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Original Research

High Compliance Rates and the Roles of Gender in Hand Hygiene Practices Among Medical Laboratory Technologists at USM Health Campus

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ABSTRACT

Background: Effective hand hygiene is crucial to prevent laboratory-acquired infections (LAIs), yet research on MLTs' practices remains limited. The study examines hand hygiene compliance and adherence factors among Medical Laboratory Technologists (MLTs) at Universiti Sains Malaysia (USM) Health Campus. **Methods:** A cross-sectional study involved 125 MLTs, utilising self-administered questionnaires to assess sociodemographic characteristics, knowledge, attitudes, practices (KAP), and access to hand hygiene tools. Descriptive and inferential statistical analyses were performed to identify key compliance predictors. **Results:** The findings revealed a high compliance rate of 97.6%, with 94.4% of participants reporting good access to hand hygiene resources. Female MLTs demonstrated significantly higher adherence to hand hygiene protocols as compared to their male counterparts (Adj β= 0.222, 95% CI: 0.040, 0.404), while other factors such as age, education, and training did not significantly affect compliance ($p>0.05$). **Conclusion:** Despite high KAP scores, these variables did not predict adherence, highlighting the complex interplay of behavioural and systemic factors in hand hygiene practices. Future studies should explore innovative approaches, including direct observational methods, gender-specific initiatives, and organisational strategies to enhance hand hygiene practices further. These efforts are essential to strengthen infection control measures, promote laboratory safety, and improve outcomes for healthcare workers and patients.

Keywords: Hand hygiene compliance; laboratory-acquired infections; Infection control; KAP

1. INTRODUCTION

Hand hygiene is a fundamental practice for preventing the transmission of infectious agents in healthcare and laboratory environments. Medical Laboratory Technologists (MLTs) are vulnerable to laboratory-acquired infections (LAIs) due to frequent exposure to biological, chemical, and physical hazards during diagnostic and research procedures. Therefore, effective hand hygiene practices serve as a barrier against cross-contamination and the spread of healthcare-associated infections (HAIs), as well as ensuring laboratory personnel's and patients' safety.(1) Despite the

global emphasis on hand hygiene compliance among various healthcare workers, however study among MLTs, is still lacking. Several factors were identified to influence compliance, including knowledge, attitudes, accessibility to hygiene tools, and workplace culture. Studies have shown that while healthcare workers know and know hand hygiene protocols, barriers such as lack of resources, time constraints, and insufficient training often hinder proper adherence.[2,3] Furthermore, sociodemographic variables, such as gender and age, have been found to influence hand hygiene behaviours.[4,5]

The COVID-19 pandemic highlighted the need for strict infection control practices, including hand hygiene in laboratory settings. A cross-sectional study in 12 Asian countries in 2021 showed that Southeast Asian participants demonstrated higher compliance with physical distancing measures than those from East Asia. (6) Factors contributing to increased compliance included prior safe distancing practices, pre-pandemic mask-wearing habits, reliance on online news sources, and strong psychological well-being. Although the study did not report a 25% increase in compliance rates, it emphasised the positive influence of heightened awareness and the implementation of preventive measures during the early phase of the pandemic. MLTs are at risk of increased infectious materials, thus emphasising their need to adhere to effective hand hygiene compliance. Hence, specific interventions are needed to address the barriers MLTs face due to compliance rates across laboratory settings and regions. (6). In Malaysia, research mainly has focused on nurses and physicians, leaving a gap in understanding the practices of MLTs. Given their roles in diagnostics and research laboratories, examining the factors influencing their adherence to hand hygiene protocols is essential. Therefore, understanding the knowledge, attitudes, and practices (KAP) related to hand hygiene among MLTs can provide valuable insights for improving compliance and reducing infection risks in this occupational group. (7,8).

Knowledge, Attitude, and Practice (KAP) are critical factors influencing hand hygiene adherence among healthcare workers, and their role has been extensively studied across various settings. A survey in a Nigerian tertiary hospital found that 98.95% of healthcare workers had good hand hygiene knowledge. However, only 44.65% practised it before and 56.2% after patient contact, highlighting a gap between knowledge and practice. (9) Similarly, Ekwere and Okafor (10) stated that non-compliance was influenced by factors like lack of resources, forgetfulness, and time constraints, suggesting that workplace culture and systemic factors significantly impact adherence to hand hygiene protocols across healthcare settings.

