Awareness and Compliance with Health and Safety Guidelines among University Students

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ABSTRACT

Health and safety practices in university laboratories are critical for ensuring student well-being and preparing future professionals for risk-sensitive environments. This study examines university students' levels of health and safety awareness, compliance with laboratory protocols, and perceptions of the safety climate, with the aim of understanding how these dimensions interact within an educational context. A quantitative, cross-sectional survey design was employed, involving 144 undergraduate students enrolled in laboratory-based programmes. Data were collected using a structured questionnaire and analysed using descriptive statistics, independent samples t-tests, and Pearson correlation analysis. The findings indicate that students demonstrate generally high levels of health and safety awareness (M = 4.08), compliance (M = 3.94), and positive perceptions of the safety climate (M = 4.04) . Gender comparisons revealed that female students scored slightly higher across all domains, with a statistically significant difference observed only in safety climate perception (p = 0.025). No significant differences were found between students from different academic entry pathways. Importantly, strong positive correlations were identified among awareness, compliance, and safety climate (r = 0.750–0.801), indicating that these constructs operate as an interconnected system rather than independent factors. This study contributes to the literature by proposing a conceptual framework that integrates cognitive (awareness), behavioural (compliance), and perceptual (safety climate) dimensions of safety practices. The findings suggest that effective safety management in university laboratories should adopt a holistic approach that combines knowledge development, behavioural reinforcement, and supportive environmental conditions. While the results highlight the effectiveness of current institutional practices, the relatively modest effect sizes indicate that continuous and multifaceted interventions are required to sustain improvements in safety behaviour. Overall, this study offers both theoretical and practical insights into the development of safety culture in higher education, providing a foundation for future research and policy enhancement in laboratory safety management.

Keywords: Health and Safety Awareness; Laboratory Safety Compliance; Safety Culture; Safety Climate; University Students

INTRODUCTION

In recent years, health and safety practices in academic institutions have become an essential focus, particularly in disciplines involving laboratory work. Educational settings, especially university laboratories, are often sites of hazardous activities involving chemicals, equipment, and complex procedures. Given the potential risks, both institutions and students share the responsibility of maintaining a safe learning

environment (Walters et al., 2017). While compliance with health and safety standards is typically enforced through institutional policies and safety protocols, the extent to which students are aware of and adhere to these guidelines remains a topic of concern (Olewski & Snakard, 2017). Awareness of health and safety rules encompasses students' understanding of risks, knowledge of personal protective equipment (PPE), and familiarity with emergency procedures. Research shows that students who possess higher safety awareness are more engaged in their lab activities, face fewer accidents, and develop confidence in managing laboratory environments (Abdullah & Aziz, 2020). However, significant variation exists in students' knowledge and practices related to safety, often influenced by factors such as prior training, individual attitudes, and institutional reinforcement (Wu et al., 2023). Such variations can lead to inconsistent compliance, which increases the risk of accidents and impedes the development of a robust safety culture within educational settings (Puteri & Nurcahyo, 2018). Health and safety awareness and compliance are critical in higher education as they lay the groundwork for students' transition into professional roles. In many industries, especially those involving laboratory and fieldwork, adherence to safety standards is not only a legal requirement but also a key competency. Therefore, understanding the determinants of safety awareness and compliance at the university level provides valuable insights for improving safety education and preparedness (Wiriyakraikul et al., 2022). Educational institutions that integrate comprehensive safety training into their curricula, including induction sessions, safety audits, and accessible safety materials, generally experience higher levels of compliance among students, indicating the effectiveness of proactive institutional measures (Walters et al., 2017). Previous research has explored various dimensions of health and safety awareness in university contexts. (Abdullah & Aziz, 2020) conducted a study assessing the effectiveness of safety training on students' laboratory behavior, finding that regular, hands-on training significantly improved students' use of safety protocols. (Abd Hamid et al., 2021) emphasized the role of instructors in modeling safe behaviors, demonstrating that students' compliance is often influenced by their instructors' attitudes toward safety. Similarly, (Ayi & Hon, 2018) argued that institutional support, including access to up-to-date safety documents and resources, is essential for fostering a positive safety climate. Despite these findings, there remains a gap in understanding how demographic factors, such as gender, academic level, and educational background, influence students' health and safety awareness and compliance behaviors. For example, students entering university through various academic pathways, such as matriculation or diploma programs, may have differing levels of exposure to safety practices, impacting their readiness to comply with safety regulations (Nor et al., 2020). Exploring these variations can provide a nuanced view of the factors influencing safety awareness and help universities tailor their safety programs to address diverse student needs.

