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Exploring Occupational Health Risk among laboratory technicians in Rajnandgaon: Insights from a cross-sectional survey

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ABSTRACT

Background: Laboratory technicians are routinely exposed to a wide range of occupational health risks, including biological, chemical, physical, ergonomic, and psychosocial hazards. Inadequate awareness and suboptimal adherence to occupational health and safety (OHS) measures increase the risk of laboratory-acquired infections, injuries, and work-related illnesses. Evidence from district-level health facilities in India remains limited.

Objectives: To assess the occupational health risks and the level of awareness regarding occupational safety measures and preventive practices among laboratory technicians in Rajnandgaon district, Chhattisgarh.

Methods: An institutional-based cross-sectional study was conducted among laboratory technicians working in government medical colleges, district hospitals, community health centres, and primary health centres in Rajnandgaon district, Chhattisgarh. Data were collected using a pre-tested interviewer-administered questionnaire and an observational checklist assessing general awareness and biological, chemical, physical, and psychosocial hazards. Data were analysed using Microsoft excel spreadsheet and the chi-square test; $p < 0.05$ was considered statistically significant.

Results: A total of 66 laboratory technicians participated in the study. Most participants were male (71.2%) and had more than five years of work experience (68.2%). While awareness of incident reporting procedures (95.5%) and emergency response plans (93.9%) was high, only 27.3% knew where to access OHS regulations or had reviewed the OHS hazards and controls handbook. Consistent use of personal protective equipment was reported by 68.2% participants. Chemical safety awareness was poor, with only 37.9% having received chemical safety training and 4.5% knowing the location of MSDS/SDS. Significant associations were observed between PPE use and chemical spill response training ($p = 0.002$), educational status and chemical safety training ($p = 0.008$), and years of experience with safe autoclave use ($p = 0.014$).

Conclusion: Technicians with more experience showed better awareness of emergencies, ergonomic risks, and safe equipment use. Those with higher education levels demonstrated stronger understanding of safety procedures and chemical handling. Spill-response training had the greatest impact, improving PPE use, disinfectant preparation, and knowledge of OHS rules and rights. Trained technicians were also far more likely to review safety documents and undergo respirator fit-testing. Hence experience, education, and targeted training are key to improving occupational health and safety among laboratory staff.

Keywords: Occupational health, laboratory technicians, biosafety, chemical hazards, safety practices, Chhattisgarh.

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INTRODUCTION

Laboratory technicians are routinely exposed to a wide range of occupational health hazards, particularly biological risks, which can pose serious threats to their health if appropriate biosafety measures are not strictly followed.[1,2] Continuous handling of large volumes of clinical specimens places laboratory personnel at heightened risk of laboratory-acquired infections, especially when awareness and adherence to universal work precautions are inadequate.[3,4] Insufficient risk perception and lack of motivation to comply with standard safety protocols may lead to unsafe practices during specimen collection, transportation, processing, storage, and disposal, thereby increasing vulnerability to infectious exposures. [5,6] According to the guidelines issued by the Centers for Disease Control and Prevention (CDC), universal work precautions are designed to prevent the transmission of blood-borne pathogens in healthcare and laboratory settings [3,4]. These precautions apply to blood, body fluids containing visible blood, semen, vaginal secretions, body tissues, and sterile body fluids such as cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluids[3]. However, they do not generally apply to feces, nasal secretions, sputum, saliva, sweat, tears, urine, or vomitus unless these contain visible blood. [3,5] Universal work precautions emphasize the consistent use of personal protective equipment (PPE), including gloves, masks, gowns, and eye protection, to reduce occupational exposure to potentially infectious materials.[4,7] Safe handling and disposal of sharp instruments are essential to prevent percutaneous injuries and transmission of blood-borne pathogens.(8,9) Furthermore, all clinical specimens should be treated as potentially infectious regardless of their perceived risk status(1,4). Adequate knowledge of biosafety principles among laboratory personnel is therefore essential to ensure safe laboratory practices, correct use of equipment, and appropriate biomedical waste management, ultimately minimizing the risk of infection transmission within laboratory environments [2,10]. Previous studies have shown that poor compliance with standard precautions remains a major contributor to occupational infections in healthcare settings (11,12).

Material and methodology:

1. **Study design and type** –cross sectional study
2. **Study setting** – Department of Community Medicine, B.R.L.S.A.B.V.M.M.C, Rajnandgaon, Chhattisgarh.
3. **Study area** – Government Medical Colleges, government hospitals, government health centers were taken as study area.
4. **Study population** – All working laboratory technicians in various government colleges, government hospitals, government health center in Rajnandgaon block, Chhattisgarh.
5. **Sampling technique** - For the purpose of this study, a list of all laboratory technicians working in government health facilities within the Rajnandgaon block was obtained from the Chief Medical and Health Officer (CMHO) office. From this list, all the participants were selected.
6. **Sample size** – 66 (as per list obtained from CMHO office Rajnandgaon.)
7. **Study duration** – 3 months from August 2025 to October 2025
8. **Study tool and technique** – A pre-designed and pre-tested semi-structured standardized questionnaire was asked via interview technique and a standardized checklist for interviewer was employed.