The primary objective of this study is to evaluate hand hygiene compliance among medical laboratory technologists (MLTs) at a university campus, encompassing research laboratories and a hospital, while identifying the key factors influencing adherence. Specifically, the research aims to assess the knowledge, attitudes and practices (KAP) of MLTs related to hand hygiene, investigate the role of sociodemographic factors, such as gender, in shaping compliance rates, and explore how resource availability impacts adherence to hand hygiene protocols. The findings are expected to contribute to safer laboratory environments and promote sustainable hygiene practices among healthcare professionals, ultimately improving laboratory safety and benefiting healthcare workers and patients.

2. METHODS

2.1 Research Design

The study employed a cross-sectional design between January and June 2023 to assess hand hygiene compliance among Medical Laboratory Technologists. The targeted population of MLTs comprised various divisions, including the School of Medical Sciences (SMS), School of Health Sciences (SHS), School of Dental Sciences (SDS), and USM Hospital (HUSM). This study examined two types of study variables; the dependent variable was hand hygiene compliance, while the independent variables included sociodemographic factors, Knowledge, Attitude, and Practice (KAP) scores, and accessibility to hand hygiene tools.

The inclusion and exclusion criteria were clearly defined to ensure appropriate participant selection. The inclusion criteria were those between 20 and 60 and those with at least one year of work experience. Those who were not actively involved in laboratory work were excluded as subjects. Additionally, those who had participated in the pilot study also were excluded to avoid bias and ensure the reliability of the main study's findings.

2.2 Sample Size

The sample size for this study was determined using G*Power software, with an alpha level of 0.05, a desired power of 0.80, an effect size of 0.15 and 11 predictors. This calculation indicated that a minimum of 123 participants was necessary to achieve sufficient power for the study. A 20% increase was applied to account for potential dropouts, resulting in a total required sample size of 148 participants. A stratified random sampling method was employed to ensure representation across the divisions at Universiti Sains Malaysia (USM) Health Campus, which included the School of Health Sciences (SHS), School of Medical Sciences, (SMS) School of Dental Sciences (SDS), and USM Hospital (HUSM). The sampling unit for each division was calculated using the Sampling Fraction formula, which was equal to the total sample size divided by the total population size multiplied by the number of MLTs in each division.

2.3 Questionnaire

The questionnaire was the main instrument adapted from previous studies (3,11), and some modifications were made to meet the study objectives. The questionnaire comprised six sections: sociodemographic data, knowledge, attitude, practices, hand hygiene compliance, and accessibility to hand hygiene tools. It was distributed via department representatives, and respondents were given one week to complete it, with additional time provided if needed. The scoring system evaluated various aspects of hand hygiene compliance, knowledge, attitude, practices (KAP), and accessibility to hand hygiene tools among Medical Laboratory Technologists (MLTs). The scoring criteria were adapted and modified to align with the study's objectives.

The knowledge section consisted of 9 questions with three response options: 'Yes,' 'No,' and 'Not Sure.' Correct answers were awarded 1 point, while incorrect or unsure answers received 0 points. The total score ranged from 0 to 9, with scores categorised as good knowledge (80–100%; 7–9 points), moderate knowledge (50–79%; 4–6 points), and poor knowledge (<50%; 0–3 points). The attitude section included 10 Likert-scale questions, with responses ranging from 'Strongly Disagree' (0 points) to 'Strongly Agree' (4 points). The total score ranged from 0 to 40 points, categorised as good attitude (80–100%; 32–40 points), moderate attitude (50–79%; 20–31 points), and poor attitude (<50%; 0–19 points). The practice section contained 9 Likert-scale questions, categorising responses into positive and negative statements. Positive responses were scored from 0 (Never) to 4 (Always), while negative responses were reverse scored from 4 (Never) to 0 (Always). The total score ranged from 0 to 36, categorised as good practice (80–100%; 25–36 points), moderate practice (50–79%; 13–24 points), and poor practice (<50%; 0–12 points).

