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Occupational Health Risks, Safety Practices, and Institutional Gaps among Histopathologists in Nigeria: Evidence from a Nationwide Cross-Sectional Study

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ABSTRACT

Background: Histopathologists are routinely exposed to chemical, biological, physical, and ergonomic hazards that may adversely affect their health and professional performance. Despite increasing recognition of occupational risks in pathology practice, evidence from sub-Saharan Africa remains limited. This study assessed occupational health awareness, safety practices, workplace infrastructure, perceived barriers, and self-reported health effects among histopathologists in Nigeria.

Methods: A nationwide descriptive cross-sectional survey was conducted among consultant histopathologists and pathology residents practicing in Nigeria between February and March 2026. Data were collected using a structured anonymous online questionnaire that assessed occupational hazard awareness, personal protective equipment (PPE) use, workplace safety practices, institutional safety measures, self-reported occupational health effects, and perceived barriers to safe practice. Descriptive statistics were used to summarise the findings.

Results: Ninety-six histopathologists participated in the survey. Awareness of occupational hazards was high, with all respondents recognising chemical hazards and over 87% identifying biological, ergonomic, physical, and psychological risks. Nevertheless, 52.1% reported having received no formal occupational safety training. Although gloves were routinely used by all respondents, consistent use of comprehensive PPE remained suboptimal, particularly for eye protection (18.8%) and respirators (6.3%). Functional ventilation systems were available in only 27.1% of laboratories, while ergonomic workstations were reported by 31.3%. Respiratory irritation (89.6%), back pain (83.3%), eye irritation (81.3%), work-related stress (70.8%), and neck pain (66.7%) were the most frequently reported health complaints. Most respondents (87.5%) experienced at least one work-related symptom during the preceding year, yet only 22.9% had undergone evaluation or treatment for an occupational health problem. Limited institutional support (76.1%), poor laboratory infrastructure (73.9%), inadequate PPE supply (69.6%), and weak enforcement of safety regulations (69.6%) emerged as the principal barriers to safe practice. Almost all respondents (97.9%) believed that occupational hazards among Nigerian histopathologists are under-recognised.

Conclusions: Nigerian histopathologists experience a substantial occupational health burden despite high awareness of workplace hazards. Deficiencies in formal training, engineering controls, ergonomic infrastructure, institutional support, and safety governance contribute to persistent workplace risks and adverse health outcomes. Strengthening occupational safety policies, improving laboratory infrastructure, expanding access to appropriate PPE, implementing regular training programmes, and establishing routine occupational health surveillance are essential to protect the pathology workforce and improve laboratory safety in Nigeria.

Keywords: Occupational health; histopathology; pathology; workplace safety; laboratory hazards; personal protective equipment; ergonomics; formaldehyde exposure; Nigeria.

INTRODUCTION

Occupational health hazards remain a significant concern among healthcare workers, particularly those involved in laboratory-based specialities. Pathology and histopathology practice involves routine exposure to chemical reagents, biological materials, sharp instruments, and prolonged microscope use, all of which pose potential risks to physical and psychological well-being. Despite advances in laboratory technology and safety standards, these occupational exposures persist and may adversely affect productivity, job satisfaction, and long-term health outcomes among pathology professionals.[1,2]

Several studies from different regions have documented a broad range of occupational hazards among pathologists and histopathology laboratory personnel. Chemical exposures, particularly to formaldehyde and xylene, have been associated with

respiratory symptoms, mucosal irritation, and long-term health concerns. Additionally, prolonged microscope use and repetitive tasks contribute significantly to musculoskeletal complaints, including neck, back, and upper limb pain. Physical injuries such as needle-stick and sharps-related accidents, as well as exposure to infectious agents during specimen handling and autopsy procedures, further underscore the occupational risks inherent in histopathology practice.[2-6]

Despite growing global recognition of occupational health challenges in pathology, there is a paucity of data from sub-Saharan Africa, particularly Nigeria. Variations in laboratory infrastructure, availability of personal protective equipment, institutional safety policies, and occupational health training may significantly influence exposure risks among Nigerian histopathologists. To date, no nationwide study has systematically assessed awareness, safety practices, perceived barriers, and self-reported health effects related to occupational hazards among histopathologists in Nigeria.

Awareness and perception of occupational risk play a critical role in determining safety practices among healthcare professionals. In pathology, inadequate training or low risk perception may result in inconsistent use of protective measures, even when safety equipment is available. Understanding the level of awareness among histopathologists is therefore essential for identifying gaps in training and opportunities for targeted interventions.[2,3,6]

Occupational exposures in histopathology have been associated with a range of acute and chronic health effects, including respiratory irritation, ocular symptoms, headaches, musculoskeletal discomfort, and psychological stress. While many of these effects are self-reported, they may significantly impact quality of life, work efficiency, and long-term career sustainability among pathology professionals.[3-5]

Therefore, this study aimed to assess awareness of occupational health hazards, safety practices and personal protective equipment use, self-reported health effects, institutional safety infrastructure, perceived barriers to workplace safety, and training related to occupational health among histopathologists in Nigeria through a nationwide cross-sectional survey. The findings are intended to inform policy development, training programs, and workplace safety interventions.

