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Analysis of Bakery Workplace Environment and Occupational Exposure to Heat and Humidity Hazards in Ibadan, Nigeria

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Abstract
Bakery environments are often characterized by elevated temperatures and high humidity due to the continuous operation of ovens and poor ventilation. These physical hazards, combined with inadequate built environmental conditions, expose workers to significant occupational health risks. This study assessed the structural and hygiene conditions of bakeries in Ibadan, Nigeria, and measured workers' exposure to temperature and humidity. A descriptive design was employed. Sixteen bakeries were proportionately selected from Ibadan North and Ibadan South-West Local Government Areas using multistage sampling. Data collection involved two components: (1) a walk through checklist assessing lighting, ventilation, floors, ceilings and windows of bakeries as well as (2) worker interviews on perceived heat-related symptoms. Results showed that the majority of bakeries had poor built environmental conditions, with permeable floors, cracked ceilings, poorly fitted windows, and inadequate ventilation. Indoor temperature averaged 32.2 ± 2.0°C, while relative humidity averaged 63.5 ± 5.8%. Both exceeded the United States Environmental Protection Agency (USEPA) indoor comfort standards of 16–24°C for temperature and 30–60% for humidity. Workers frequently reported heat-related health symptoms such as dehydration, catarrh, and musculoskeletal discomfort, suggesting direct links between the bakery environment and adverse health outcomes. The study concludes that bakery environments in Ibadan are characterized by poor infrastructure and excessive exposure to heat and humidity, posing substantial occupational hazards to workers. Continuous monitoring of indoor environmental quality is essential for safeguarding the health and productivity of bakery workers.

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Keywords: Bakery Environment, Occupational Hazards, Workplace Safety, Temperature, Humidity.

1.0. Introduction

The bakery industry represents an important component of urban food production systems in Nigeria and across sub-Saharan Africa. Bread constitutes a major dietary staple, and bakery enterprises provide employment opportunities within informal and semi-formal economic sectors. Despite their economic importance, bakery workplaces frequently operate in structurally constrained environments characterized by limited ventilation, continuous oven operation, and inadequate thermal regulation, conditions that may predispose workers to excessive occupational heat exposure. Occupational heat exposure has increasingly been recognized as a growing public health concern worldwide, particularly in low- and middle-income countries where enforcement of occupational safety standards remains weak (International Labour Organization, 2019). The World Health Organization (2021) reports that exposure to elevated workplace temperatures contributes to dehydration, impaired cognitive performance, reduced productivity, and increased risk of occupational accidents. Climate change projections further indicate rising ambient temperatures that may intensify occupational heat burden, especially in tropical regions where baseline environmental temperatures are already high. Although numerous global studies have documented flour dust exposure and allergic respiratory outcomes among bakery workers (Baur & Bakehe, 2014; Jeebhay et al., 2019), comparatively fewer investigations have examined physical environmental stressors such as heat and humidity in African bakery settings.

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In Nigeria, empirical evidence on indoor thermal conditions and their associated health implications among bakery workers remains limited despite the country's tropical climate and rapidly expanding informal food production sector. This study therefore assessed structural determinants of heat exposure in bakeries in Ibadan, Nigeria, measured indoor temperature and relative humidity levels, and evaluated associated health symptoms among workers, thereby providing evidence to support occupational health interventions aimed at reducing heat-related risks in informal bakery environments.

2.0. Materials and Methods

2.1. Study Area
The study was conducted in Ibadan, Oyo State, Nigeria, a tropical city characterized by high ambient temperature andhumidity, conditions that may influence indoor occupational thermal environments**.**

2.2. Study Design
A descriptive cross-sectional study design was adopted.

2.3. Study Population
The study population consisted of bakery workers employed in Ibadan North and Ibadan South-West Local Government Areas. Eligible participants were adults aged 18 years and above who had worked in the bakery for at least six months.

2.4. Sample Size and Sampling
Sample size was determined using Leslie Kish's formula for single population proportion. After adjustment for finite population correction and non-response, sixty-five bakeries were selected for structural assessment. Sixteen bakeries were randomly selected for environmental monitoring and administration of worker questionnaires involving sixty-four respondents.

2.5. Data Collection
Data collection included a walk-through checklist assessing ventilation, lighting, structural integrity, windows, doors, electrical installations, and waste disposal systems. Indoor temperature and relative humidity were measured twice daily over three consecutive days using calibrated digital monitors.