Five binary-response questions assessed compliance for hand hygiene compliance, with 'Yes' responses scoring 1 and 'No' responses as 0. The total score ranged from 0 to 5, categorised as good compliance (80–100%; 4–5 points), moderate compliance (50–79%; 2–3 points), and poor compliance (<50%; 0–1 points). For accessibility to hand hygiene tools: This section consisted of 8 questions, with responses scored 1 for correct answers and 0 for incorrect or unsure answers. The total score ranged from 0 to 8, categorised as good accessibility (80–100%; 6–8 points), moderate accessibility (50–79%; 3–5 points), and poor accessibility (<50%; 0–2 points).

A pilot test was conducted among 15 Medical Laboratory Technologists (MLTs) from the Pathology Laboratory at the School of Medical Sciences USM to ensure reliability and validity. The reliability of the questionnaire was assessed using Cronbach's Alpha, which yielded an overall score of 0.889, indicating good internal consistency. The questionnaire was reliable for evaluating hand hygiene compliance, knowledge, attitude, practices (KAP), and accessibility to hand hygiene tools among the study population. Some adjustments were made based on feedback from the pilot test to refine the questionnaire before its final version.

2.4 Data Collection

A self-administered questionnaire was used as the primary tool for data collection. The questionnaire, participant information sheet, and consent form were distributed to Medical Laboratory Technologists (MLTs) through designated representatives in each department. The list of MLTs, including their names, emails, and departmental affiliations, was obtained from the USM Administration Office to facilitate distribution. Participants were given a week to complete the questionnaire, with instructions and guidelines in the questionnaire set. A week was granted for departments unable to complete the questionnaire within the initial

timeframe due to work schedules or public holidays. The department representatives collected completed questionnaires and consent forms and handed them to the researcher for analysis.

The questionnaire required approximately 15 to 25 minutes to complete and covered topics such as sociodemographic data, hand hygiene knowledge, attitudes, practices, compliance, and accessibility to hand hygiene tools. All participants were informed about the study objectives, confidentiality measures, and their right to withdraw at any time without consequences. No honorarium was provided for participation, and the collected data were securely stored for further analysis.

2.4 Data Analysis

Data analysis was performed using IBM SPSS Version 27. Descriptive statistics were used to summarise hand hygiene compliance scores, resource accessibility scores, and KAP scores. Multiple linear regression was used to determine the associations between hand hygiene compliance and its influencing factors.

2.5 Ethical Clearance

The study received ethical approval from the Human Research Ethics Committee (HREC) of Universiti Sains Malaysia (USM) under protocol code USM/JEPeM/23010012, dated April 5, 2023. Before data collection, all participants were informed about the study's objectives, procedures, potential benefits, and risks through an information sheet. Information consent was obtained from all participants, ensuring voluntary participation. Participants were assured of confidentiality and anonymity, with all data stored securely and accessible only to the research team. The study adhered to the ethical principles outlined in the Declaration of Helsinki, ensuring the protection of participants' rights and well-being throughout the research process.

3. RESULTS

3.1 Sociodemographic Background

Only 125 MLTs were participated, with an overall response rate of 84.5%. Most (78.4%) were female, while 21.6% were male. The mean age of participants was 37.4 ± 5.66 years, and the mean duration of employment was 13.1 ± 5.92 years. Most participants were Malay (97.6%), followed by Chinese (0.8%) and Iban (1.6%). Half of them (50.4%) were degree holders, while 49.6% were diploma holders. Most of them were from the School of Medical Sciences (SMS) (72%), with the remainder from the School of Health Sciences (SHS) (14.4%), Hospital USM Hospital (HUSM) (10.4%), and the School of Dental Sciences (SDS) (3.2%). Regarding infection control training, 56% of participants received training at their workplace, 42.4% during their education, and 1.6% reported no training.

3.2 Hand Hygiene Compliance Score

Table 1 shows that hand hygiene compliance score was assessed using a structured scoring system based on self-reported practices. The compliance scores were calculated from responses to questions on hand hygiene practices across different scenarios, including before and after patient or specimen contact, after potential contamination, and when accessing clean or sterile supplies. The total compliance score ranged from 0 to 5, with higher scores indicating better compliance.