9. **Data Analysis-** Data was entered into Microsoft excel spread sheet and was subjected for appropriate statistical analysis. Quantitative or categorical data was analyzed in frequency or percentage. Appropriate statistical test was used and $p < 0.05$ was consider statistically significant.

RESULT:

The study included a total of 66 participants, consisting of 20 participants (30.3 %) between 25-30 year age group,19 participants (28.8%) between the age group 30 to 35 years age, 13 participants (19.7%) in 35-40 year age and 14 participants (21.2%) in >40 year age group. The gender distribution was identified as follows: with 71.2% as male

and 28.8% as female. The majority of participants had a more than 10 years of experience as medical laboratory technicians (MLT).

Table 1. Distribution of the study participants according to their sociodemographic profile.

		Frequency	Percentage
Age groups (in years)	Less than 25	0	0%
	25-30	20	30.3%
	30-35	19	28.8%
	35-40	13	19.7%
	More than 40	14	21.2%
Gender	Male	47	71.2%
	female	19	28.8%
Education Status	Higher Secondary	0	0%
	Diploma	26	39.4%
	Graduation	25	37.9%
	Post graduation	15	22.7 %
Years of experience as MLT	0-2 years	1	1.5 %
	2-5 years	20	30.3%
	5-10 year	19	28.8%
	More than 10 years	26	39.4%
Type of department	Hematology	10	15.2%
	Biochemistry	14	21.2%
	Microbiology	15	22.7%
	Histopathology	27	40.9%
	research	0	0%
Centre in which they work	Subcenter	0	0%
	PHC	16	24.2%
	CHC	15	22.7%
	District hospital	17	25.8%
	Medical college and hospital	18	27.3%

Educationally, 39.4% held a diploma, 37.9% a bachelor's degree, and 22.7% held a postgraduate qualification. Regarding professional experience, 39.4% had more than ten years of service and 30.3% had 2–5 years. Technicians worked across histopathology (40.9%), microbiology (22.7%), biochemistry (21.2%), and hematology (15.2%); facilities included medical college hospitals (27.3%), district hospitals (25.8%), PHCs (24.2%), and CHCs (22.7%).

Table 2. : This table depicts the association between years of experience as a Laboratory technician and their awareness variables

Variable	Years of Experience as a Laboratory Technician		p value	Result
	More than 5 years	Less than 5 years		
Knows emergency eyewash shower locations				

No	15	14	0.011*	Significant
Yes	30	7		
Aware of ergonomic risks				
No	8	12	0.001*	Significant
Yes	37	9		
Demonstrates safe autoclave use				
No	35	10	0.014*	Significant
Yes	10	11		
Aware of support service				
No	20	15	0.04*	Significant
Yes	25	6		

** Chi-square ,# Fisher exact test, p value <0.05 is Significant, significance at 95%CI*

Technicians with more than five years' experience were significantly more likely to know the locations of emergency eyewash/shower facilities (p = 0.011) and to demonstrate awareness of ergonomic risks (p = 0.001). Experienced staff also showed significantly better safe autoclave practices (p = 0.014) and greater awareness of available support services (p = 0.040). These findings indicate that practical experience correlates with improved emergency preparedness, ergonomic awareness, and equipment handling.

Table 3. Association of variables with Highest Level of Education

Variable	Highest level of education		p value	Result
	Diploma	Graduation / Post graduation		
Uses biological safety cabinet properly				
No	12	8	0.023*	Significant
yes	14	32		
Chemical safety training				
No	19	16	0.008*	significant
yes	7	24		

** Chi-square ,# Fisher exact test, p value <0.05 is Significant, significance at 95%CI*

Higher education (graduation/postgraduation) was significantly associated with correct use of biological safety cabinets (p = 0.023), and having received chemical safety training (p = 0.008). Diploma-qualified technicians reported lower rates on these measures, suggesting that formal education level influences theoretical knowledge and uptake of documented safety guidance