Purpose of the Study

The purpose of this study is to assess university students' levels of awareness and compliance with health and safety guidelines, particularly in laboratory settings. It seeks to evaluate their understanding of safety rules, adherence to laboratory protocols, and how demographic factors such as gender, academic year, and intake type influence these behaviors. The study is guided by three research questions: (1) What is the general level of awareness regarding health and safety protocols among university students? (2) To what extent do students comply with established health and safety guidelines in laboratory settings? and (3) Are there significant differences in awareness and compliance levels across demographic factors? By answering these questions, the study aims to identify potential knowledge gaps and propose strategies for improving safety education within university contexts. The findings will provide evidence-based insights to help universities enhance their safety training programs, foster a culture of safety, and prepare students for professional environments that prioritize health and safety. Furthermore, the results will inform policy development within educational institutions, highlighting areas where safety practices can be strengthened to ensure student well-being and compliance with institutional regulations (Ibrahim et al., 2023)(Yilmaz, 2022).

LITERATURE REVEW

Health and safety awareness in educational institutions, particularly in laboratory settings, has become an increasingly critical area of research. University students, who may encounter various risks associated with laboratory work, need a strong foundation in health and safety to ensure both their well-being and academic success.

Health and Safety Awareness in Educational Settings

Awareness of health and safety guidelines among students is essential for reducing the frequency of laboratory incidents and for fostering a positive safety culture in educational institutions (Xing Gao, 2025). Health and safety awareness, often understood as knowledge of rules, regulations, and appropriate behavior in hazardous environments, is particularly relevant for students in science, engineering, and technology fields who work with potentially dangerous materials and equipment (Yilmaz, 2022). Studies have shown that students who possess a thorough understanding of safety protocols demonstrate lower anxiety and higher engagement in lab activities, as they feel better prepared to handle risks (Alhammadi et al., 2024). Furthermore, universities often play a crucial role in promoting this awareness through targeted programs and courses. For example, laboratory induction sessions and safety workshops have been found to significantly increase students' understanding of personal protective equipment (PPE) use and emergency procedures (Wu et al., 2023). Despite such efforts, many students still report gaps in their knowledge, especially when moving from theoretical training to practical applications. These knowledge gaps highlight the need for more immersive and frequent safety training that aligns with students' actual laboratory experiences (Wijewickrama et al., 2022).

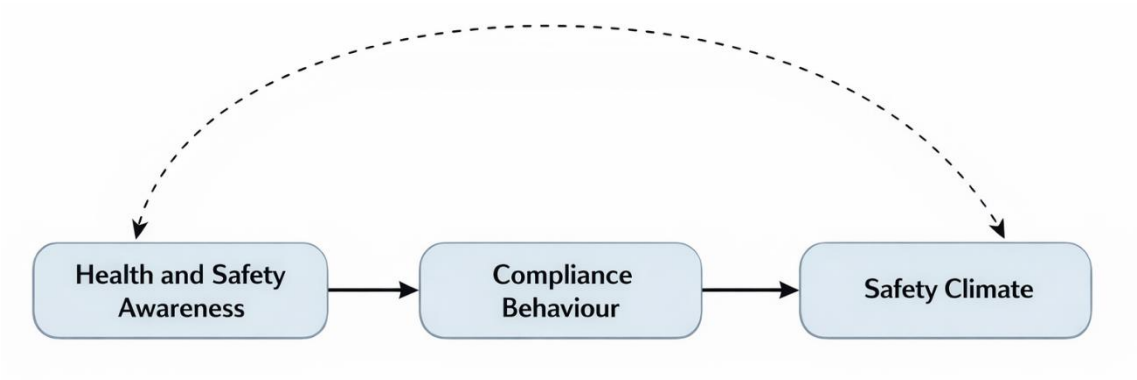
Compliance with Health and Safety Guidelines