Table 1. Score percentage of hand hygiene compliance among respondents

Level	Range	Mean ± SD	Percentage score
Good	4 -5	4.94 ± 0.234	97.6
Moderate	2-3	3.00 ± 0.000	2.4
Low	0-1	0	0

Table 2 shows hand hygiene compliance among laboratory workers. Most respondents demonstrated high compliance with hand hygiene practices. All respondents reported performing hand hygiene after exposure to body fluids or specimens, after handling contaminated materials such as sharps or PPE, and after their hands were visibly soiled. Similarly, all respondents reported adhering to hand hygiene practices before leaving the laboratory. In scenarios requiring proactive measures, compliance was slightly lower. For instance, 96.8% reported performing hand hygiene before accessing clean or sterile supplies, such as gloves and sterile containers. The lowest compliance rate was observed in hand hygiene practice before entering clean areas or touching clean surfaces, with 92.8% reporting adherence. These results reflect generally high compliance rates among respondents, with some variability depending on the specific context of hand hygiene practices. This scoring system provides

Table 2. Hand hygiene compliance among respondents

No.	Domain	Response	N (%)
1.	I do hand hygiene before entering a clean area and touching a clean surface	No	9 (7.2)
		Yes	116 (92.8)
2.	I do hand hygiene before accessing clean and sterile supplies, including personal protective equipment (PPE) (e.g., gloves, collection supplies, sample containers, and sterile blood products)	No	4 (3.2)
		Yes	121 (96.8)
3.	I do hand hygiene after body fluid/specimen exposure risk (e.g. after handling specimens like urine, after removing PPE like gloves, after disposing of contaminated sharps)	No	0 (0)
		Yes	125 (100)
4.	I do hand hygiene after my hands are visibly soiled/contaminated	No	0 (0)
		Yes	125 (125)
5.	I do hand hygiene before leaving the laboratory	No	0
		Yes	125 (125)

valuable insights into areas requiring targeted interventions to improve hand hygiene.

3.3 Accessibility to Hand Hygiene Tools

Table 3 shows the score percentage for hand hygiene tools among respondents. A majority (94.4%) agreed that their workplace had good accessibility to hand hygiene tools, with a mean score of 7.56 ± 0.648. All tools were reported to be accessible, except for disposable hand towels; only 78.4% agreed they were available and accessible at their workplace. Notably, the availability of alcohol-based hand rubs (85.6%) and hand hygiene posters demonstrating proper handwashing techniques (87.2%) may contribute to good hand hygiene compliance. Table 4 shows the accessibility of hand hygiene resources among respondents as follows: gloves (98.4%), handwashing basins in each laboratory room (96.8%), easy access to handwash basins (96.0%), hand soap (95.2%), and functional soap dispensers (92.8%).

Table 3. Score percentage of hand hygiene tools

Level	Range	Mean ± SD	Percentage Score
Good	6 - 8	7.56 ± 0.648	94.4
Moderate	3 - 5	4.00 ± 1.000	4.0
Low	0 - 2	1.00 ± 0.000	1.6

Table 4. Accessibility to hand hygiene tools among respondents

Domain	Response	N (%)
Hand soap is available and accessible	No	6 (4.8)
	Yes	119 (95.2)
There is easy access to the hand wash basin	No	5 (4.0)
	Yes	120 (96.0)
Soap dispenser available and functional	No	9 (7.2)
	Yes	116 (92.8)
Disposable hand towels are available and accessible	No	27 (21.6)
	Yes	98 (78.4)
There are hand hygiene posters that demonstrate good handwashing techniques	No	16 (12.8)
	Yes	109 (87.2)
There are adequate and accessible gloves in my working place	No	2 (1.6)
	Yes	123 (98.4)
Alcohol hand rubs are available and functional	No	18 (14.4)
	Yes	107 (85.6)
There are handwashing basins in each laboratory room	No	4(3.2)
	Yes	121 (96.8)

3.4 Associated Factors towards Hand Hygiene Score

Table 6 shows that only gender was a significant predictor of hand hygiene compliance scores among the studied population (Adj β = 0.222, p < 0.05), with a positive association when controlling other confounding factors. Other factors such as age, race, educational level, department, duration of employment, training on infection control, KAP Score on hand hygiene and accessibility to hand hygiene tool score are insignificant (p>0.05).

