World Journal of Biology Pharmacy and Health Sciences
eISSN: 2582-5542
Cross Ref DOI: 10.30574/wjbphs
Journal homepage: https://wjbphs.com/

(RESEARCH ARTICLE)

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Occupational and Environmental Health Challenges in Abattoir

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World Journal of Biology Pharmacy and Health Sciences, 2026, 25(02), 051-073

Publication history: Received on 18 December 2025; revised on 27 January 2026; accepted on 29 January 2026

Article DOI: https://doi.org/10.30574/wjbphs.2026.25.2.0056

Abstract

Ensuring clean and safe abattoir has been recognized as one of the ways of preventing zoonotic infections. This study evaluated the level of public health challenges in a central abattoir in Bayelsa State Nigeria. The study utilized a cross-sectional and experimental study designs. A simple questionnaire was used to elicit responses from 20 abattoir workers and a semi-structured interview administered questions to get information from the management of the abattoir on the overall public health practices in the abattoir. For their responses,(16) 80% of the sampled abattoir workers have no knowledge of zoonotic diseases, only (7)35% were seen using personal protective equipment (PPE), and (10) 50% do not see reason to go for medical check at all. The sanitation facilities (toilets) were seen to be dirty, open and littered with papers, plastic nylon and grasses grown around it. Major source of water supply at the abattoir is a close by river which also serves as source of water supply for the community. Samples were ascetically collected from different points of the river and taken to Wizlink Consult Research Center for analysis. The microbial analysis revealed high counts of total heterotrophic bacteria (7.2×10^6 CFU/ml), enteric bacteria (5.0×10^6 CFU/ml), and fungi (8×10^3 SFU/ml), indicating significant contamination. Pathogenic agents such as *Clostridium* spp, *Bacillus* spp, and *Fusarium* spp were identified. Additionally, the improper handling of wastes and the disposal of untreated effluents contribute to water pollution, environmental degradation, affecting the surrounding community. This study recommends the immediate improvement on the toilet facilities, proper waste management, occupational health of workers and routine microbial monitoring. Implementing these measures will not only enhance food sanitation but also, protect public health and reduce the environmental impact of abattoir operations.

Keywords: Abattoir; Zoonoses; Public Health; Food Sanitation

1. Introduction

An abattoir is a place where animals are slaughtered or killed for human consumption (Bello and Oyedemi, 2009; Lawan *et al*., 2013). A standard abattoir should have the following components; the area where animals are kept temporarily before they are slaughtered, allowing them to rest, the main area where animals are humanely killed and processed, a flat surface used for slaughtering and processing smaller animals, where the intestines (gut) and stomach (tripe) are cleaned and processed, a holding area for meat that needs further inspection before it can be approved for sale, where internal organs (like liver, heart, and kidneys) are processed, a storage area for meat deemed unfit for consumption, awaiting disposal, a system ensuring clean water is to be available throughout the facility for hygiene and processing needs and a refrigerated area for storing meat to keep it fresh until it's distributed. Others are; where animal hides (skin) are removed, processed, and stored, an area where a vet checks animals and meat to make sure they're safe and healthy for consumption, a place dedicated to cleaning and hygiene, ensuring all equipment and surfaces are sanitized, an office for the veterinarian responsible for overseeing animal welfare and meat safety in the facility, rooms for testing

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meat and samples to detect any diseases or contaminants, and areas or systems for properly handling and disposing of waste products from processing animals (Douglas et. al., 2013).