Compliance with health and safety guidelines among students is often measured through their adherence to established protocols, such as the use of PPE, chemical handling procedures, and emergency response actions (Mugivhisa et al., 2021). Compliance behavior is a crucial indicator of students' respect for safety rules and their perception of risk. A study by (Ayi & Hon, 2018) suggests that compliance is largely influenced by students' perceived severity of laboratory hazards, as well as by the enforcement of safety measures by instructors. Their findings indicate that students are more likely to follow safety protocols when they recognize the potential dangers and when professors model safe behavior through consistent supervision and reinforcement of safety norms. Another key factor in compliance is the students' familiarity with equipment and safety documentation, such as Material Safety Data Sheets (MSDS) and chemical hygiene plans. (Wiriyakraikul et al., 2022) observed that students who are consistently exposed to safety documentation and are required to follow strict laboratory protocols tend to exhibit better compliance behaviors than those who have more relaxed laboratory guidelines. Moreover, (Shabani et al., 2024) noted that regular safety assessments and audits could enhance compliance by reminding students of the risks and the importance of safety measures.

Factors Influencing Health and Safety Behavior

Health and safety behavior among students is influenced by a range of factors, including prior experience, the educational background of students, and institutional support. For instance, students with prior exposure to laboratory environments, either through previous educational levels or work experience, often exhibit higher levels of both awareness and compliance with safety standards (Abdullah & Aziz, 2020). These findings are consistent with a study by (Ahsan et al., 2024), which found that students entering with a diploma were more likely to demonstrate familiarity with safety practices compared to those entering directly from secondary school or through matriculation. Another influential factor is the role of institutional support, which includes the provision of safety resources, consistent safety education, and reinforcement of safety protocols. (Olewski & Snakard, 2017) highlight that strong safety leadership from faculty members, such as proactive safety briefings and direct involvement in student training, positively affects students' attitudes toward safety. Universities that prioritize safety by allocating resources for safety personnel, safety manuals, and routine safety inspections tend to have students who are more compliant and vigilant about health and safety practices. In summary, both awareness and compliance with health and safety protocols are essential for a safe educational environment, particularly in laboratory settings. Awareness initiatives, including safety training and information dissemination, form the foundation of students' safety knowledge. However, awareness alone does not guarantee compliance; effective compliance often depends on practical experience, perceived risk, and the presence of safety-oriented faculty and institutional support. This study builds on these findings by assessing current levels of awareness and compliance among university students, with an emphasis on identifying areas where institutions can better support students in adhering to health and safety standards.

Proposed Conceptual Model



The proposed model positions health and safety awareness as the foundational construct that shapes students' understanding of risks and safety procedures. This awareness influences compliance behaviour, reflecting the extent to which students adhere to safety protocols in practice. In turn, consistent compliance contributes to a more positive safety climate perception, as students experience a safer and more structured laboratory environment. At the same time, safety climate may reinforce both awareness and compliance through institutional norms, supervision, and peer influence, creating a cyclical and self-reinforcing system. This model extends existing literature by integrating cognitive, behavioural, and perceptual dimensions into a single framework, offering a more comprehensive explanation of safety practices in educational settings.

METHODOLOGY

This study used a quantitative, cross-sectional survey to explore how well undergraduate students understand and follow health and safety practices in university laboratories. A total of 144 students from civil engineering programs, where lab work is a core component, were carefully selected through stratified random sampling to ensure a balanced mix of gender, academic year, and intake type. Data were gathered over four weeks using an online questionnaire designed to be accessible and convenient, while also maintaining anonymity to encourage honest responses. The questionnaire had four sections: demographic details, students' knowledge of health and safety rules, their actual safety practices such as using PPE and following procedures, and their views on how well the university supports safety. Likert scales were used to measure these areas, making it easier to analyze patterns and levels of awareness and compliance. The collected data were analyzed using SPSS software, with descriptive statistics to summarize trends, t-tests and ANOVAs to compare differences between groups, and Pearson's correlation to see how awareness relates to actual safety behavior. Ethical approval was obtained from the university's Institutional Review Board (IRB), and all participants were informed about the purpose of the study, their rights, and the confidentiality of their responses.