Table 6: Factors associated with hand hygiene compliance score among MLTs

Factor	SLR[a]		MLR[b]		
	β (95% CI)	p-value	Adj β (95% CI)	t-statistics	p-value
	Hand hygiene compliance score (R^2 = 0.137)				
Constant	5.294 (4.133, 6.454)				
Gender					
Female	0.198(0.039, 0.357)	0.015*	0.222 (0.040, 0.404)	2.418	0.017*
Male	Reference				
Age	-0.012 (-0.024, -0.0001)	0.047*	-0.009 (-0.029, 0.012)	-0.840	0.403
Race					
Malay	-0.107 (-0.643, 0.430)	0.695	-0.084 (-0.628, 0.460)	-0.305	0.761
Chinese	0.105 (-0.648, 0.857)	0.783	0.242 (-0.703, 1.188)	0.508	0.613
Others	Reference				
Educational level					
Degree	-0.018 (-0.152, 0.116)	0.795	-0.009 (-0.159, 0.141)	-0.122	0.903
Diploma	Reference				
Department					
HUSM	-0.231 (-0.658, 0.197)	0.287	-0.067 (-0.521, 0.387)	-0.293	0.770
SHS	-0.167 (-0.580, 0.247)	0.476	0.013 (-0.443, 0.469)	0.057	0.955
SMS	-0.078 (-0.460, 0.304)	0.688	0.021 (-0.382, 0.425)	0.104	0.917
SDS	Reference				
Employment (year)	-0.007 (-0.019, 0.004)	0.205	-0.001 (-0.021, 0.018)	-0.137	0.891
Training on infection control					
During education	-0.132 (-0.673, 0.409)	0.603	-0.382 (-0.986, 0.222)	-1.252	0.213
At workplace	-	-	-	-	-
No training (reference)	-0.086 (-0.624, 0.453)	0.753	-0.305 (-0.897, 0.287)	-1.022	0.309
Knowledge score	0.024 (-0.045, 0.094)	0.490	0.040 (-0.048, 0.127)	0.896	0.372
Attitude score	0.009 (-0.007, 0.026)	0.245	0.009 (-0.010, 0.028)	0.927	0.356
Practice score	0.001 (-0.013, 0.016)	0.836	0.000 (-0.017, 0.017)	0.037	0.970
Accessibility to hand hygiene tools score	-0.031 (-0.084, 0.023)	0.261	-0.062 (-0.135, 0.011)	-1.681	0.096

HUSM: USM Hospital; SDS: School of Dental Sciences; SHS: School of Health Sciences; SMS: School of Medical Sciences;
[a]Simple Linear Regression;
[b]Multiple Linear Regression;
*Significant at p<0.05

4. DISCUSSION

This study reported a high hand hygiene compliance rate of 97.6%, significantly higher than findings from other studies in different regions. For instance, a study in Ethiopia reported compliance rates as low as 14.9% in Central Gondar Zone public primary hospitals and 9% at the Wachemo University Hospital.[3,12] Furthermore, a systematic review and meta-analysis of Ethiopian healthcare workers found a compliance rate of 38% with wide regional variations,[13] with Addis Ababa City health workers demonstrating the highest compliance (73%) while the Southern Nations Nationalities, and Peoples' (SNNP) regional state having the lowest at 9%. Another study focusing on primary hospitals in the Waghimira Zone, Northeast

Ethiopia, found low hand hygiene compliance among healthcare providers.[14] These variations could be due to sociodemographic factors, workplace environments, resource availability and the level of hand hygiene promotion. Factors such as training, accessibility to soap and alcohol-based rubs and a positive attitude towards hand hygiene have been associated with higher compliance. These findings suggest that enhancing hand hygiene compliance among healthcare workers requires addressing resource availability and educational components. Implementing comprehensive training programs, ensuring the consistent availability of hand hygiene supplies, and cultivating positive attitudes toward hand hygiene practices are essential to improve compliance rates and reduce associated infections.