2.6. Health Assessment
Structured questionnaires collected socio-demographic data and self-reported health symptoms including dehydration, respiratory symptoms, musculoskeletal pain, and fever.

2.7. Data Analysis
The data were analyzed using SPSS version 26. Descriptive statistics, including means, frequencies, and percentages, were generated, and the measured environmental parameters were compared with recommended occupational standards.

2.8. Ethical Considerations
Ethical approval was obtained from the University of Ibadan/University College Hospital Ethical Review Board. Participation was voluntary, and informed consent was obtained from all participants prior to data collection.

3.0. Results and Discussion

3.1. Built Environmental Conditions and Structural Determinants of Heat Exposure
Figure 1–6 revealed widespread infrastructural deficiencies including inadequate cross-ventilation, cracked ceilings, permeable floors, poorly sealed windows, and substandard electrical panel enclosures. These structural inadequacies have been documented in other studies of bakery environments in Nigeria, where workplaces are often situated in converted residential or small commercial buildings not originally designed for heat-intensive industrial activities (Adelekan and Olajide, 2022). These deficiencies reduce airflow, facilitate heat retention, and contribute to elevated indoor temperatures and humidity levels (USEPA, 2016; WHO, 2021). The absence of mechanical exhaust systems further exacerbates heat accumulation from continuous oven operation, as supported by findings that insufficient air exchange rates significantly

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increase indoor thermal load (Chen et al., 2016). In contrast, bakeries in high-income countries are more likely to have engineered ventilation systems and insulation materials that help reduce heat accumulation (European Agency for Safety and Health at Work, 2018). Data collection using a walk-through checklist confirmed deficiencies in ventilation, lighting, structural integrity, and waste disposal systems in the study bakeries. These findings underscore the need for comprehensive engineering, administrative, and regulatory interventions to address occupational heat exposure in Ibadan bakeries (Adelekan and Olajide, 2022).

3.2. Indoor Temperature and Humidity Levels

Indoor temperature of Figure 7 ranged from 30°C to 36°C with a mean of 32.2 ± 2.0°C, substantially surpassing the United States Environmental Protection Agency (USEPA, 2016) recommended range of 16–24°C and the World Health Organization (WHO, 2021) occupational range of 18–28°C. Several bakeries recorded temperatures exceeding 35°C, indicating sustained occupational heat stress. Relative humidity in figure 8 ranged between 58% and 72%, with a mean of 63.5 ± 5.8%, also exceeding recommended thresholds (30–60%). The humidity values observed are consistent with findings from other tropical bakery environments, where steam release during baking elevates moisture levels (Park & Kim, 2017). High humidity impairs evaporative cooling, thereby intensifying perceived heat stress even when temperature remains constant. The interaction between elevated temperature and high humidity is particularly concerning, as heat stress is determined by the combined effect on the body's ability to dissipate heat through sweat evaporation (ILO, 2019). When humidity exceeds 60%, sweat evaporation efficiency declines, increasing the risk of dehydration, heat exhaustion, and reduced cognitive performance. This physiological mechanism likely explains the reported prevalence of dehydration and fatigue-related symptoms among workers.

3.3. Health Outcomes among Bakery Workers

Table 1 presents socio-demographic characteristics and reported health conditions among the bakery workers. Most were male (96.9%), had at least a secondary education, were married, and were within economically productive age groups. A high prevalence of musculoskeletal pain, fever, respiratory symptoms, and dehydration was reported, consistent with findings from similar occupational settings in Nigeria (Bello et al., 2013). Musculoskeletal disorders including body pain (76.6%), joint pain (75.0%), and low back pain (70.3%) affected the majority of respondents. While repetitive tasks, prolonged standing, and manual lifting are established risk factors for musculoskeletal strain, excessive heat exposure may amplify these risks by accelerating fatigue and reducing muscular endurance (Kjellstrom et al., 2016). Dehydration (31.3%) further contributes to muscle cramps and joint discomfort, suggesting that thermal stress may indirectly worsen ergonomic strain (WHO, 2021). Respiratory symptoms, particularly catarrh, were reported by over half of the workers. Although flour dust exposure is a well-documented cause of respiratory irritation in bakery environments (Baur & Bakehe, 2014; Jeebhay et al., 2019), elevated humidity may have compounded these effects, as high humidity prolongs the suspension time of airborne particles and promotes microbial growth, potentially increasing allergen exposure (USEPA, 2016). Fever and generalized discomfort reported by workers may reflect episodes of heat exhaustion or inflammatory responses triggered by environmental stress. Chronic occupational heat exposure has been associated with systemic strain and increased susceptibility to illness (Glaser et al., 2016). These findings underscore the importance of improved workplace practices and environmental controls to protect the health of bakery workers in Ibadan.

