00	11th
7	Doors are frequently open, allowing air movement	10	42	54	48	28	504	2.77	100.80	5th
8	High-level openings improve air movement	9	34	49	57	33	475	2.61	95.00	7th
9	Courtyards or open spaces contribute	16	42	46	55	23	519	2.85	103.80	2nd

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	to natural ventilation									
10	Other ventilation openings are adequately provided	10	29	33	77	33	452	2.48	90.40	10th
11	Ventilation openings are easily operable	13	39	57	55	18	520	2.86	104.00	1st
12	Openings are not obstructed by internal layout	6	16	42	81	37	419	2.30	83.80	14th
13	External factors do not block airflow into the building	5	28	47	73	29	453	2.49	90.60	9th
14	Ventilation openings are adequate for the number of occupants	4	29	38	72	39	433	2.38	86.60	12th

General Evaluation of Ventilation Opening Characteristics

The results in Table 5 show that the Mean Weighted Values range from 2.30 to 2.86. This indicates that respondents generally rated the characteristics of ventilation openings below the neutral midpoint of 3.00. The low MWV values suggest that the ventilation openings in the surveyed community health centres are not perceived as adequate, well positioned, or sufficiently effective.

The highest-rated statement is “Ventilation openings are easily operable,” with an MWV of 2.86. Although this is the highest score, it is still below 3.00, indicating that operability is only moderately perceived and does not represent a strong performance area.

The second highest score is “Courtyards or open spaces contribute to natural ventilation,” with an MWV of 2.85. This suggests that respondents recognize the usefulness of courtyards and open spaces where they exist. However, the value remains below the agreement level, indicating that these spaces are either not sufficiently available or not fully effective.

The weakest variable is “Openings are not obstructed by internal layout,” with an MWV of 2.30. This confirms that internal obstruction is a major problem affecting ventilation performance. It also supports the descriptive findings, where internal partitions and furniture blockage were frequently reported as airflow obstructions.

The second weakest variable is “Windows are well positioned to promote cross ventilation,” with an MWV of 2.32. This aligns with the earlier finding that most windows are located on the same wall only and that cross ventilation is unavailable in many facilities. The low mean scores indicate that while openings exist in the surveyed buildings, their design and performance are inadequate for effective natural ventilation.

Sectional Mean Analysis of Ventilation Opening Characteristics

Table 5: Sectional Summary of Ventilation Opening Characteristics

Section	Number of Items	Total TWV	Sum of MWV	Average MWV	Interpretation
Windows	4	1905	10.47	2.62	Low to moderate performance
Doors	3	1406	7.73	2.58	Low to moderate performance
Other ventilation openings	3	1446	7.95	2.65	Low to moderate performance

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General performance of openings	4	1825	10.03	2.51	Weakest performance
Overall	14	6582	36.18	2.58	Generally inadequate

The sectional mean analysis shows that other ventilation openings recorded the highest average MWV of 2.65, followed by windows with 2.62, and doors with 2.58. The lowest sectional mean was recorded under general performance of openings, with an average MWV of 2.51.

Although other ventilation openings recorded the highest sectional mean, the value is still below the neutral midpoint. This indicates that features such as high-level openings, courtyards, and other ventilation openings are not sufficiently effective or widely provided.

The window section also recorded a low average MWV. This suggests that while windows are present, their number, size, type, and placement are not strong enough to support effective ventilation. This finding is consistent with the descriptive results, which showed that many windows are small, have low window-to-wall ratios, and are positioned on the same wall only.

The door section also performed weakly. This may be because doors are not consistently open and are not deliberately positioned to support airflow. The weakest section is the general performance of openings. This confirms that the overall ventilation system is affected by obstruction, external blockage, and inadequate opening provision relative to occupancy levels.

Level of Natural Ventilation: Objective and Subjective Assessment

This section presents the analysis of the level of natural ventilation in selected community health centres in Ogbomoso. The analysis covers both perceived ventilation performance and users' satisfaction with ventilation conditions. The objective is to determine how users assess airflow, air movement, stuffiness, ventilation during hot periods, ventilation in waiting and consultation spaces, cross ventilation, indoor heat reduction, and overall comfort.

Natural ventilation is a critical design requirement in community health centres because these facilities accommodate different categories of users, including patients, visitors, nurses, doctors, and administrative staff. In the Nigerian climatic context, where high temperature and humidity often affect indoor comfort, effective natural ventilation helps reduce heat stress, improve indoor air quality, and enhance user satisfaction. Poor ventilation, on the other hand, can lead to stuffiness, discomfort, unpleasant indoor air, and reduced tolerance for long waiting periods.

The analysis was carried out using descriptive statistics, including frequency counts, percentages, Total Weighted Value, Mean Weighted Value, severity index ranking, and challenge prioritization. The Likert scale used for the analysis was:

Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, Strongly Disagree = 1

For the interpretation of this section, low Mean Weighted Values indicate weak ventilation performance and higher severity of ventilation-related challenges. The severity index was derived from the level of performance shortfall, with higher severity values showing areas that require urgent design attention.