In this study, respondents consistently performed hand hygiene after exposure to body fluids or specimens (≅ 100%), such as handling urine samples, removing personal protective equipment (PPE) like gloves, and disposing of contaminated sharps. However, compliance was slightly lower in preventive scenarios, such as performing hand hygiene before assessing clean supplies (96.8%) or entering clean areas and sterile supplies, including PPE, collection materials, sample containers, and sterile blood products (92.8%). These trends are consistent with observations from two tertiary hospitals in Freetown, Sierra Leone, where hand hygiene compliance was notably low before patient contact by 24% before touching a patient and 34% before a clean or aseptic procedure.[15] Similarly, healthcare workers were more likely to comply with hand hygiene protocols after exposure to contamination (91%) compared to before patient contact (68%).[16] The observed differences between pre- and post-contact hand hygiene compliance may be attributed to several factors, including increased awareness of contamination risk after patient contact, time constraints, and workflow interruptions that discourage hand hygiene before patient interactions. The lower compliance in preventive scenarios could be attributed to reduced perceived risk, time constraints or workflow interruptions. Therefore, addressing these challenges through comprehensive training, adequate resource provision, and fostering a culture prioritising hand hygiene is essential for enhancing compliance rates and reducing healthcare-associated infections. Furthermore, the Centers for Disease Control and Prevention (CDC) emphasises the importance of hand hygiene for healthcare workers by providing guidelines to ensure patient and staff safety.[17]

Resource availability plays a critical role in ensuring compliance with hand hygiene. Most respondents reported access to essential resources, with gloves being the most accessible (98.4%), followed by handwashing basins in each laboratory room (96.8%), easy access to handwash basins (96.0%), hand soap (95.2%), and functional soap dispensers (92.8%). However, only 78.4 % of respondents reported access to disposable and towels. Alcohol-based hand rubs have significantly enhanced hand hygiene compliance by reducing the time required for hand hygiene and improving convenience.[18] The World Health Organization (WHO) highlights the vital role of knowledge-sharing in promoting hand hygiene to prevent the spread of harmful germs in healthcare settings. Their 2024 campaign poster reinforces the importance of proper hand hygiene practices.[19] These findings highlight the importance of ensuring the availability and accessibility of alcohol-based hand rubs and educational resources, such as posters, to support and encourage optimal hand hygiene practices among healthcare workers.

While resource availability is fundamental to hand hygiene compliance, other factors, such as healthcare workers' attitudes, institutional priorities, the design of taps, and the distance between hand basins, significantly influence compliance rates. Despite adequate resources, behavioural and systemic issues can hinder consistent adherence to hand hygiene practices. It is necessary to continuously upgrade facilities and equipment to address these challenges while tackling behavioural and organisational factors that impact compliance. Sikkem et al. emphasised that individual characteristics, work environment, team dynamics, task complexity, patient interactions, organisational culture, and management support are key contributors to hand hygiene compliance.[20] Similarly, the World Health Organization (WHO) highlighted that average hand hygiene compliance, without targeted improvement interventions, remains at 40%, with notable disparities between high- and lower-income countries.[21] This emphasises the need for strategies that extend beyond resource provision to enhance global compliance rates effectively.

Gender is a significant predictor of hand hygiene compliance, with female healthcare workers demonstrating higher compliance scores than their

male counterparts. This finding aligns with previous research indicating that women generally have higher hand hygiene compliance rates than men.[22] These gender disparities have been observed in other studies and attributed to differences in health-related attitudes, risk perception and cultural norms. In contrast, research on Saudi nursing students found that male students performed better in hand hygiene practices than female students, suggesting that cultural factors may influence these behaviours.[23] Therefore, gender differences in compliance rates suggest that targeted initiatives to improve adherence. Moreover, fostering a culture of accountability, where hand hygiene is a shared responsibility, can further enhance compliance rates. The Joanna Briggs Institute recommends implementing unit-specific protocols, institutional programs, and educational campaigns to address behavioural barriers and improve adherence to hand hygiene guidelines.[24]

In our study, age was not a significant factor influencing hand hygiene compliance among healthcare workers, although a slight negative trend suggested that compliance may decrease with age. This finding contrasts with previous research indicating that younger healthcare workers are more likely to adhere to hand hygiene practices than their older counterparts. For instance, a study by Kim et al. in the Republic of Korea found that younger healthcare workers reported higher hand hygiene compliance rates than older staff members.[1] Similarly, research by von Auer et al. highlighted that younger healthcare workers demonstrated better hand hygiene practices, potentially due to more recent training and greater familiarity with current guidelines.[15] Race, ethnicity, and education did not significantly influence hand hygiene compliance, suggesting that individual priorities and behaviour modifications are more essential. This aligns with Anderson et al., who observed no significant differences in hand hygiene practices among college students across different ethnic groups.[25] This indicates that factors beyond demographic characteristics may play a more substantial role in influencing hand hygiene behaviour.