METHODS

Study Design and Setting

This was a nationwide, descriptive cross-sectional survey conducted among histopathologists in Nigeria between February 2026 and March 2026. Data were collected using an anonymous, self-administered online questionnaire designed to assess occupational health awareness, safety practices, and self-reported health effects.

The study population comprised consultant histopathologists and histopathology residents (senior and junior registrars) currently practising in Nigeria. Pathologists not actively involved in histopathology practice and respondents who did not provide consent were excluded.

Sampling and Sampling Techniques

A target sample size of approximately 100–200 respondents was set based on feasibility. Participants were recruited using convenience sampling through professional histopathology networks, including professional messaging platforms.

Data Collection

Data were collected using a structured questionnaire developed after a review of relevant literature on occupational health hazards in pathology practice. The questionnaire comprised six sections assessing demographic and professional characteristics, awareness of occupational hazards, safety practices and personal protective equipment use, self-reported health effects, institutional safety infrastructure, perceived barriers to occupational safety, and training and policy awareness. Most items were closed-ended multiple-choice questions.

The questionnaire was reviewed for content validity by senior histopathologists with experience in occupational health and laboratory safety. Minor revisions were made for clarity and relevance before dissemination. The questionnaire was administered

using Google Forms and distributed electronically. Participation was voluntary, anonymous, and restricted to one response per participant. Data collection was open for a period of 6 weeks.

Data Analysis

Data were analysed using SPSS version 25. Descriptive statistics were used to summarise responses, with categorical variables presented as frequencies and percentages.

Ethics

Ethical approval was obtained from the Nnamdi Azikiwe University Teaching Hospital Ethics Committee, or the study was deemed exempt as a minimal-risk survey. Informed consent was implied by voluntary participation after respondents reviewed the study information page. No personally identifiable information was collected.

RESULTS

A total of 96 histopathologists participated in the study (Table 1). Most respondents were consultant histopathologists (62.5%, n = 60), while senior registrars and junior registrars each accounted for 18.8% (n = 18). The largest proportion of participants had 5–10 years of practice (41.7%, n = 40), followed by those with <5 years and 11–20 years of experience (each 27.1%, n = 26), while a small proportion (4.1%, n = 4) had more than 20 years of practice.

Regarding workload, the majority of respondents reported working 40–60 hours per week (64.6%, n = 62), while 22.9% (n = 22) worked less than 40 hours and 12.5% (n = 12) worked more than 60 hours weekly.

Most respondents practiced in federal teaching hospitals (68.8%, n = 66), followed by state teaching hospitals (14.6%, n = 14), federal medical centres (12.5%, n = 12), and private laboratories (4.1%, n = 4).

Participants were drawn from all six geopolitical zones of Nigeria, with the highest representation from the North Central zone (25.0%, n = 24), followed by the South East (22.9%, n = 22), South-South (16.7%, n = 16), South West (16.7%, n = 16), North East (14.6%, n = 14), and North West (4.2%, n = 4).

Table 1: Socio-professional characteristics of participating histopathologists (N = 48).

Variable	Category	n (%)
Professional Designation	Consultant Histopathologist	60 (62.5)
	Senior Registrar	18 (18.8)
	Junior Registrar	18 (18.8)
Years of Practice	< 5 years	26 (27.1)
	5–10 years	40 (41.7)
	11–20 years	26 (27.1)
	> 20 years	4 (4.1)
Weekly Working Hours	< 40 hours	22 (22.9)
	40–60 hours	62 (64.6)

	> 60 hours	12 (12.5)
Type of Institution	Federal Teaching Hospital	66 (68.8)
	Federal Medical Centre	12 (12.5)
	State Teaching Hospital	14 (14.6)
	Private Laboratory	4 (4.1)
Geopolitical Zone	North-Central	24 (25.0)
	North-East	14 (14.6)
	North-West	4 (4.2)
	South-East	22 (22.9)
	South-South	16 (16.7)
	South-West	16 (16.7)

Awareness of occupational hazards among participants is summarised in Table 2. All respondents (100%, n = 96) were aware of chemical hazards, such as exposure to formalin and xylene. Awareness of physical hazards was also high (97.9%, n = 94), followed by ergonomic hazards related to prolonged microscope use (93.8%, n = 90). Awareness of biological hazards and psychological stress/burnout was reported by 87.5% (n = 84) of respondents.