Abattoirs are pivotal in ensuring that meat products are safe for consumption. Properly managed abattoirs contribute to food safety by preventing the spread of zoonotic diseases that can be transmitted from animals to human such as salmonellosis, *Escherichia coli* infections, some intestinal parasites and brucellosis (Wang *et al*., 2023). The conditions, under which animals are slaughtered, including the cleanliness of the facility and the handling of carcasses, directly impact the microbial quality of the meat (Antunes *et al*., 2022). Poor sanitation practices in abattoirs can lead to the contamination of meat products, posing significant risks to public health. Sanitation in abattoirs involves a series of practices aimed at maintaining cleanliness throughout the slaughtering process. These practices include the proper handling of animals, hygienic slaughtering techniques, and the effective disposal of waste materials. However, in many regions, particularly in low- and middle-income countries, abattoirs are often characterized by inadequate sanitation facilities, poorly trained staff, and insufficient regulatory oversight (Adeoye *et al*., 2021). The lack of clean water for washing carcasses, improper waste management systems, and overcrowded conditions contribute to the proliferation of pathogens in abattoirs, increasing the risk of foodborne illnesses (Mensah *et al*., 2022).Abattoirs generate substantial amounts of waste, including blood, bones, fat, hair, and offal, which, if not properly managed, can lead to environmental pollution. The improper disposal of abattoir waste can contaminate water sources, soil, and air, leading to adverse environmental and public health outcomes (Rodríguez-Rodríguez *et al*., 2023). For instance, untreated effluents from abattoirs can contain high levels of organic matter, nutrients, and pathogens, which can degrade water quality and harm aquatic ecosystems (Müller *et al*., 2022). Moreover, the emission of odour and greenhouse gases from abattoir waste contributes to air pollution, which can have respiratory and other health effects on nearby communities (Bakare *et al*., 2023).

For occupational health, workers in abattoirs may be exposed to a range of occupational health risks, including injuries from sharp tools, exposure to zoonotic diseases, and long-term health effects from handling hazardous materials (Amoah *et al*., 2021). The high physical demands of slaughtering and processing animals, coupled with inadequate protective equipment and training, increase the vulnerability of workers to accidents and illnesses (Tsegaye *et al*., 2022). Additionally, the mental health of abattoir workers is often overlooked, despite evidence suggesting that the repetitive nature of their work and exposure to animal suffering can lead to psychological distress (Henry and Brien, 2023). Addressing these occupational health challenges is crucial for ensuring the well-being of abattoir workers and preventing the spread of diseases to the wider community. The effective management of public health risks in abattoirs requires a vast regulatory and policy framework that enforces sanitary standards and promotes environmental sustainability (World Health Organization [WHO], 2022). However, the enforcement of these regulations is often hampered by limited resources, corruption, and lack of coordination between relevant agencies (Osman *et al*., 2022). Strengthening regulatory frameworks and improving compliance through regular inspections, training programs, and penalties for non-compliance are essential for reducing public health risks in abattoirs (Akinde *et al*., 2023).Community engagement and education are key components of public health strategies aimed at improving abattoir sanitation and environmental management. Raising awareness among abattoir operators, workers, and the surrounding communities about the importance of hygiene and waste management can lead to better practices and reduced health risks (Kambiranda *et al*., 2022). Educational campaigns that highlight the links between abattoir sanitation and public health can empower communities to demand better services and hold authorities accountable (Nwosu *et al*., 2023). Additionally, involving communities in monitoring and reporting on abattoir conditions can help identify and address public health challenges more effectively.

In Nigeria, the National Environmental Sanitation Policy identified market and abattoir sanitation as one of the key policy issues to address the enormous problems of environmental sanitation in the country. The sanitation challenges were as a result of improper planning of abattoirs, lack of facilities such as portable water, institutional regulations, enforcement and monitoring as well as corrupt and sharp practices by the supervisors of abattoirs (Nafada *et al*., 2012). A study in Kano, Nigeria to evaluate slaughter practices showed that despite having a good design, virtually all the facilities (including water supply) were no longer functional. The available lairage was hardly used and no pre-slaughter ante-mortem done. In addition, processes like immobilization, killing, evisceration, post mortem examination and by-product handling were either inadequate or non-existent (Dandago *et al*., 2009).

