ORIGINAL ARTICLE

Prevalence, Knowledge, Attitude, and Practice on Latent Tuberculosis Infection (LTBI): A Cross-sectional Study Among Medical Students at a Malaysian University

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ABSTRACT

Introduction: Latent TB Infection (LTBI), although asymptomatic, can potentially develop into active TB. This study aimed to assess LTBI prevalence, knowledge, attitude and practices (KAP) among medical students in Negeri Sembilan, Malaysia. **Materials and methods:** A cross-sectional study was conducted involving 171 clinical-year medical students. A tuberculin skin test (TST) with a 10mm cutoff identified LTBI, confirmed by the QuantiFERON® TB Gold. A questionnaire included sociodemographics, TB exposure, and KAP on LTBI. The Kruskal-Wallis and Spearman correlation coefficients were employed to explore associations among the study variables. **Results:** LTBI prevalence among medical students was 0.6% (95% CI 0.000, 0.032). The mean of total correct answers for LTBI knowledge was 10.63, SD = 2.064 (range: 5–15), with only 36.8% of the students scoring higher than the median score. The mean total attitude was 36.59, SD = 3.362 (range = 16–40), with 49.1% having a total attitude above the median. The mean total scores for LTBI practice are 22.86, SD = 1.31 (range = 15–24), with 36.3% answering always to all the practice statements. Student's clinical years were associated with knowledge scores (p<0.001). Weak but significant positive correlations existed between knowledge score with age (p<0.001) and practice score (p<0.001). The attitude score was weakly and significantly correlated with practice score (p=0.004). While, the practice score also weakly but significantly correlated with clinical exposure hours (p=0.019). **Conclusion:** Though promising, the study highlighted knowledge gaps and suboptimal LTBI attitudes and practices among medical students. Comprehensive interventions are crucial to enhance medical students' KAP.
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INTRODUCTION

Latent tuberculosis infection (LTBI) is characterized by the World Health Organization (WHO) as "a condition marked by a sustained immune response to Mycobacterium tuberculosis antigens, without any clinically evident signs of active tuberculosis (TB)" (1). There is currently no gold standard test for detecting LTBI in people. Most people with LTBI have no symptoms of tuberculosis but are at risk of developing active tuberculosis (1, 2). Consequently, WHO guidelines consider factors such as the probability of progression to active TB disease within a specific risk category, TB epidemiology and prevalence, resource availability, and the potential for a significant public health impact when addressing LTBI considerations.

Malaysia has an intermediate tuberculosis burden, with a notification rate of less than 100 cases per 100,000 people (3). There is currently no published data on the frequency of latent TB infection in the Malaysian general population. However, healthcare professionals, including medical students, belong to one of the 15 risk categories recognized by the WHO, which are associated with an increased prevalence of latent tuberculosis infection (LTBI), a heightened likelihood of transitioning from LTBI to active TB disease, and a higher incidence of active TB. (1). According to a study of available data from Malaysian research, the prevalence of LTBI among healthcare professionals was between 10.6% and 46% (4). Meanwhile, a systematic review by Ismail et al. (5)

reported that from tuberculin skin test (TST) and blood interferon-gamma release assay (IGRA) findings, the average prevalence of LTBI among medical and nursing students in countries with an intermediate burden was 16.7% and 4.7 %, respectively.

According to Abdullah et al. (6), when medical students do their clinical postings and are exposed to patients, they are at risk of contracting tuberculosis. From their findings, none of the pre-clinical year one medical students who had never been exposed to healthcare facilities tested positive for LTBI. However, 8.0% of clinical students in their fifth year tested positive for LTBI. In addition, a review by Ismail et al. (5) also reported an increased risk of LTBI with increased hours of hospital exposure. Thus, continuous study on the LTBI prevalence is essential in providing input on the current LTBI prevalence in this vulnerable group.

As there are two types of TB conditions which is the active TB disease and LTBI, several studies have been conducted to assess the medical student's knowledge, attitudes and practices (KAP) on this globally and in Malaysia. A study by More et al. (7) among medical students in Udaipur, India, before the intervention programs reported low KAP on TB diseases among the participants. Another study among medical students in Malaysia showed moderate knowledge and attitudes level with good attitudes level towards TB diseases among the respondents (8). However, other than exposure to clinical settings, previous studies also reported that other factors that increased the risk of LTBI were the lack or insufficiency of personal protective equipment and preventive measures (9, 10).