Table 2: Awareness of occupational hazards among participating histopathologists (N = 48).

Occupational Hazard	Frequency (n)	Percentage (%)
Chemical exposure (e.g., formalin, xylene)	96	100.0
Physical hazards (e.g., sharps injuries, cuts)	94	97.9
Ergonomic hazards (e.g., microscope posture, repetitive strain)	90	93.8
Biological hazards (e.g., tuberculosis, blood-borne pathogens)	84	87.5
Psychological stress/burnout	84	87.5

More than half of the participants (52.1%, n = 50) reported having no formal training on occupational hazards. Among those who had received training, the most common source was postgraduate training

(25.0%, n = 24), followed by workplace training or continuing medical education (18.8%, n = 18) and undergraduate training (16.7%, n = 16).

Regarding self-assessment of knowledge, half of the respondents (50.0%, n = 48) rated their knowledge as good, while 31.3% (n = 30) considered it fair. A smaller proportion rated their knowledge as very good (14.6%, n = 14), whereas 4.1% (n = 4) reported poor knowledge of occupational hazards.

PPE use among respondents is summarised in Table 3. Among the 94 participants who responded to this question, 36.2% (n = 34) reported often using PPE, while 31.9% (n = 30) reported sometimes using PPE. A quarter of respondents (25.5%, n = 24) indicated that they always used PPE, whereas 6.4% (n = 6) reported rarely using PPE. None of the respondents reported never using PPE.

Regarding the types of PPE routinely used, gloves were used by all respondents (100.0%, n = 98). Laboratory coats or gowns were used by 83.3% (n = 80) of participants, while 66.7% (n = 64) reported routine use of face masks. Eye protection was used by 18.8% (n = 18) of respondents, and only 6.3% (n = 6) reported routine use of respirators or N95 masks.

Table 3: Personal protective equipment (PPE) use among respondents.

Variable	Category	n (%)
Frequency of PPE Use (n = 94)	Always	24 (25.5)
	Often	34 (36.2)
	Sometimes	30 (31.9)
	Rarely	6 (6.4)
	Never	0 (0.0)
Types of PPE Routinely Used (n = 96)*	Gloves	96 (100.0)
	Laboratory coat/gown	80 (83.3)
	Face mask	64 (66.7)
	Eye protection (goggles/shield)	18 (18.8)
	Respirator/N95 mask	6 (6.3)

*Multiple responses were allowed.

Workplace safety practices among the participants (n = 96) demonstrated varying levels of adherence across different types of occupational hazards. While a large majority of respondents (81.3%, n = 78) reported consistently practising safe sharps handling and disposal, adherence was lower for chemical and ergonomic safety measures. Only 52.1% (n = 50) reported consistent use of personal protective equipment when handling formalin, and 66.7% (n = 64) indicated that they regularly took breaks during prolonged microscopy sessions. These findings suggest better compliance with sharps safety practices compared to measures aimed at reducing chemical exposure and ergonomic strain.

The availability of essential laboratory safety equipment and institutional safety measures demonstrated notable variability. Only a minority of respondents (27.1%, n = 26) reported the presence of a functional fume hood or adequate ventilation system in their laboratories. In contrast, adequate sharps disposal containers were widely available, with

75.0% (n = 72) of respondents affirming their presence.

Personal protective equipment (PPE) was reported to be readily available by 58.3% (n = 56) of participants, whereas 41.7% (n = 40) indicated inadequate access. Similarly, ergonomic provisions were limited, as only 31.3% (n = 30) reported the availability of an adjustable microscope or ergonomic chair. Encouragingly, handwashing facilities were available in most laboratories, as reported by 89.4% (n = 86) of respondents.

Regarding institutional safety frameworks, 58.3% (n = 56) of respondents reported that their laboratories had a written safety policy or standard operating procedures (SOPs), while 25.0% (n = 24) reported none and 16.7% (n = 16) were unsure of their existence. However, only 33.3% (n = 32) of participants indicated that safety guidelines were visibly displayed in their laboratories, compared to 66.7% (n = 64) who reported otherwise.

Furthermore, periodic workplace safety inspections were conducted in only 18.8% (n = 18) of laboratories, while 62.5% (n = 60) reported that such inspections were not carried out and 18.8% (n = 18) were uncertain.

While basic safety provisions such as sharps disposal and hand hygiene facilities were relatively well established, significant deficiencies were observed in ventilation systems, ergonomic infrastructure, safety visibility, and routine safety monitoring practices.

The prevalence of self-reported occupational health effects among histopathologists is shown in Figure 1. The most frequently reported symptom was nasal irritation or sore throat, affecting 89.6% (n = 56) of respondents. This was followed by back pain (83.3%, n = 80) and eye irritation (81.3%, n = 78), indicating a high burden of both respiratory and musculoskeletal complaints within this group.