RESULTS

Descriptive Statistics

Table 1: Demographic

		Frequency	Percent
Gender	Male	69	47.9
	Female	75	52.1
	Total	144	100.0
Intake to the degree course	Matriculation	10	6.9
	Diploma	134	93.1
	Total	144	100.0

Table 1 presents the demographic distribution of the respondents in this study. Out of the total 144 participants, a slightly higher proportion were female students, accounting for 52.1% (n = 75), while male students represented 47.9% (n = 69). This indicates a relatively balanced gender distribution, with females making up just over half of the sample. In terms of intake type, the vast majority of respondents, 93.1% (n = 134), entered their degree program through a diploma pathway, whereas only 6.9% (n = 10) were from a matriculation background. This suggests that most of the students involved in the study had prior diploma-level education before progressing to their current degree program. These demographics provide context for interpreting the levels of awareness and compliance with health and safety guidelines, as differences in educational background could potentially influence students' understanding and practices.

Table 2: Reliability Analysis

Reliability Statistics	Cronbach's Alpha	N of Items
SECTION B (Health and Safety Awareness)	0.951	4
SECTION C (Laboratory Safety Items)	0.984	26
SECTION D (Individual Safety Climate)	0.957	15

Table 2 shows the results of the reliability analysis for Sections B, C, and D of the questionnaire. The Cronbach's Alpha values for all three sections are exceptionally high, indicating excellent internal consistency among the items. Section B, which measures Health and Safety Awareness, recorded a Cronbach's Alpha of 0.951 for its four items, demonstrating that the questions reliably assess this construct. Section C, focusing on Laboratory Safety Items, achieved the highest reliability score of 0.984 across 26 items, suggesting that the responses were very consistent and stable. Similarly, Section D, which examines Individual Safety Climate, had a Cronbach's Alpha of 0.957 for its 15 items, further confirming strong reliability. These results indicate that the questionnaire is a highly dependable tool for measuring students' awareness, compliance, and perceptions related to health and safety in laboratory settings.

Table 3: Awareness and Compliance Scores

Descriptive Statistics	N	Mean	Std. Deviation
SECTION B (Health and Safety Awareness)	144	4.08	0.72
SECTION C (Laboratory Safety Items)	144	3.94	0.64
SECTION D (Individual Safety Climate)	144	4.04	0.64
Valid N (listwise)	144		

Table 3 presents the descriptive statistics for the three main sections of the questionnaire: Health and Safety Awareness (Section B), Laboratory Safety Items (Section C), and Individual Safety Climate (Section D). The mean score for Section B was 4.08 (SD = 0.72), indicating that, on average, students demonstrated a high level of awareness regarding health and safety practices. Section C had a slightly lower mean score of 3.94 (SD = 0.64), suggesting that while students generally adhered to laboratory safety protocols, there is still room for improvement in certain areas. Section D recorded a mean score of 4.04 (SD = 0.64), showing that students perceive the safety climate in their laboratory environments positively. Overall, these findings highlight that students are generally well-informed and compliant with safety practices, though targeted interventions could help enhance specific aspects of laboratory safety management.

Comparative Analysis

Table 4: Group Statistics (Gender Differences: Independent Samples T-Test)

Score	Gender	N	Mean	Std. Deviation	Std. Error Mean	Cohen's d
AWARENESS ON HEALTH AND SAFETY ASPECTS	Male	69	3.97	0.752	0.091	0.38
	Female	75	4.18	0.683	0.079	

AWARENESS ON LABORATORY SAFETY ITEMS	Male	69	3.85	0.639	0.077	0.29
	Female	75	4.03	0.625	0.072	
PERCEPTION ON INDIVIDUAL SAFETY ITEMS	Male	69	3.92	0.640	0.077	0.28
	Female	75	4.16	0.623	0.072	