Equipment for killing, holding, processing, storing, and distributing the carcass should be present at an abattoir as it has been defined as a facility or location authorized and registered for the purpose of killing and dressing animals for human consumption (Dandago *et al*., 2009). However, the local government, which is in charge of all slaughterhouses and abattoirs in Nigeria, has largely disregarded this duty. According to Ezeohaa and Ugwuishiwu (2011), this led to the deteriorating state of most facilities, unhygienic premises, poor meat inspection procedures, and insufficient hygienic processes, all of which had an adverse influence on public health. The majority of slaughterhouses and abattoirs lack

operating facilities, as well as sewage and waste disposal systems, potable water supplies, cold storage systems, and employee restrooms (Lawan et al., 2013; Akpabio *et al*., 2015).

Unsanitary procedures by abattoir employees make it easier for zoonoses to spread among the staff and contaminate the meat that is sold. Sadly, sub-Saharan nations like Nigeria have meat in butcher shops and abattoirs with microbial profiles higher than those recommended by the World Health Organization (WHO) (Haileselassie *et al*., 2013). Additionally, zoonoses have been reported in cattle and among abattoir workers in Nigerian abattoirs (Fasanmi *et al*., 2017; Allwin *et al*., 2015). Even though slaughterhouse and abattoir sanitation is a crucial part of Nigeria's National Environmental Sanitation Policy, studies conducted have reported inadequate facilities, unhygienic conditions, and poor hygienic practices (Adesokan and Sulaimon, 2014; Azuamah and Amadi, 2019)

1.1. Zoonotic Disease Transmission in Abattoirs; a threat to Occupational and Environmental Health

The spread of zoonotic infections in Nigerian slaughterhouses is one of the biggest threats to public health. The close contact between animals and those who work in abattoirs makes zoonoses (diseases that spread from animals to humans) a serious problem. The intimate relationships between animals, meat processing, and the abattoir staff make these facilities vulnerable to the spread of zoonotic diseases (Adesokan and Akanbi, 2018).

Research has indicated that zoonotic illnesses including Q fever and brucellosis are quite prevalent among Nigerian abattoir workers (Adesokan and Akanbi, 2018). These illnesses provide a serious risk to the health of not just the employees of abattoirs but have the potential to spread across the community and also customers who purchase meat processed in these establishments. For instance, there is a serious risk to public health from illnesses like brucellosis and Q fever, which have been linked to Nigerian slaughterhouses (Adesokan and Akanbi, 2018).

1.2. Occupational Health Challenges for Workers in Abattoirs

Occupational hazards within Nigerian abattoirs pose health risks to workers. Abattoir employees face an array of dangers, including physical injuries from handling live animals and machinery (FSA, 2017). Lacerations, falls, and even amputations are common injuries in such settings. Moreover, the psychological stress associated with the challenging work environment and exposure to animal slaughter can affect the mental well-being of abattoir workers. Workers may experience stress, anxiety, and even post-traumatic stress disorder as a result of their work (FAO, 2018).

Occupational hazards within Nigerian abattoirs are multifaceted. Workers in these facilities are exposed to a range of risks, including physical, chemical, biological, and ergonomic hazards (FSA, 2017). These hazards are associated with tasks such as animal handling, use of cutting and processing equipment, exposure to chemicals used for sanitation, and even the nature of the work itself, which can be physically demanding and mentally challenging. In addition to physical injuries, abattoir workers are exposed to various health risks. This includes the potential for zoonotic disease transmission, given their close contact with animals. Workers are at risk of contracting diseases such as brucellosis and Q fever. Furthermore, exposure to chemicals used for cleaning and sanitation poses a threat to their respiratory and skin health (FSA, 2017).

1.3. Environmental Health Challenges for Communities near Abattoirs

Abattoirs not only impact those working within their confines but also have far-reaching effects on the surrounding communities. Environmental consequences include the release of pollutants into the air and water, along with noise pollution (UNEP, 2020). Furthermore, disease transmission from abattoirs to nearby communities remains a significant public health concern.

The operations within abattoirs in Nigeria can extend their impact beyond their walls, affecting the environment and the health of the communities residing in their vicinity.