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Table 6: Perceived Ventilation Performance in Community Health Centres, n = 182

S/N	Statement	SA (5)	A (4)	N (3)	D (2)	SD (1)	TWV	MWV	Performance Index (%)	Severity Index (%)	Rank
1	There is adequate airflow within the building	2	38	44	75	23	467	2.57	51.4	48.6	5th
2	Air flows freely across spaces	8	27	35	80	32	445	2.45	49.0	51.0	4th
3	Rooms rarely feel stuffy	8	26	44	73	31	453	2.49	49.8	50.2	3rd
4	Ventilation is effective during hot periods	5	25	36	69	47	418	2.30	46.0	54.0	7th
5	Waiting areas are well ventilated	9	37	35	75	26	474	2.60	52.0	48.0	8th
6	Consultation rooms are well ventilated	2	24	36	86	34	420	2.31	46.2	53.8	6th
7	Cross ventilation exists in most spaces	3	22	39	79	39	417	2.29	45.8	54.2	1st
8	Natural ventilation reduces indoor heat	7	32	48	61	34	463	2.54	50.8	49.2	2nd

The results in Table 6 show that the Mean Weighted Values for perceived ventilation performance range from 2.29 to 2.60. This indicates that respondents generally rated the ventilation performance of the health centres below the neutral midpoint of 3.00. The low MWV values suggest that natural ventilation is not performing satisfactorily across most spaces within the surveyed facilities.

The highest-rated variable is waiting areas are well ventilated, with an MWV of 2.60. Although this is the highest value in this section, it still falls below the neutral point, indicating that waiting area ventilation is only weak to moderate. The lowest-rated variable is cross ventilation exists in most spaces, with an MWV of 2.29, followed closely by ventilation is effective during hot periods, with an MWV of 2.30. These findings show that the major ventilation challenge is the lack of effective air movement across spaces, particularly during periods of heat.

The section has an overall average MWV of 2.44, which indicates a generally poor perception of natural ventilation performance. This means that users do not strongly agree that airflow is adequate, that air moves freely, or that ventilation reduces indoor heat effectively.

Findings on Perceived Natural Ventilation Performance

The findings indicate that the overall perceived performance of natural ventilation in the selected community health centres is relatively poor. Most respondents reported inadequate airflow, restricted air movement, and frequent stuffiness within the buildings. The statement on adequate airflow recorded an MWV of 2.57, with only 22.0% agreeing, while 53.8% disagreed. Similarly, free movement of air across spaces recorded an MWV of 2.45, with 61.5% disagreeing, indicating that internal layouts, partitions, furniture, and closed doors may be restricting airflow.

The experience of stuffy rooms was also evident, with an MWV of 2.49 and 57.1% of respondents disagreeing that rooms rarely feel stuffy. Ventilation performance during hot periods was particularly poor, recording an MWV of 2.30, with 63.7% of respondents disagreeing that ventilation was effective. This suggests that existing ventilation systems are least effective when climatic conditions demand them most.

Among the different spaces assessed, waiting areas recorded the highest MWV of 2.60, although performance was still weak, with 55.5% of respondents disagreeing that they were well ventilated. Consultation rooms performed poorly, recording an MWV of 2.31, with 65.9% disagreeing that they were well ventilated. The particularly low performance of consultation rooms highlights the challenge of maintaining both privacy and adequate airflow.

The most critical finding was the limited availability of cross ventilation, which recorded the lowest MWV of 2.29. Only 13.7% of respondents agreed that cross ventilation exists in most spaces, while 64.8% disagreed. This confirms the earlier finding that many facilities lack openings positioned to create effective air inlet and outlet paths. Natural ventilation was also not perceived as sufficiently effective in reducing indoor heat, recording an MWV of 2.54, with 52.2% of respondents disagreeing.

The findings show that the major weaknesses in natural ventilation are inadequate airflow, restricted air movement, stuffiness, poor performance during hot periods, inadequate ventilation of consultation and waiting spaces, limited cross ventilation, and insufficient heat reduction. These findings support the need for the proposed Aroje community health centre to incorporate well-positioned operable openings, effective cross ventilation, high-level ventilation outlets, shaded openings, ventilated waiting areas, courtyards or verandas, and unobstructed airflow paths as fundamental design strategies.

V. CONCLUSION

The study concludes that natural ventilation in the selected community health centres in Ogbomoso is generally inadequate and does not sufficiently support users’ thermal comfort and satisfaction. Although the facilities have various windows, doors, verandas and other ventilation features, their effectiveness is limited by small openings, poor positioning, inadequate cross ventilation, obstructions and partially functional openings. The users’ responses further indicate frequent warmth, heat discomfort, stuffiness and a strong preference for cooler indoor conditions.

The findings therefore demonstrate that the presence of ventilation openings alone does not guarantee effective natural ventilation. Their size, location, operability, relationship with the internal layout, and connection to outdoor airflow are equally important. The study consequently emphasizes the need to integrate natural ventilation with other passive design strategies such as appropriate building orientation, shading, courtyards, verandas and vegetation. These considerations are particularly important in informing the design of the proposed community health centre at Aroje, Ogbomoso, to provide a more comfortable, functional and climate-responsive healthcare environment.

VI. RECOMMENDATIONS

The study recommends improving cross-ventilation by providing openings on opposite or adjacent walls to facilitate effective air entry and exit. Adequately sized and operable windows should also be provided, with appropriate window-to-wall proportions and proper positioning to enhance airflow. High-level ventilation openings, such as clerestory windows, transoms, and roof vents, should be incorporated to facilitate the removal of warm air. Shaded outdoor spaces, including verandas, courtyards, and open waiting areas, should be provided to improve airflow, reduce indoor congestion, and enhance thermal comfort. Finally, the proposed Aroje Health Centre should adopt a climate-responsive design that integrates appropriate building orientation, shading, vegetation, and natural ventilation strategies to reduce indoor heat and improve users' satisfaction.

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