Table 5: Independent Samples Test analysis (Gender Differences)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
AWARENESS ON HEALTH AND SAFETY ASPECTS	Equal variances assumed	0.782	0.378	-1.750	142	0.082	-0.20928	0.11957	-0.44565	0.02709
	Equal variances not assumed			-1.743	137.514	0.084	-0.20928	0.12006	-0.44668	0.02813
AWARENESS ON LABORATORY SAFETY ITEMS	Equal variances assumed	0.829	0.364	-1.644	142	0.102	-0.17327	0.10537	-0.38157	0.03503
	Equal variances not assumed			-1.643	140.390	0.103	-0.17327	0.10547	-0.38179	0.03526
PERCEPTION ON INDIVIDUAL SAFETY ITEMS	Equal variances assumed	0.074	0.786	-2.266	142	0.025	-0.23865	0.10533	-0.44687	-0.03042
	Equal variances not assumed			-2.263	140.262	0.025	-0.23865	0.10545	-0.44713	-0.03016

Tables 4 and 5 present the results of the independent samples t-test comparing male and female students on three key areas: awareness of health and safety aspects, awareness of laboratory safety items, and perception of individual safety climate. The descriptive statistics in Table 4 show that female students scored slightly higher across all three areas, with mean scores of 4.18, 4.03, and 4.16, compared to males who scored 3.97, 3.85, and 3.92, respectively. However, as shown in Table 5, the t-test results indicate that only the perception of individual safety climate was significantly different between genders ($t(142) = -2.266$, $p = 0.025$), with females reporting a more positive perception than males. There were no statistically significant differences for awareness of health and safety aspects ($p = 0.082$) or awareness of laboratory safety items ($p = 0.102$). These findings suggest that while both male and female students generally demonstrate similar levels of awareness and compliance, females tend to perceive the overall safety climate more positively.

Although statistical significance was observed only for safety climate perception, effect size analysis provides further insight into the practical magnitude of these differences. The Cohen's d value for safety climate perception was approximately 0.38, indicating a small to moderate effect. In contrast, awareness ($d \approx 0.29$) and compliance ($d \approx 0.28$) demonstrated small effect sizes, suggesting that while female students scored higher, the differences are modest in practical terms. These findings highlight the importance of interpreting statistical significance alongside effect size to better understand real-world implications.

Table 6: Group Statistics (Intake from Differences: Independent Samples T-Test)

	Intake from	N	Mean	Std. Deviation	Std. Error Mean
AWARENESS ON HEALTH AND SAFETY ASPECTS	Matriculation	10	4.03	0.661	0.209
	Diploma	134	4.08	0.728	0.063
AWARENESS ON LABORATORY SAFETY ITEMS	Matriculation	10	3.91	0.593	0.187
	Diploma	134	3.95	0.641	0.055
PERCEPTION ON INDIVIDUAL SAFETY ITEMS	Matriculation	10	3.94	0.661	0.209
	Diploma	134	4.05	0.641	0.055

Table 7: Independent Samples Test (Intake from Differences)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
AWARENESS ON HEALTH AND SAFETY ASPECTS	Equal variances assumed	0.603	0.439	-0.233	142	0.816	-0.05522	0.23745	-0.52463	0.41418
	Equal variances not assumed			-0.253	10.700	0.805	-0.05522	0.21827	-0.53728	0.42683
AWARENESS ON LABORATORY SAFETY ITEMS	Equal variances assumed	0.374	0.542	-0.185	142	0.854	-0.03863	0.20901	-0.45181	0.37454
	Equal variances not assumed			-0.198	10.631	0.847	-0.03863	0.19547	-0.47070	0.39343
PERCEPTION ON INDIVIDUAL SAFETY ITEMS	Equal variances assumed	0.022	0.881	-0.517	142	0.606	-0.10876	0.21051	-0.52489	0.30738
	Equal variances not assumed			-0.503	10.303	0.626	-0.10876	0.21625	-0.58867	0.37116