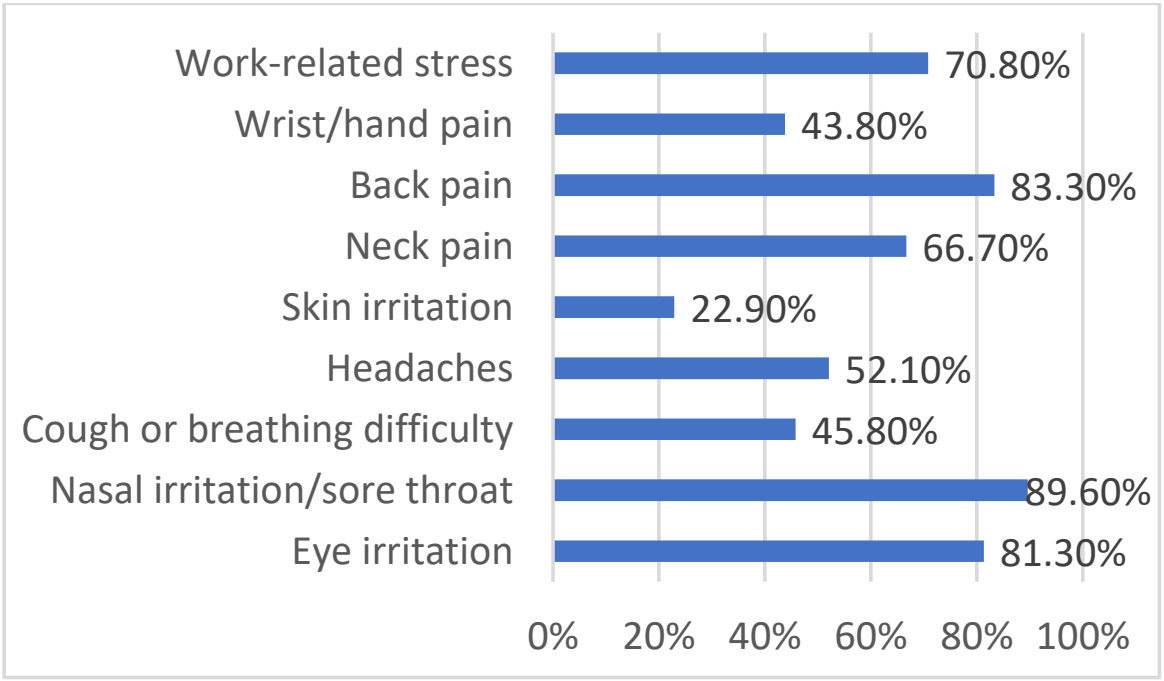

Figure 1: Distribution of self-reported health effects among study participants

Work-related stress was also commonly reported, affecting 70.8% (n = 68) of histopathologists, while neck pain was reported by 66.7% (n = 64%). More than half of the respondents experienced headaches (52.1%, n = 50), further highlighting the impact of occupational exposures and work conditions on their overall well-being.

Less commonly reported symptoms included cough or breathing difficulty (45.8%, n = 44) and wrist/hand pain (43.8%, n = 44). Skin irritation was the least reported health effect, affecting 22.9% (n = 22) of participants.

These findings demonstrate a high prevalence of work-related health complaints, particularly involving respiratory, visual, and musculoskeletal systems among histopathologists.

These findings underscore the significant occupational health burden among histopathologists and highlight the need for improved workplace safety measures, including enhanced ventilation, ergonomic interventions, and regular health surveillance.

Within the last 12 months, a substantial proportion of histopathologists reported experiencing work-related health symptoms, with 87.5% indicating that they had experienced at least one of the previously listed symptoms.

Sharps-related injuries were also relatively common, as 31.3% of respondents reported having sustained a sharps injury during the same period.

Despite the high prevalence of symptoms, only 22.9% of participants reported having been evaluated or treated for a work-related health issue.

These findings suggest a high burden of occupational health symptoms among histopathologists, with a notable gap between symptom occurrence and healthcare-seeking or formal evaluation.

As shown in Figure 2, multiple barriers to the practice of optimal laboratory safety were identified among respondents. The most frequently reported barrier was limited institutional support, cited by 76.1% (n = 70) of participants. This was closely followed by poor laboratory infrastructure (73.9%, n = 68), as well as inadequate supply of personal protective equipment (69.6%, n = 64) and poor enforcement of safety regulations (69.6%, n = 64).