2. Methodology

2.1. Study Design

This study utilized a cross-sectional design and experimental designs. These designs allow for the assessment of public health challenges vis a vis, occupational and environmental health issues within the abattoir at a single point in time, and providing laboratory based assessment of the abattoir processing water.

2.2. Study Area

The study was conducted at the Swali Market Abattoir, located in Yenagoa, the capital of Bayelsa State, Nigeria. Swali Abattoir is a significant meat processing center in the State, serving a large portion of the population of persons and the inhabitants are mostly traders and civil servants. The temperature in Yenagoa varies from 25℃ to 31℃ annually. The area was chosen due to its central role in meat supply. The geographical scope of the study included the abattoir and its immediate surroundings, which is a river, where the impact on public health is most pronounced.

2.3. Study Population

The study population size comprised of 100 abattoir workers, management of the abattoir and health officials from the Bayelsa State Ministry of Agriculture and Natural resources.

2.4. Sample size

The sample size of 20% of the study population which comprised of 20 abattoirs workers was used. These groups were selected to provide a comprehensive understanding of the public health risks associated with the abattoir's operations. Participants were included based on their direct or indirect involvement with the abattoir.

2.5. Method of data collection

Data collection involved both quantitative and qualitative methods to ensure a comprehensive understanding of the challenges. A Pre-tested, well-structured questionnaire was distributed to twenty (20) individuals working in various abattoir area (Burining of skin, slaughtering, selling of meat and washing intestinal content) to obtain relevant information concerning activities at the abattoir. The questionnaire was designed to gather data on the participants' demographics, knowledge of public health issues and zoonosis, and practices related to hygiene at the abattoir. . The questionnaire was pre-tested and refined based on feedback to ensure clarity and relevance. Additionally, in-depth interviews were conducted with the management of the abattoir to gain expert insights into regulatory practices and public health concerns. This allowed for in-depth exploration of specific issues while providing flexibility for participants to discuss additional relevant topics.

2.6. Microbiological Analysis of Abattoir Water Source

2.6.1. Sample collection

Processing water for the abattoir which is water from a nearby river was aseptically collected into sterile bottles and transported in ice -cool containers to Wizlink Environmental laboratory Tombia Bayelsa State, within 12 – 24 hrs. The samples were collected from different points of the river and labelled P1-P5.

2.6.2. Sample preparation

Exactly 1 ml of each sample was aseptically drawn with the one millilitres syringe and emptied into 9ml of normal saline in 20ml test-tube. This formed the stock sample which was afterward serially diluted to the fifth dilution [10^{-5}]. These diluted samples were homogenised by gently tilting the tube severally and allowed to stand for about 30 minutes before culturing.

2.7. Microbiological assay

2.7.1. Enumeration

Samples were enumerated for total heterotrophic bacteria count; total enteric bacteria count and fungi count using the spread plate technique. The dilutions 10^{-3} and 10^{-5} were used for culturing. Exactly 1 ml was drawn from the dilution tubes and released unto the centre of solidified agar in a disposable plastic plate and spread with a disposal plastic spreader. Nutrient agar, MacConkey agar and Potato dextrose agar (PDA) were used for total heterotrophic bacteria count, total enteric bacteria count and fungi count respectively. Cultures plates were inverted and incubated for 18 to 24 hrs for heterotrophic and enteric bacteria while plates for fungi were not inverted and incubated at room temperature for 2 to 5 days respectively. After the duration of incubation colonies were counted an expressed in colony forming unit per ml [cfu/ml] of processing water sample.

2.7.2. Isolation and identification of bacteria

Distinct colonies from the Nutrient and MacConkey plates were picked with the sterile wire loop and streak plated on fresh Nutrient agar plates inverted and incubated at 37^{o}c for 24hours. Then, pure isolates were preliminarily

characterised with the colonial morphology and coded. The pure isolates were streak cultured unto nutrient slants for further investigations. The isolates were further characterised with gram staining, nutrient broth growth, MacConkey broth growth, catalase test, citrate test, TSI agar test and *Salmonella – Shigella* agar growth.