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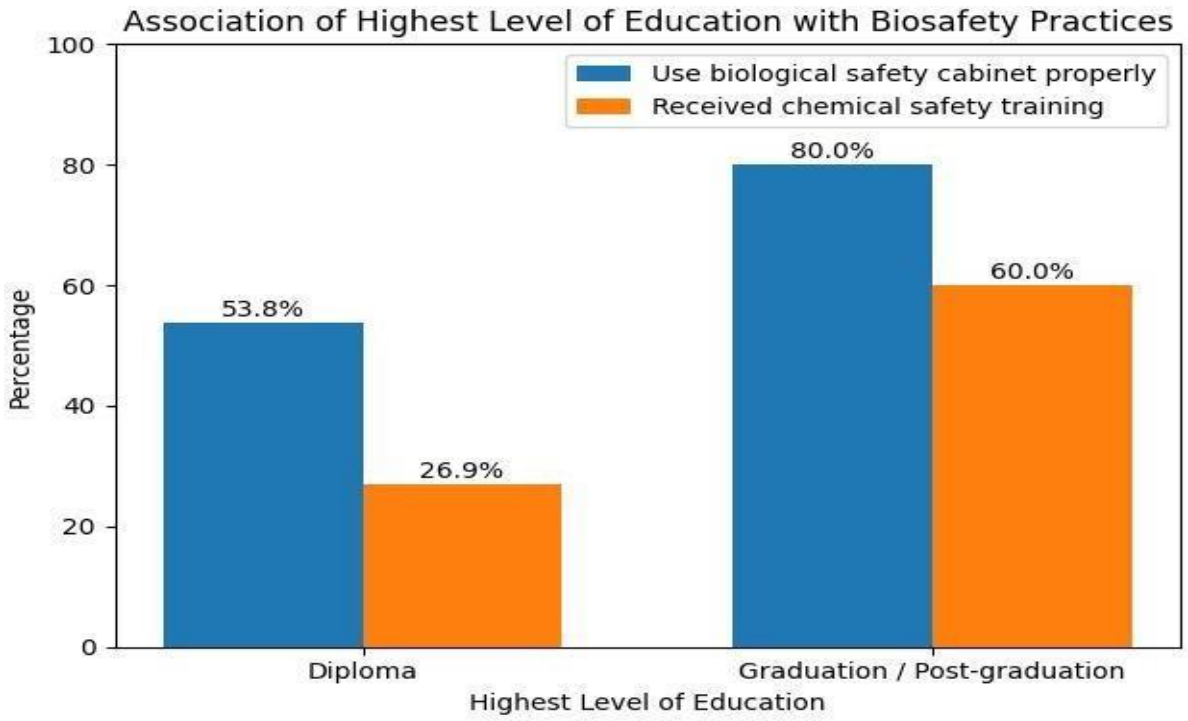

Table 4. Association of variables with Trained in Spill response.

Variable	Trained in Spill response		p value	Result
	Yes	No		
Demonstrates safe autoclave				
No	33	8	0.000*	Significant
Yes	4	21		
Understanding legal rights under OHS				
No	21	5	0.000*	Significant
Yes	16	24		
Reviewed OHS health risks /controls handbook				
No	34	14	0.001#	Significant
Yes	3	15		
Selects and dilutes disinfectants properly				

No	3	3	0.041#	Significant
Yes	34	26		
Fit tested for respirator				
No	25	29	0.000#	Significant
Yes	12	0		
Consistent PPE use				
No	6	15	0.002*	Significant
Yes	31	21		
Reviewed MSDS/SDS (material safety data sheet)				
No	31	29	0.005#	Significant
Yes	6	0		
Chemical safety training				
No	17	24	0.000*	Significant
Yes	20	5		

** Chi-square ,# Fisher exact test, p value <0.05 is Significant, significance at 95%CI*

Technicians who had received spill-response training differed markedly from untrained staff across multiple safety domains. Trained individuals were significantly more likely to demonstrate safe autoclave use ($p < 0.001$), understand their legal rights under OHS ($p < 0.001$), review the risks/controls handbook ($p = 0.001$), correctly prepare and dilute disinfectants ($p = 0.041$), consistently used PPE ($p = 0.002$), have reviewed MSDS/SDS documents ($p = 0.005$), and have undergone chemical safety training ($p < 0.001$). Fit-testing for respirators was also associated with spill-response training ($p < 0.001$).

DISCUSSION

Occupational health and safety (OHS) remains a critical concern for laboratory personnel due to continuous exposure to biological, chemical, and physical hazards.[1,13] The present study from Rajnandgaon district highlights both strengths and deficiencies in safety-related knowledge and practices among government laboratory technicians. While awareness of incident reporting procedures (95.5%) and emergency response plans (93.9%) was high, systematic engagement with regulatory provisions was inadequate, with only 27.3% of participants having accessed OHS regulations. Similar deficiencies in regulatory awareness have been documented in previous Indian studies.[7,14]

Consistent use of personal protective equipment (PPE) was reported by 68.2% of participants in the present study, which is comparable to findings from Bhubaneswar, Odisha, where approximately 67% of healthcare personnel demonstrated good safety practices.[14] However, chemical safety awareness was notably poor, with only 37.9% having received chemical safety training and merely 4.5% knowing the location of MSDS/SDS documents. These findings indicate substantial gaps in chemical hazard management, consistent with observations reported by Punia et al.
(13)

Role of Professional Experience

Professional experience significantly influenced safety awareness in this study. Technicians with more than five years of service were more likely to recognize ergonomic risks, know the location of emergency eyewash and shower facilities, and demonstrate awareness of available institutional support services. Similar trends have been reported in African and Asian healthcare settings, where experienced workers showed greater compliance with biosafety protocols [11,12].