The persistence of occupational heat exposure in Ibadan bakeries is compounded by limited regulatory enforcement and economic constraints typical of Nigeria's informal sector (Okojie & Isah, 2014), a challenge also observed in other African countries, whereas bakeries in high-income settings benefit from stricter occupational standards and better ventilation (Jeebhay et al., 2019; European Agency for Safety and Health at Work, 2018).

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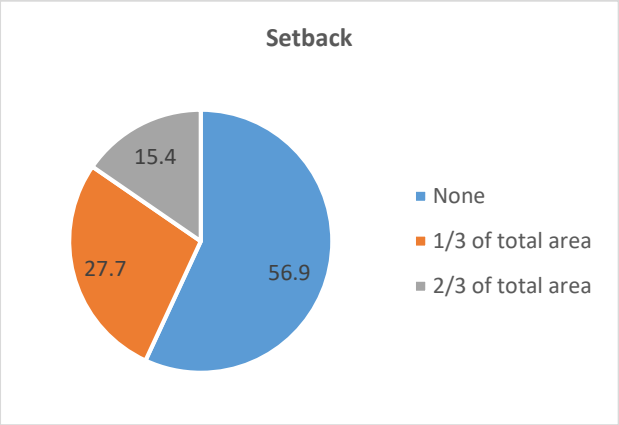