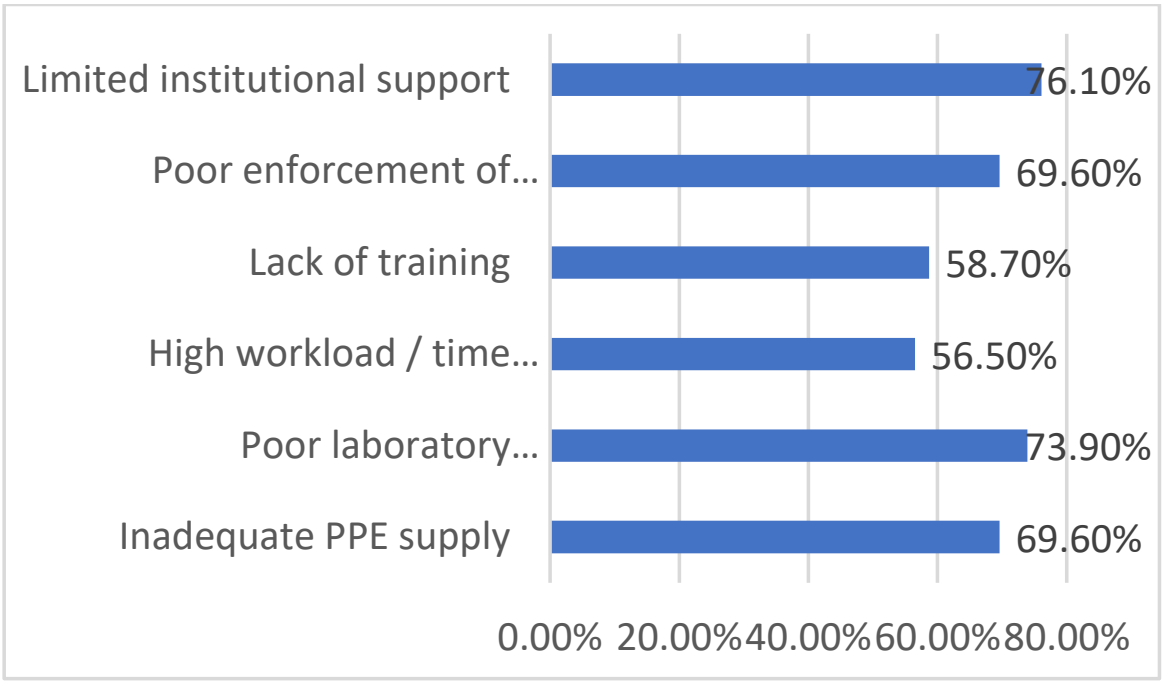

Figure 2: Perceived barriers to optimal laboratory safety practices among histopathologists

Additionally, more than half of the respondents reported lack of training (58.7%, n = 54) and high workload or time pressure (56.5%, n = 52) as significant barriers to safe laboratory practice.

These findings highlight systemic and organisational challenges, particularly related to institutional support, infrastructure, and policy enforcement, as key impediments to optimal laboratory safety.

The multiplicity of reported barriers underscores the need for comprehensive, multi-level interventions targeting both institutional and individual factors to improve laboratory safety practices.

Respondents were asked to rate the adequacy of current safety measures in their workplace. Overall, the majority of histopathologists perceived existing safety measures as suboptimal, with 54.2% rating

them as inadequate and 12.5% as very inadequate. In contrast, 31.3% of respondents considered the measures to be adequate, while only a small proportion (2%) rated them as very adequate. These findings suggest a generally low level of satisfaction with workplace safety measures among histopathologists.

Respondents expressed strong consensus regarding the need for improved occupational safety measures in histopathology practice. All participants (100%) agreed that regular occupational safety training should be mandatory for histopathology staff. Similarly, 100% of respondents believed that improved laboratory infrastructure would reduce occupational health risks.

In addition, a vast majority of participants (97.9%) agreed that occupational hazards in histopathology are under-recognised in Nigeria.

These findings reflect a high level of awareness among histopathologists regarding existing gaps in occupational safety and the need for systemic improvements in training and infrastructure.

DISCUSSION

This nationwide survey provides important insights into occupational health challenges among histopathologists in Nigeria and demonstrates a substantial burden of workplace hazards, suboptimal safety practices, and limited institutional safety infrastructure. Although awareness of occupational hazards was high among respondents, more than half reported no formal training, and consistent use of personal protective equipment was suboptimal. Furthermore, critical safety infrastructures such as functional ventilation systems, ergonomic workstations, and routine safety inspections were lacking in many laboratories. These deficiencies were reflected in the high prevalence of self-reported work-related symptoms, particularly respiratory irritation, musculoskeletal pain, eye strain, and work-related stress. Collectively, these findings highlight a significant gap between awareness and implementation of occupational safety measures in histopathology practice in Nigeria.