Our study also examined the relationship between Knowledge, Attitude, and Practice (KAP) scores and hand hygiene compliance scores among laboratory workers, but no significant relationship was found between these variables. Higher KAP scores do not necessarily translate into improved hand hygiene practices, and recent studies have found no significant association between high knowledge scores and actual hand hygiene compliance. For instance, Alshammari et al. observed that healthcare workers' self-reported hand hygiene practices did not align with direct observations, indicating that knowledge alone does not ensure compliance.[26] Similarly, a study by Chen and Xu assessed disinfection and hand hygiene KAP among childcare facility staff during the COVID-19 pandemic in Anhui, China.[27] Despite high knowledge and attitude scores, hand hygiene practice was suboptimal, indicating that factors beyond KAP scores influence compliance. These findings highlight the complexity of hand hygiene behaviour and suggest that interventions aiming to improve compliance should consider additional factors beyond enhancing knowledge and attitudes. The nonsignificant findings for training and accessibility to hand hygiene tools in this study may reflect a baseline level of resource availability and training adequacy within the study population. Most respondents reported good accessibility to hand hygiene tools and high KAP scores, potentially reducing variability and limiting their predictive power. Nonetheless, these factors remain essential to effective hand hygiene programs and should be continually monitored and improved.

This study has several notable strengths. It demonstrated a high hand hygiene compliance rate among MLTs and provided valuable insights into best practices and areas of improvement. It also assessed factors influencing compliance, such as gender, training, and accessibility of hand hygiene tools, and KAP scores offer a multidisciplinary perspective on hand hygiene behaviours. Additionally, the focus on resource availability, such as alcohol-based hand rubs and hand hygiene posters, aligns with recommendations from WHO and CDC to enhance compliance through resource provision and education. Despite these strengths, the study has several limitations. It relied on self-reported data, which may introduce response bias and potentially lead to overestimation of compliance rates due to social desirability bias. The lack of significant associations for certain factors, such as training and KAP scores, may reflect that homogeneity availability was high; however, it had a limited impact on compliance by suggesting that behavioural and cultural factors may play a more critical role. The study also lacked direct observational measures to validate self-reported compliance rates. Discrepancies between self-reported and observed

hand hygiene practices emphasise the need for objective monitoring. Finally, a small number of males and minority ethics groups limited the ability to explore these demographic factors' influence comprehensively. Future studies should incorporate longitudinal design, direct observation, and a more diverse population to address these limitations and provide a deeper understanding of hand hygiene behaviours in different contexts.

This study's findings have important implications for developing targeted interventions to improve hand hygiene compliance among MLTs. Gender-specific strategies, such as addressing cultural norms and risk perception differences, could enhance compliance among male workers. Additionally, KAP scores alone do not guarantee compliance; therefore, interventions should incorporate behavioural change theories, peer-led initiatives, and periodic reinforcement such as leadership support. Routine audits should also be strengthened to foster a compliance-driven environment.

5. CONCLUSION

Hand hygiene compliance among medical laboratory technologists (MLTs) at the Universiti Sains Malaysia (USM) Health Campus is remarkably high, with rates exceeding 97%. Factors such as accessible resources and gender differences significantly influence compliance, highlighting that female MLTs adhere more strictly to protocols. While knowledge, attitude, and practice (KAP) scores were generally high, they were not statistically significant in predicting compliance, indicating that behaviour and systemic factors may play a more pivotal role than knowledge alone. The study underscores the importance of continuous support, regular training, and resource availability to maintain and improve hand hygiene practices. It also suggests that targeted interventions, particularly addressing behavioural and organisational challenges, are necessary to foster a sustained compliance culture. Future research should focus on diverse settings, incorporating direct observational methods and innovative interventions to understand better and enhance hand hygiene practices among healthcare workers. Overall, this research provides valuable insights for infection prevention and control in healthcare laboratories, reinforcing that maintaining high compliance with hand hygiene can contribute to safer working environments and improved patient outcomes.

Ethical Approval

The study received ethical approval from the Human Research Ethics Committee (HREC) of Universiti Sains Malaysia (USM) under protocol code USM/JEPeM/23010012, dated April 5, 2023.

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Competing Interests

All the authors declare that there are no conflicts of interest.

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Underlying Data

Derived data supporting the findings of this study are available from the corresponding author on request.

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