Tables 6 and 7 present the results of the independent samples t-test comparing students from matriculation and diploma intakes across three key areas: awareness of health and safety aspects, awareness of laboratory safety items, and perception of individual safety climate. As shown in Table 6, the mean scores for both groups were very similar, with diploma students scoring slightly higher across all three areas. For example, diploma students had a mean score of 4.08 for health and safety awareness compared to 4.03 for matriculation students, while their scores for laboratory safety awareness were 3.95 and 3.91, respectively. Similarly, for perception of individual safety climate, diploma students scored 4.05 compared to 3.94 for matriculation students. Table 7 shows that these differences were not statistically significant, with *p*-values of 0.816, 0.854, and 0.606, respectively, all well above the 0.05 threshold. These results indicate that students' intake background whether matriculation or diploma does not significantly influence their levels of awareness, compliance, or perceptions regarding health and safety in laboratory settings.

Correlation Analysis

Table 8: Correlations analysis

		AWARENESS ON HEALTH AND SAFETY ASPECTS	AWARENESS ON LABORATORY SAFETY ITEMS	PERCEPTION ON INDIVIDUAL SAFETY ITEMS
AWARENESS ON HEALTH AND SAFETY ASPECTS	Pearson Correlation	1	.791**	.750**
	Sig. (2-tailed)		0.000	0.000
	N	144	144	144
AWARENESS ON LABORATORY SAFETY ITEMS	Pearson Correlation	.791**	1	.801**
	Sig. (2-tailed)	0.000		0.000
	N	144	144	144
PERCEPTION ON INDIVIDUAL SAFETY ITEMS	Pearson Correlation	.750**	.801**	1
	Sig. (2-tailed)	0.000	0.000	
	N	144	144	144
**. Correlation is significant at the 0.01 level (2-tailed).				

Table 8 presents the correlation analysis between awareness of health and safety aspects, awareness of laboratory safety items, and perception of individual safety climate. The results indicate strong, positive, and statistically significant relationships among all three variables ($p < 0.01$). Specifically, there is a high correlation between awareness of health and safety aspects and awareness of laboratory safety items (r = 0.791), suggesting that students who have greater general health and safety awareness also tend to be more knowledgeable about laboratory-specific safety practices. Similarly, awareness of health and safety aspects is strongly correlated with perceptions of individual safety climate (r = 0.750), indicating that increased awareness is associated with a more positive view of the safety culture. The strongest correlation is observed between awareness of laboratory safety items and perception of individual safety climate (r = 0.801), highlighting that students who are more familiar with laboratory safety protocols also tend to perceive their lab environment as safer and more supportive. These findings suggest that improving students' laboratory safety knowledge could enhance both their overall safety awareness and their perceptions of a positive safety culture.

SUMMARY

The study involved a total of 144 students, with a fairly balanced gender distribution of 52.1% female and 47.9% male, and most students entering their degree program through a diploma pathway (93.1%) compared to matriculation (6.9%). The reliability analysis showed excellent internal consistency for all sections of the questionnaire, with Cronbach's Alpha values of 0.951 for Health and Safety Awareness, 0.984 for Laboratory Safety Items, and 0.957 for Individual Safety Climate. The descriptive results revealed high average scores across all three areas, with means of 4.08 for Health and Safety Awareness, 3.94 for Laboratory Safety Items, and 4.04 for Individual Safety Climate. Gender comparisons indicated that female students scored slightly higher than males, but only the perception of individual safety climate showed a significant difference ($p = 0.025$). When comparing intake types, no significant differences were found between matriculation and diploma students in any of the three areas. Lastly, the correlation analysis revealed strong, positive, and significant relationships between all three areas, with the strongest link observed between laboratory safety awareness and individual safety climate (r = 0.801, $p < 0.01$), indicating that higher scores in one area tended to be associated with higher scores in the others.

DISCUSSION

The findings of this study indicate that university students generally reported high levels of health and safety

awareness, compliance with laboratory safety practices, and positive perceptions of the individual safety climate. These results suggest that the students were not merely exposed to safety information, but were also able to translate that knowledge into relatively consistent laboratory behaviour. In academic laboratories, this pattern is important because safety is not sustained by rules alone; it depends on whether students internalise expectations and reproduce them in practice. The present findings therefore point to a reasonably supportive safety environment in which awareness, behaviour, and perception appear to reinforce one another. This interpretation is consistent with work showing that safety culture and safety compliance in academic laboratories are closely related, and that institutional safety conditions can shape how safety is understood and enacted by laboratory users (Ayi & Hon, 2018).