Awareness and Training

Awareness of key hazard domains was high in this cohort (chemical, physical/sharps, ergonomic, biological, and psychological hazards), yet more than half of respondents reported having no formal occupational hazard training. This "awareness–implementation gap" mirrors concerns raised elsewhere: in Algeria, lack of training was reported as common and was explicitly discussed as a contributor to preventable occupational accidents and work-related diseases in hospital laboratories[9], while Kenyan laboratory settings show relatively weaker performance in ergonomic and emergency-preparedness domains compared with PPE culture, suggesting that knowledge and systems are unevenly distributed across safety pillars.[11] In pathology-specific cohorts, training/experience patterns also influence risk: Swiss data showed residents were more likely than consultants to report injuries in the previous year, indicating that training environments can both increase exposure opportunity and reveal structural vulnerabilities.[7] Taken together, the Nigerian findings support the interpretation that high professional awareness alone is insufficient; formalised, repeated training and organisational reinforcement are likely necessary to translate awareness into sustained safer practice.[7,9,11]

PPE Use and Safety Practices

PPE use was reported by nearly all respondents to some degree, but intensity and completeness were inconsistent: gloves were universal, laboratory coats were commonly used, face masks were used by about two-thirds, while eye protection and respirators/N95 use were uncommon. This distribution is consistent with broader laboratory observations in which "basic" PPE is more readily adopted than higher-burden or less-available items, and where enforcement and supply shape compliance.[9,11] In Kenya, respondents reported relatively strong PPE compliance culture and availability (higher average PPE domain scores) but training/reminders and ergonomic implementation lagged, an imbalance that resonates with the Nigerian pattern of partial PPE penetration and weaker ergonomic supports.[11] In Switzerland, cut-resistant gloves were not available for more than one-third of pathologists, and injury prevalence did not differ significantly between users and non-users,

underscoring that PPE alone may not eliminate harm if task systems and environmental controls remain suboptimal.[7] Therefore, Nigeria's PPE pattern should be interpreted within a hierarchy of controls: incomplete PPE uptake, particularly for eye/respiratory protection, likely compounds chemical splash/inhalational risks, but sustained injury reduction will also require engineering and administrative controls.[7,9,11]

Workplace Infrastructure and Policy

Institutional safety infrastructure in Nigerian histopathology practice appears uneven: handwashing facilities and sharps disposal containers were commonly available, but functional ventilation/fume hoods and ergonomic equipment (adjustable microscopes/ergonomic chairs) were reported by only a minority, and routine safety inspections were uncommon. Comparable deficits have been documented in hospital laboratories: in Algeria, reported gaps included missing fume hoods and insufficient protective eyewear/gloves, with non-compliance often linked to negligence and lack of resources.[9] Multiple formaldehyde-focused studies underscore why ventilation matters in histopathology. In North Borneo, formaldehyde exposure levels were substantially higher in histopathology laboratories than administrative areas and were associated with significantly higher prevalence of several irritation symptoms in exposed staff.[4] In India-based tracking, formaldehyde concentrations rose markedly during grossing without effective exhaust, and levels reduced after switching on exhaust, illustrating the centrality of local control measures for peak exposures.[10] Real-world monitoring data from a large pathology laboratory show exposure peaks can be tied to specific tasks (grossing large specimens, refilling reservoirs, incorrect hood sash use) and can decrease with targeted management and improved spaces/workflows.[15] Collectively, these comparisons support an inference that limited ventilation capacity and weak safety visibility & inspection in Nigeria likely contribute to the high respiratory/ocular symptom burden and reinforce the need for enforceable safety policy, display of SOPs, and routine inspections as part of laboratory governance.[4,9,10,15]

Self-Reported Health Effects

Respondents reported a high prevalence of work-related symptoms spanning musculoskeletal pain, ocular irritation & strain, upper-airway symptoms, headaches, and psychological stress. This pattern aligns closely with pathology cohorts internationally, where microscopy, workstation posture, and combined microscope–computer work are consistently implicated. Swiss pathologists reported musculoskeletal problems affecting more than three-quarters of participants, most commonly in the neck/shoulder region, with many perceiving benefit from ergonomically optimised microscopes.[7] Irish laboratory personnel similarly reported a high incidence of episodic musculoskeletal problems (neck, back, shoulder) and visual fatigue, with symptom prevalence rising with higher microscopy hours.[6] Studies from India and Pakistan also report musculoskeletal disorders as highly prevalent among pathologists and trainees, alongside prominent visual strain and stress & anxiety, reinforcing that these are not isolated to one geography but may be amplified by local conditions and workload.[2,8] Mechanistically, microscope work and prolonged static posture, including neck flexion, are recognised contributors to cumulative trauma disorders, especially when combined with prolonged computer tasks; ergonomic workstation design, posture neutrality, break structure, and task variation are repeatedly advocated as preventive strategies.[14] The high reported stress in Nigeria is also consistent with broader discussions of pathologists' occupational stress and burnout, often linked to workload, institutional support, and role expectations; importantly, international data cited in professional lifestyle syntheses indicate that only a minority of affected pathologists seek professional help for burnout, echoing the Nigerian finding that relatively few respondents had been evaluated or treated despite frequent symptoms.