Figure 1: setback in selected bakeries

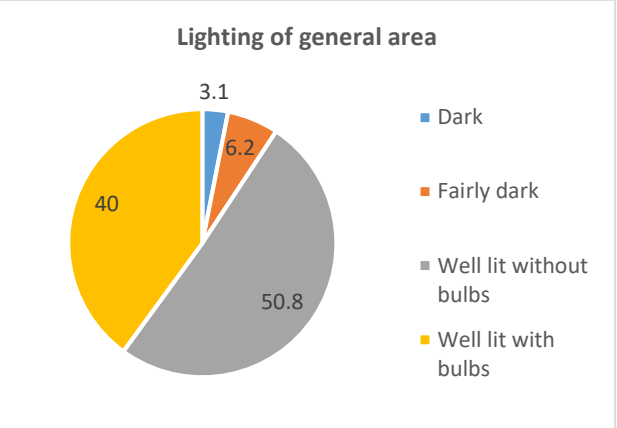


Figure 2: Lighting general area of the bakery

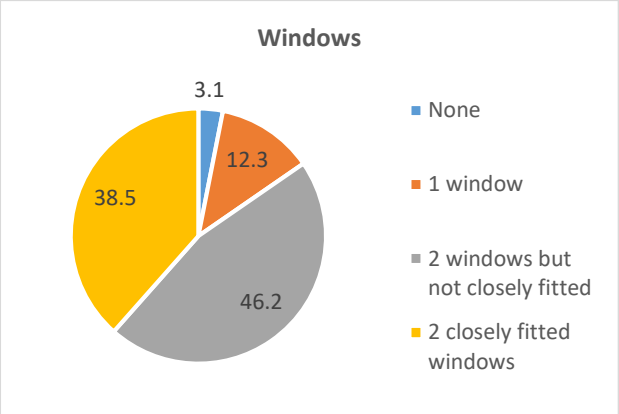


Figure 3: Windows in selected bakeries

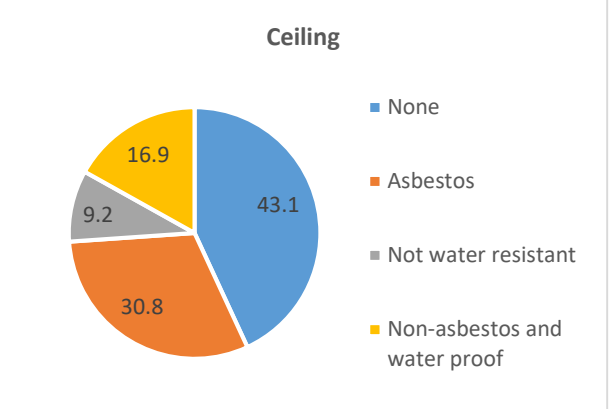


Figure 4: Ceiling in selected bakeries

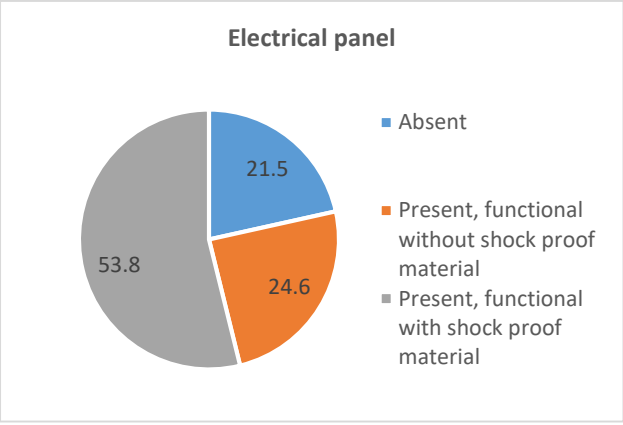


Figure 5: Electrical panel in selected bakeries

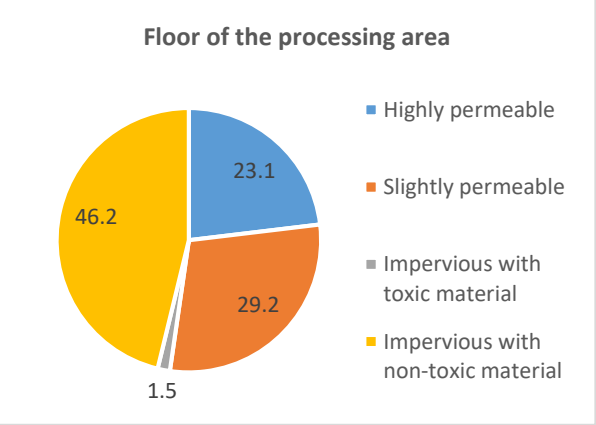


Figure 6: Floor of the processing area in selected bakeries

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Table 1: Socio-demographic characteristics and Health conditions of respondents (N=64)

Sociodemographics	Frequency (%)
Age	
18-24	13 (20.3)
25-31	25 (39.1)
32-39	5 (7.8)
40-46	12 (18.8)
47-53	5 (7.8)
54-60	4 (6.3)
Education	
None	3 (4.7)
Primary	14 (21.9)
Secondary	35 (54.7)
Tertiary	12 (18.8)
Sex	
Male	62 (96.9)
Female	2 (3.1)
Marital Status	
Single	23 (35.9)
Married	40 (62.5)
Separated	1 (1.56)
Health Conditions	
Dehydration	
Yes	20 (31.3)
No	44 (68.8)
Catarrh	
Yes	34 (53.1)
No	30 (46.9)
Joint pain	
Yes	48 (75.0)
No	16 (25.0)
Low back pain	
Yes	45 (70.3)
No	19 (29.7)
Shoulder/wrist disorder	
Yes	38 (59.4)
No	26 (40.6)
Body pain	
Yes	49 (76.6)
No	15 (23.4)
Fever	
Yes	41 (64.1)
No	23 (35.9)

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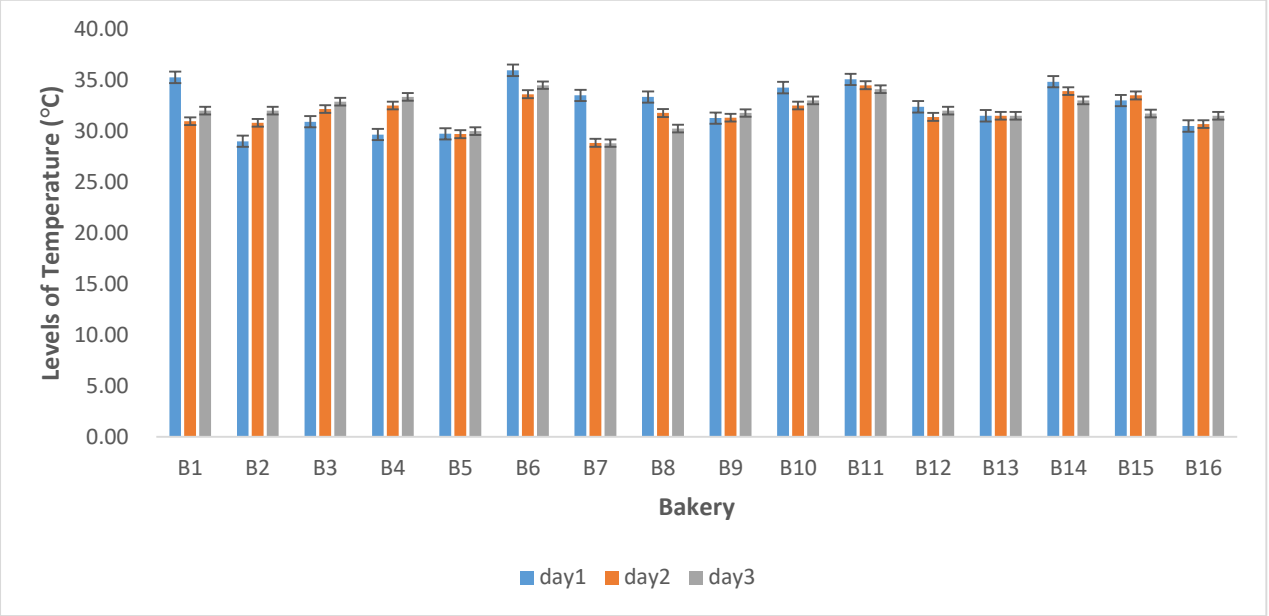