Although the descriptive scores were high, the slightly lower mean for laboratory safety compliance compared with awareness deserves attention. This gap is analytically important because it suggests that knowing safety rules does not automatically guarantee full behavioural adherence. In other words, awareness appears necessary but not sufficient. Students may understand the importance of personal protective equipment, emergency procedures, and laboratory protocols, yet still vary in the consistency with which they apply them during actual lab work. Prior research in university laboratory settings has similarly shown that safety knowledge and safety practice, while positively related, do not always move in perfect alignment because behaviour is also shaped by supervision, convenience, habit, and the immediate laboratory environment. This means the present findings should not be read simply as evidence that safety education has "worked," but rather as an indication that the university has established a promising base that still requires reinforcement at the behavioural level (Ayi & Hon, 2018)(Wang et al., 2023)(Wu et al., 2023).

The gender analysis also warrants closer interpretation. Female students scored slightly higher than male students across all three domains, but only the difference in perception of individual safety climate reached statistical significance. This pattern is meaningful because it suggests that the gender distinction in this study lies less in basic knowledge or reported compliance and more in how the safety environment is experienced and evaluated. One possible explanation is that female students may be more attentive to contextual safety cues, supervision quality, or the overall atmosphere of care and order within the laboratory. This interpretation is broadly in line with studies reporting that female students often demonstrate stronger safety perception and awareness or more cautious orientations in safety-related contexts. At the same time, the absence of significant gender differences in awareness and compliance should prevent overstatement. The results do not indicate a fundamentally different safety culture between male and female students; rather, they point to a modest perceptual difference that may reflect variations in risk sensitivity, attentiveness, or interpretation of laboratory conditions (Ahsan et al., 2024)(Salazar-Escoboza et al., 2020).

The absence of significant differences between matriculation and diploma students is another noteworthy finding. On the surface, this may suggest that prior academic pathway does not substantially influence students' safety awareness, compliance, or safety perception. More critically, however, the finding may indicate that the university's safety practices are sufficiently standardised to reduce initial differences in background. If students from different entry routes converge toward similar safety outcomes, this implies that institutional induction, laboratory briefing practices, and ongoing exposure to safety procedures may be functioning as equalising mechanisms. Rather than treating the non-significant result as merely "no difference," it can be interpreted as indirect evidence that safety learning in the university context is being normalised across student groups. This is important because effective safety systems should not depend too heavily on what students already know before entering the programme; they should build consistent expectations once students are in the laboratory environment (Ayi & Hon, 2018)(Wu et al., 2023).

The correlation findings provide some of the strongest analytical value in this study. The significant positive relationships among health and safety awareness, laboratory safety compliance, and individual safety climate suggest that these constructs should not be discussed as isolated variables. Instead, they appear to form an interconnected system in which gains in one domain are associated with gains in the others. The strongest relationship between laboratory safety items and safety climate perception is particularly revealing. It suggests that students who are more engaged with practical safety procedures also tend to perceive their laboratory environment as safer and more supportive. This may reflect a reciprocal process: a positive safety climate

encourages better compliance, while repeated compliance behaviours reinforce students' confidence in the safety culture around them. Research on academic laboratory environments similarly shows that institutional commitment, management attitudes, and safety climate are closely linked to safety-related behaviour and risk perception. Thus, the present results strengthen the argument that universities should not focus narrowly on awareness campaigns alone; they should cultivate an integrated safety culture in which information, practice, and environment mutually reinforce one another.