Occupational Injuries and Formalin/Xylene Exposure

Sharps injury within the past year was reported by a substantial minority of Nigerian respondents, supporting occupational injury as an ongoing hazard in histopathology settings. Pathology cohorts elsewhere report high cumulative injury experience across careers. Swiss pathologists reported injuries in a large majority over their career, with residents more often

affected in the previous year.[7] In India, occupational injuries were also reported among pathology/microbiology professionals, and injury types commonly include needle-stick injuries, cuts, and splashes to mucous membranes, events that mirror the task profile of grossing and specimen handling.[8] Broader pathology-laboratory personnel studies from India highlight even higher accident burdens in some settings, with needle-stick injuries frequently predominant and "carelessness," lack of facilities, and lack of awareness cited as contributors; factors which overlap conceptually with Nigeria's reported barriers of workload and weak enforcement.[12] Regarding chemical exposure, irritation symptoms in Nigeria (ocular and upper-airway complaints, headaches) are consistent with formaldehyde-associated symptom clusters reported in exposed histopathology workers: North Borneo data showed significant associations between formaldehyde exposure and irritated eyes, sore throat, cough, and other symptoms,[4] while formaldehyde tracking studies and discussions explain acute irritation thresholds and emphasize ventilation/negative pressure and exposure control during high-risk tasks such as grossing.[10] Longitudinal monitoring from large laboratories further demonstrates that exposure peaks are task-dependent and modifiable with appropriate engineering controls and work-practice changes, including better containment and correct use of local exhaust systems.[15] Although this Nigerian survey did not directly measure airborne formaldehyde/xylene, the combination of frequent irritation symptoms, inconsistent PPE use when handling formalin, and limited ventilation strongly supports prioritising chemical exposure control in local safety planning, following the risk-management logic demonstrated in measurement-based studies.[4,10,15]

Barriers to Safety and Institutional Support

Respondents most frequently identified limited institutional support, poor infrastructure, inadequate PPE supply, and weak enforcement as barriers to optimal safety practice, with additional contributions from lack of training and workload/time pressure. This barrier profile matches multi-level explanations in laboratory safety research. Algerian hospital laboratory staff attributed incidents to negligence and lack of protective measures, and highlighted the role of working conditions and provision of protective resources in prevention.[9] Kenyan laboratory systems research similarly illustrates that even where PPE culture is relatively strong, gaps in ergonomic principles, emergency preparedness, and structured review processes persist, implying that safety maturity is domain-specific and requires systems-level strengthening rather than single interventions.[11] Professional lifestyle discussions in pathology emphasise that stress and burnout are often driven by workload and insufficient support/respect within institutions, factors conceptually aligned with "limited institutional support" emerging as Nigeria's leading barrier.[13] Therefore, Nigeria's barrier pattern plausibly reflects structural constraints that can perpetuate both exposure and under-treatment: where enforcement is weak, and resources are limited, individuals may adopt partial protective behaviours but remain exposed to high-risk tasks (grossing, specimen handling) and chronic ergonomic strain.[9,13,14]

Strengths, Limitations, and Implications

A key strength of this study is its nationwide scope across geopolitical zones and representation of both consultants and trainees, providing a broad snapshot of occupational hazards specific to Nigerian histopathology practice. However, important limitations should frame interpretation: the cross-sectional design cannot establish causality; self-reported exposures and symptoms are susceptible to recall and reporting bias; and the absence of objective exposure monitoring (e.g., formaldehyde/xylene measurements) limits attribution of symptoms to specific chemicals compared with measurement-based studies.[4,10,15] Nonetheless, the convergence of patterns, such as high symptom burden, partial PPE adoption, limited ventilation and ergonomic support, and dominant system-level barriers, creates a coherent narrative consistent with international pathology and laboratory evidence.[7,9,11-15] For Nigeria, the practical implication is that improving safety will likely require a bundled approach: enforceable institutional policies & SOPs with visible guidance, recurring training, reliable PPE supply (including eye &

respiratory protection), engineering controls for chemical fumes during high-risk tasks, ergonomic redesign for microscopy/computer work, and routine inspections plus health surveillance. Swiss and Irish findings suggest that microscopy-related injury remains prevalent even in higher-resource settings, but perceived symptom relief from ergonomic microscopes and the rationale for posture-neutral, break-structured work provide actionable levers that can be adapted locally.[6,7,14] Chemical monitoring studies show that controlling peaks during grossing and improving ventilation are feasible and can meaningfully reduce exposure.[10,15] Overall, the Nigerian data indicate that occupational health risks in histopathology are not merely individual-level issues but reflect modifiable institutional and systems constraints that should be addressed as part of laboratory quality and workforce sustainability.