2.7.3. Isolation and identification of fungi

Distinct colonies of fungi on PDA were preliminarily characterised using the colonial morphology; the features of the surface and backside growth. These isolates were picked and drop plated on fresh PDA incubated at room temperature for another 2 to 5 days, isolates were further characterised with lactophenol blue staining microscopy and potato dextrose broth growth pattern.

2.8. Data Analysis

Data was analyzed using simple percentages. Water sample was compared with world health organization standard for drinking water quality.

3. Results

Table 1 Demographics of Sampled Swali Market Abattoir workers

Variables	**Frequency N=20**	**Percentage (%)**
Gender		
Male	20	100.0
Female	0	0.0
Age in years		
20 - 40	10	50.0
41- 60	10	50.0
Educational status		
Primary	3	15.0
Secondary	13	65.0
Informal	4	20.0
Year of working in the abattoir		
5 – 10	6	30.0
11 – 20	10	50.0
21 – 30	4	20.0
Area/sector of work in the abattoir		
Slaughtering	5	25.0
Selling of meat products	5	25.0
Burning hide and skin	6	30.0
Washing intestinal contents	4	20.0

Table 2 Public Health Challenges and Knowledge of Zoonoses

Variables	**Frequency N=20**	**Percentage (%)**
How often do you go for medical check-up?		
Monthly	4	20.0
Yearly	6	30.0
Not at all	10	50.0
Washing of hand before and after handling of animal products		
Yes	20	100.0
No	0	
Any form of Personal Protective Equipment		
Yes	7	35.0
No	13	65.0
Knowledge of any disease contacted through handling animal by-products		
Yes	4	20.0
No	16	80.0
Willingness to receive health education on zoonosis and one health		
Yes	16	80.0
No	4	20.0

Table 3 Responses of in-depth interview with the management of Swali Market abattoir Bayelsa State

Question	Response
Year of establishment of Swali Market abattoir	2000
Number of workers 100	100
Are animals inspected before slaughtering	Yes
Type of processing water	River water
Method of abattoir waste disposal	Dumping in the river
Treatment of abattoir effluents	None
Source of fuel	Firewood Plastics Old car tyres
Presence of demarcated toilets	Yes
Cleanliness of toilets	Very poor
Frequency of environmental sanitation within the abattoir	Monthly
Pest control	Yes
Method of pest control	Fumigation

Table 4 Total Heterotrophic bacteria and total enteric bacteria count of the abattoir water source samples.

Sample ID	Total heterotrophic Bacteria			Enteric Bacteria			Fungi		
	Plate count		Cfu/ml	Plate count		Cfu/ml	Plate count		Sfu/ml
	10^{-3}	10^{-5}	10^{-5}	10^{-3}	10^{-5}	10^{-5}	10^{-3}	10^{-5}	10^{-3}
Water source		72	7.2×10^{6}	70	50	5.0×10^{6}	8	3	8×10^{3}

Table 5 Characterization of bacteria isolated from the process water source of the abattoir

Sample ID	Morphology Nutrient agar	Gram Type	Growth in MacConkey broth	Growth in Nutrient broth	Citrate Test	Tentative isolate
P 1	**Circular Creamy in nutrient agar**	+Bacci	NF/NG	Turbid	Positive [blue colour]	*Clostridium spp*
P 2	**Circular Creamy in nutrient agar**	+Bacci	NF/NG	Flocculant	Positive [blue colour]	*Clostridium spp*
P 3	**Circular Creamy in nutrient agar**	+Bacci	NF/NG	Pellicle	Positive [blue colour]	*Bacillus spp*
P 4	**Circular Creamy in nutrient agar**	+Bacci	NF/NG	Pellicle	Positive [blue colour]	*Bacillus spp*
P 5	**Circular Creamy in nutrient agar**	+Bacci	NF/NG	Pellicle	Positive [blue colour]	*Bacillus spp*

Table 6 Characterisation of fungi isolates from process water source of Swali Market abattoir