Taken together, the findings carry important implications for health and safety education in higher education. First, the generally high scores across the three domains indicate that current safety initiatives are producing positive outcomes, but the small gap between awareness and compliance suggests that training should move beyond information delivery toward repeated application, monitoring, and reinforcement. Second, the gender pattern indicates that perception of safety climate may vary even when awareness and compliance remain broadly similar, which means universities should pay attention not only to safety instruction but also to how students experience the safety environment. Third, the lack of intake-based differences implies that structured institutional practices may be more influential than prior educational background, further underscoring the central role of the university in shaping safety norms. Overall, the study contributes to the literature by showing that in a university laboratory context, awareness, compliance, and safety climate are closely connected and should be addressed through a holistic rather than fragmented safety strategy.

Limitations of the Study

This study should be interpreted in light of several limitations. First, the sample was drawn from a single university context, which may limit the generalisability of the findings to other institutions or disciplines. Although the sample size was adequate for statistical analysis, the dominance of diploma-entry students may also influence the overall representation. Second, the study relied on self-reported data, which may be subject to social desirability bias, where respondents tend to report behaviours that are perceived as acceptable rather than their actual practices. This may result in slightly inflated levels of awareness and compliance. Third, the cross-sectional design restricts the ability to establish causal relationships between variables. While strong correlations were identified, these relationships should be interpreted as associative rather than causal. Finally, although statistical significance was reported, the study did not include effect size measures, which would provide a clearer indication of the practical importance of the findings. Future studies should incorporate such measures to enhance the interpretability of results.

Future Research Directions

Future research should consider adopting a longitudinal design to examine how students' safety awareness and compliance evolve over time, particularly as they gain more laboratory experience. Such an approach would provide deeper insights into the development of safety behaviour rather than relying on a single time-point assessment. Additionally, expanding the study to include multiple institutions and diverse academic disciplines would enhance the generalisability of the findings and allow for meaningful comparisons across different educational contexts. A mixed-method approach could also be employed to complement quantitative findings with qualitative insights. Interviews or focus groups may help uncover underlying motivations, attitudes, and contextual factors that influence safety behaviour, which are not easily captured through survey instruments. Finally, future studies could test and validate the proposed conceptual model using advanced statistical techniques such as Structural Equation Modeling (SEM). This would allow for a more rigorous examination of direct and indirect relationships between awareness, compliance, and safety climate, thereby strengthening both theoretical and practical contributions.

CONCLUSION

This study examined university students' awareness, compliance, and perceptions of health and safety practices within laboratory environments, offering both empirical insights and theoretical implications for understanding safety behaviour in higher education. The findings demonstrate that students generally possess high levels of safety awareness and exhibit consistent compliance with laboratory protocols, accompanied by a positive perception of the safety climate . However, the contribution of this study lies not merely in confirming

these patterns, but in revealing the structured interrelationship among these constructs. The strong correlations observed between awareness, compliance, and safety climate indicate that these elements function as an integrated system rather than independent factors. Awareness appears to serve as the cognitive foundation for safe behaviour, while compliance reflects its behavioural manifestation, and safety climate represents the contextual environment that sustains and reinforces these practices. This interconnected dynamic supports the argument that safety in educational settings is best understood through a holistic framework rather than isolated variables, aligning with broader perspectives on safety culture in academic laboratories (Ayi & Hon, 2018; Salazar-Escoboza et al., 2020).

From a theoretical standpoint, this study contributes by proposing a conceptual model that integrates cognitive (awareness), behavioural (compliance), and perceptual (safety climate) dimensions into a unified explanatory structure. This model extends existing literature by highlighting the reciprocal and reinforcing nature of safety-related constructs, offering a more nuanced understanding of how safety behaviour is developed and maintained among students. In practical terms, the findings emphasise the importance of sustained institutional efforts in fostering a strong safety culture. The absence of significant differences across educational backgrounds suggests that structured safety training, consistent laboratory practices, and institutional reinforcement play a critical role in standardising safety outcomes among students. At the same time, the presence of only small to moderate effect sizes indicates that improvements in safety behaviour may require continuous, multi-layered interventions rather than isolated initiatives. Overall, this study provides a meaningful contribution by moving beyond descriptive assessment toward a more integrated interpretation of safety behaviour in university laboratories. The proposed framework and empirical findings offer a foundation for future research and institutional policy development aimed at enhancing safety awareness, strengthening compliance, and cultivating a resilient safety culture in higher education environments.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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