Comparison of Key Findings (Nigeria vs Rest of the World)

Nigeria survey (N = 96)	Other Countries
Musculoskeletal symptoms were highly prevalent (e.g., back and neck pain frequently reported), consistent with heavy microscopy/postural load.	Musculoskeletal problems affected >75% of Swiss pathologists, commonly neck/shoulders; ergonomic microscopes were perceived to alleviate symptoms.[7]
Ventilation controls were limited: only a minority reported a functional fume hood/adequate ventilation.	Fume hoods were reported missing in ~one quarter of Algerian hospital laboratory settings, alongside other protection gaps.[9]
Sharps injury within the last 12 months affected a substantial minority.	Injuries were reported by most Swiss pathologists at some point in their career, with residents more often affected in the previous year[7]; occupational accidents were reported by 18.87% of Algerian laboratory workers.[9]
Irritation symptoms (ocular/upper-airway, headaches) were common alongside inconsistent PPE use for formalin handling.	Formaldehyde exposure was significantly associated with higher prevalence of irritated eyes, sore throat, cough and other symptoms among histopathology laboratory workers in North Borneo.[4]

Actionable Recommendations for Nigerian institutions and policymakers

- Establish mandatory, recurring occupational safety training for histopathology staff (consultants, residents, scientists/technicians), including task-specific modules for grossing, specimen handling, and spill response, with competency sign-off and refreshers.[7,9,11]
- Prioritise engineering controls for chemical fumes: install/restore and maintain functional fume hoods/local exhaust ventilation in grossing and processing areas; implement correct hood-sash and ventilation-use practices during peak tasks.[4,10,15]
- Ensure consistent availability of complete PPE bundles (gloves, coats/gowns, medical masks/respirators where appropriate, and critically, eye protection) and link provision to enforcement and auditing.[7,9,11]
- Implement ergonomic interventions for microscopy and combined microscope–computer work: adjustable microscopes/eyepieces where feasible, ergonomic seating, posture training, and structured micro-break routines integrated into workflow.[6,7,14]

- Strengthen institutional safety governance: written SOPs, visible safety signage, incident reporting pathways, and scheduled workplace safety inspections with documented corrective actions.[9,11]

- Introduce basic occupational health surveillance and support (screening for recurrent irritation symptoms, musculoskeletal disorders, and stress/burnout; referral pathways), addressing the observed gap between symptom prevalence and evaluation/treatment.[13,14]

- Embed safety metrics into laboratory quality management and accreditation efforts, aligning safety investment (ventilation, ergonomics, training, monitoring) with workforce retention and diagnostic quality goals.[11,13]

CONCLUSION

Nigerian histopathologists report high awareness of occupational hazards yet continue to experience a substantial burden of work-related symptoms in the context of inconsistent protective practices and limited enabling infrastructure. This persistent awareness–implementation gap highlights a structural rather than individual deficit: knowledge alone has not translated into safe practice because the systems, equipment, and institutional supports required to operationalise that knowledge remain inadequate.

The evidence indicates that meaningful improvement in occupational safety will require a coordinated, multi-level response. Priority actions include structured and recurrent training programmes that reinforce hazard recognition and safe-handling procedures; stronger enforcement mechanisms to ensure compliance with existing safety standards; and investment in engineering controls, particularly adequate ventilation, fume extraction, and safe chemical-handling systems, which remain critically underdeveloped in many laboratories. Ergonomic redesign of workspaces and equipment is also essential, given the high prevalence of musculoskeletal complaints reported across studies.

In addition, routine monitoring, surveillance, and documentation of occupational exposures should be institutionalised to support early risk detection and guide continuous quality improvement. Without such systemic interventions, the current pattern of high awareness but limited protection will likely persist. A comprehensive, well-resourced, and enforceable occupational-health framework is therefore necessary to safeguard the histopathology workforce and strengthen the resilience of diagnostic services in Nigeria.

AUTHOR CONTRIBUTION

All authors played a substantive role in shaping this study and developing the manuscript. K.G.I. conceptualised the work and designed the overall study framework. Data analysis, interpretation of data and validation of findings were carried out collaboratively, with each author contributing to the discussions that informed the final results. K.G.I. and K.O.O. prepared the initial manuscript draft, covering the introduction, methods, results and discussion. Co-authors strengthened the analysis, offered detailed revisions and enhanced the clarity and coherence of the final document. Every author reviewed the complete manuscript, approved the final version and accepted responsibility for the integrity of the work.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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