Sample ID	Morphology in PDA agar	Morphology in PDA broth	Microscopy	Tentative isolate
P1	Fluffy white surface creamy backside	Dusty green pellicle brownish hard meniscus white fluffy mycelium dispatching into medium	Presence of characteristic macro-conidia and sickle shaped	*Fusarium* spp
P2	Circular entire off-white surface creamy backside	Dusty green pellicle brownish hard meniscus white fluffy mycelium dispatching into medium	Presence of characteristic macro-conidia and sickle shaped	*Fusarium* spp
P3	Fluffy white surface creamy backside	Dusty green pellicle brownish hard meniscus white fluffy mycelium dispatching into medium	Presence of characteristic macro-conidia and sickle shaped	*Fusarium* spp
P4	Circular entire off-white surface creamy backside	Dusty green pellicle brownish hard meniscus white fluffy mycelium dispatching into medium	Presence of characteristic macro-conidia and sickle shaped	*Fusarium* spp
P5	Fluffy white surface creamy backside	Dusty green pellicle brownish hard meniscus white fluffy mycelium dispatching into medium	Presence of characteristic macro-conidia and sickle shaped	*Fusarium* spp

4. Discussions

A total of 20 abattoir workers which represents 20% of the total population of abattoir workers and 4 management staff participated in the study. The age of respondents ranged from 20 to 60 years, with the majority being between 23 and 55 years old. This age group is particularly significant as it represents the essential workforce in the abattoir, which could also influence their exposure and susceptibility to public health risks. The gender distribution showed only male respondents (100%), reflecting the male-dominated nature of abattoir work in Swali market abattoir. Among the respondents, 5(25%) of the workers are specialized in slaughtering area, 5(25%) selling of meat products, 6(30%) burning and roasting of animal skin and 4(20%) washing of intestines. The educational level of respondents varied, with 3(15%) of the workers having primary education, 4(20%) having informal education and majority 13(65%) having secondary education. None of the abattoir workers attended a tertiary institution and this could be seen as a factor impacting on their level of knowledge of zoonoses. The assessment of the knowledge and awareness of public health risks associated with working in an abattoir and zoonoses among the respondents as contained in *Table 2* showed that only 4(20%) of the participants were aware of the health risks associated with abattoir operations. Among the 20 abattoir workers sampled, 4(20%) of the workers reported that they go for medical checkup monthly, 6(20%) go for checkup yearly and 10(50%) of the workers do not go for medical checkup at all. A significant number of the respondents 13(65%) don't use any form of personal protective equipment gears when working however, all the respondents 20(100%) reported washing their hands regularly before and after handling meat products. Further response revel that 16(80%) of the workers have willingness to receive health education on health risks in abattoir setting. The management of the abattoir acknowledged that waste management practices at the abattoir were inadequate as wastes are casually dumped into the nearby river without any form of treatment. The toilet facilities in the abattoir though demarcated into male and female sections were seen to be very dirty and non-functional with a lot of papers and plastics deposited inside and unwanted weeds, charcoal stains and other waste surrounding the facilities on the outside. This is perceived as a reservoir for pathogens, exacerbating the risk of disease transmission and spread of foodborne infections within the abattoir. The management of the abattoir reported that abattoir effluents and other wastes are dumped into the nearby river which also provides water for processing the meat products and for the market generally. The source of fuel is plastics, firewood and used car tyres. The microbial count for water source in the abattoir as shown in *table 4* was 7.2×10^6 CFU/ml for total heterotrophic bacteria, 5.0×10^6 CFU/ml for enteric bacteria, and 8×10^3 SFU/ml for fungi. These values are significantly high, suggesting poor water management practices in the abattoir, which could result in cross-contamination of meat products during processing. Bacteria and Fungi isolated as reported in *table 5* and *table 6* were of the genera *Clostridium* spp, *Bacillus* spp and *Fusarium* spp. These microorganisms can thrive in poorly managed environments, leading to foodborne outbreaks, toxin production, and contamination of meat products. This is similar to the study by Douglas *et al*. (2013), which reported that water quality in Port Harcourt, Nigeria abattoirs were contaminated with high microbial loads of total heterotrophic and enteric bacteria and hence the studies stressed that water used for meat processing, should meet potable standards, free from microbial contaminants