Interestingly, less experienced staff in the present study demonstrated better safe autoclave practices. This finding suggests that recently trained technicians may retain technical skills more effectively due to exposure to updated training curricula .[2,15] This observation supports earlier evidence that continuous professional development is essential for maintaining technical competence (1,16).

Education and Safety Practices

Educational attainment was significantly associated with occupational safety practices in the present study. Technicians with graduate and postgraduate qualifications demonstrated stronger adherence to safety measures than diploma- qualified staff. Higher educational status was associated with correct use of biological safety cabinets and better participation in chemical safety training. This pattern is consistent with findings from Nepal, where graduate-level healthcare workers showed higher compliance with universal precautions compared to less qualified staff [15]. Similarly, a study from Pakistan reported that trained and educated personnel were more likely to use PPE consistently [16]. Higher education appears to enhance conceptual understanding of biosafety principles and improves the interpretation and application of written safety guidelines (10,11).

Effectiveness of Training

Training interventions, particularly spill-response training, were found to be highly effective in improving workplace safety behaviour. In the present study, trained technicians demonstrated significantly better PPE usage, disinfectant preparation, and engagement with OHS documentation. These findings are consistent with WHO recommendations, which emphasize structured, competency-based training as a key determinant of biosafety compliance [1,2]. Previous research has demonstrated that regular training programs can improve adherence to universal precautions by 25–30% across healthcare facilities [2,17]. Spill-response training has also been associated with increased awareness of legal rights, respirator fit-testing, and institutional safety policies (4,18). These results underscore the importance of continuous skill-based education in strengthening occupational safety practices.

Persistent Gaps in Regulatory Awareness

Despite positive outcomes related to training and experience, persistent gaps in regulatory awareness were observed. Only 4.5% of technicians in the present study knew the location of MSDS/SDS documents, indicating poor institutional dissemination of safety documentation. Similar deficiencies have been reported by Singh et al. [7], who noted that laboratory-acquired infections continue to occur due to inadequate documentation and reporting practices. Pike's landmark review documented more than 4,000 laboratory-associated infections worldwide between 1930 and 1978, with non-compliance to safety manuals identified as a major contributing factor [6]. In low-resource settings, healthcare workers often possess reasonable operational knowledge but limited engagement with formal regulatory frameworks [12,18]. This disconnect between practice and policy remains a significant barrier to achieving comprehensive occupational safety. Overall, the findings of the present study

suggest that occupational safety among laboratory technicians is shaped by a triad of education, professional experience, and structured training. While basic awareness of protective measures is generally adequate, reliance on informal learning alone is insufficient for ensuring long-term safety compliance. Strengthening periodic refresher training, ensuring institutional access to biosafety documentation, and reinforcing regulatory responsibilities are essential steps toward improving workplace safety. Establishing regular safety audits, monitoring mechanisms, and accountability frameworks at the facility level may further enhance adherence to occupational health standards and reduce long-term risks in public laboratory settings [1,2,19,20].

LIMITATION: This study has certain limitations. Its cross-sectional nature restricts causal interpretation, and reliance on self-reported practices may introduce reporting bias. Additionally, the study was confined to a single district, which may limit generalizability. Nevertheless, the results contribute meaningful insights into laboratory safety practices within public sector health facilities and support the need for targeted interventions.

CONCLUSION: The occupational safety practices among laboratory technicians are shaped by experience, educational background, and focused training exposure. Strengthening competency-based training programs and improving access to regulatory information are critical steps toward reducing occupational risk and ensuring a safer laboratory work environment.

RECOMMENDATIONS:

The findings of this study highlight the need for regular, competency-based occupational health and safety training for laboratory technicians, with focused emphasis on biosafety practices, chemical spill management, and safe handling of sharps. Continuous availability and proper use of personal protective equipment should be ensured at all laboratory workstations to reduce occupational exposure. Biosafety guidelines, standard operating procedures, and material safety data sheets must be easily accessible and actively integrated into routine laboratory work. Periodic safety audits and supportive supervision are recommended to strengthen adherence to universal work precautions and waste management protocols. Establishing clear mechanisms for reporting occupational exposures and ensuring timely post-exposure management are essential to protect laboratory personnel and improve overall laboratory safety.

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