Figure 7: Levels of temperature in selected bakeries Key: B1 represents Bakery 1, etc.

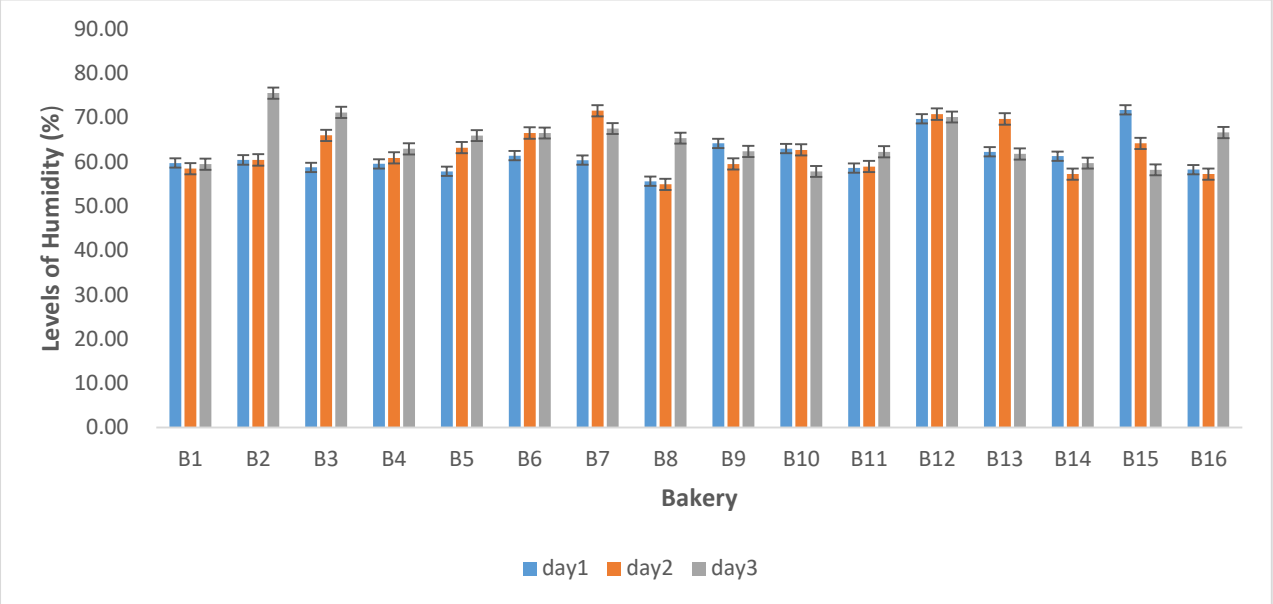


Figure 8: Levels of humidity in selected bakeries Key: B1 represents Bakery 1, etc.

4.0. Conclusion

This study provides robust empirical evidence that bakery workers in Ibadan, Nigeria, are exposed to excessive indoor temperatures and humidity levels beyond internationally recommended standards. Structural inadequacies, insufficient ventilation, and tropical climatic conditions collectively contribute to substantial occupational heat stress. The high prevalence of musculoskeletal pain, respiratory symptoms, fever, and dehydration underscores the significant health implications of sustained thermal exposure. Comparisons with Nigerian, African, and global studies confirm that while occupational heat stress is widespread, its severity is amplified in tropical informal settings.

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