Observation around the abattoir showed the abattoir workers carrying out various activities in the slaughter environment, with very few wearing personal protective equipment. The processes of bleeding, beheading, evisceration and splitting of carcasses were carried out on the open floor of the wet and dirty slaughtering slab. Parts of the slaughtered animal carcasses were seen being carried out on an open wooden table on the slaughtering environment in most unhygienic practice to possible buyers and sellers leaving traces of blood on the ground of the abattoir. Foetuses/condemned carcasses from the slaughtered animals were seen disposed into the open river beside the abattoir and also the roasting and burning of the animal skin and it is done with plastic materials, firewood and old car tyres. Meat products were seen openly transported with wheel barrows and tricycles. The drainage system leading from the slaughter area to the river within the abattoir vicinity allows for movement of abattoir effluents directly into the river. These findings are similar to those of the study by Obidiegwu et al (2019) where various kinds of public health challenges were noticed at Somachi Main Abattoir Owerri, Nigeria.

5. Conclusion

The mode of operation at Swali market Abattoir, Yenagoa Bayelsa State Nigeria predisposes abattoir workers and individuals living in close proximity to the abattoir to zoonoses. Most abattoir workers had poor knowledge of the health risk they are exposed to and very few make use of personal protective wears. Meat and meat products are further exposed to poor handling and being transported in an unhygienic manner thus, affecting the quality of meat and meat products. The presence of *Clostridium spp.*, *Bacillus spp.*, and *Fusarium spp.* in the abattoir represents a serious public health risk due to their roles in foodborne illnesses, mycotoxin contamination, and environmental pollution. Abattoirs must prioritize hygiene, waste management, and environmental monitoring to prevent disease outbreaks and ensure the safety of meat products.

Recommendations

Some measures need to be put in place to address the reported occupational and environmental challenges:

- **Improved sanitation:** there is need for regular cleaning and disinfection of abattoir surfaces, equipment, and workers' hands so as to reduce microbial contamination.
- **Proper waste management:** effluents and other wastes from Swali abattoir should be put to use in the production of biogas instead of discharging them into the river thereby contaminating water source for the whole community.
- **Training and awareness:** Workers in the abattoir must be trained regularly on personal hygiene, use of personal protective equipment, zoonoses, and sanitation practices so as to minimize the spread of pathogens during meat handling.
- **Adequate toilet facilities should be installed:** adequate toilet facilities should be installed and kept clean in order to prevent spread of diseases and infections.
- **Standard Meat Transportation:** meat transportation should be done in a sanitary and in the most hygienic way.
- **Appropriate regulation:** policies and rules should be made with regards to state abattoirs so that as to reduce health risks in abattoirs in the state

Compliance with ethical standards

Disclosure of conflict of interest

Authors declare no conflict of interest concerning the publication of this article

Statement of ethical approval

The approval for this study was obtained from the State Ministry of Agriculture and Natural resources, Bayelsa State, Nigeria

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Appendix

Plate 1 Slaughtering of Cattle at Swali Abattoir

Plate 2 Abattoir Toilet filled with trash and weeds

Plate 3 Slaughtering area and blood extraction

Plate 4 Washing of slaughtering area into the river

Plate 5 Burning of animal skin and washing in the river

Plate 6 Washing of intestinal contents in the river

Plate 7 Toilet in the abattoir showing gender demarcation

Plate 8 Washing of the slaughter slab's content into the river

Plate 9 Removal of intestinal contents before washing

Plate 10 Meat ready for sale

Plate 11 Fetching of water for various uses from the river near the abattoir

Plate 12 Intestinal contents of animals bagged and ready to be washed in the river

Plate 13 Roasting of animal skin which will be washed in the river