Despite the importance of understanding LTBI and its associated factors, limited research has focused on medical students' knowledge, attitudes, and practices (KAP) regarding this aspect of TB. Medical students, frequently exposed to TB patients during their clinical training, represent a high-risk group for LTBI. Investigating LTBI prevalence among them is essential for identifying the extent of infection and developing appropriate preventive measures. Conducting a KAP study on LTBI among Malaysian medical students is particularly relevant and significant in medical education. Such a study provides valuable insights into the awareness and perceptions of future healthcare professionals regarding TB prevention and control. Enhancing medical students' knowledge and attitudes towards LTBI can lead to better compliance with preventive practices, ultimately reducing the transmission risk. Most existing studies, including those in Malaysia, have focused on the KAP towards active TB, leaving a gap in understanding LTBI.

This cross-sectional study aims to fill this gap by examining the prevalence of LTBI among medical students and exploring their knowledge, attitudes, and practices related to LTBI. The findings will provide essential information for designing education and training programs for medical students to increase their knowledge of LTBI and raise awareness of the disease, thereby reducing LTBI transmission during their clinical years.

MATERIALS AND METHODS

Study design and population

This cross-sectional study took place between August 2021 and January 2022, involving medical students in their 4th, 5th, and 6th clinical years at the Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia. The university is a public institution situated in Negeri Sembilan on the west coast of Peninsular Malaysia. The Higher Education Minister of Malaysia reports that 2,967 medical students graduated from higher education institutes in 2020. Out of thirty-one medical universities and colleges in Malaysia with a medical curriculum with a 5-year study duration, only the Bachelor of Medicine and Surgery from Universiti Sains Islam Malaysia had a 6-year study duration.

We employed a probability sampling method to ensure the validity of our statistical inferences. A sample size of 144 was calculated based on a 95% confidence level, a population size of assuming around 9,000 medical students in Malaysia were in their clinical year, a hypothesized 10.6% frequency of the outcome factor in the population, and a design effect of 1.0 for a random sample (www.openepi.com/SampleSize/SSPropor.htm) (11). The necessary sample size was raised to 175 since it was anticipated that 20% of participants would either have incomplete data or decline blood sampling.

The following are the inclusion and exclusion criteria for the study:
Inclusion criteria:

1. Registered medical students in Year 4, Year 5, and Year 6 at the Faculty of Medicine and Health Sciences, USIM.
2. Students who have started their hospital postings.
3. Students with no symptoms of TB, such as chronic cough, haemoptysis, night sweats, and weight loss.
4. Students who agree to join this research and have provided consent.

Exclusion criteria:

1. USIM students in Year 1, Year 2, and Year 3 at the Faculty of Medicine and Health Sciences.
2. Students with active TB and currently on treatment.
3. Students with a medical condition and currently on medication.
4. Students with an acute infection.
5. Students on immunosuppressive drugs, such as those for systemic lupus erythematosus (SLE).
6. Pregnant students.

Data collection

The LTBI KAP survey questionnaire used was based on previous literature with a slight modification to the questionnaires (6, 7, 12-18). To evaluate the questionnaire's accuracy, an internal pre-validation process was undertaken. This involved two infectious disease experts reviewing the questionnaires, and a specialist conducted back-to-back translation for further scrutiny. The pilot study was done with 62 dental students since they have a similar curriculum to medical students treating patients during their clinical year.

The self-administered online questionnaires were administered using google form. The questionnaires comprised 47 multiple-choice questions encompassing five primary themes: (1) Participant demographics and general information (including gender, age, academic year, program, ethnicity, weekly clinical exposure hours, and smoking/vaping status), (2) TB exposure history, (3) Knowledge on symptoms, transmission routes, at-risk groups, and treatment of LTBI (4) LTBI attitudes and (5) practices and care-seeking behavior in LTBI.

Knowledge-related questions were graded as follows: a correct answer received a score of 1, while uncertain or incorrect responses were scored at 0. Participant attitudes toward TB were evaluated using a 5-point Likert scale: 'strongly disagree' (1 point), 'disagree' (2 points), 'not sure' (3 points), 'agree' (4 points), and 'strongly agree' (5 points) for positive statements, with reverse scoring applied to negative statements. Whereas questions on practices used ‘always’ (3 points), ‘sometimes’ (2 points), and ‘never’ (1 point).

The internal consistency of the questionnaire was measured using Cronbach’s alpha. The Cronbach’s alpha value for knowledge, attitude, and practice sections was 0.749, 0.820 and 0.610, respectively. The questionnaire is available in the supplementary materials section.

Tuberculin Skin Test (TST)

Tuberculin skin test (TST) is a common test to determine if someone has Mycobacterium tuberculosis. The bacteria that cause tuberculosis are used to create tuberculin, a sterile extract, and tuberculin pure protein derivative (PPD). The tuberculin skin test does not use live bacteria; thus, a person cannot contract TB through it. 0.1 millilitres of a pure protein derivative (PPD) solution were injected intradermally into the inner forearm to perform the TST (Alian et al., 2016). The respondents were injected with a tuberculin syringe with the needle bevel pointing upward. The injection produced a pale elevation of the skin. The injection site will be marked with a pen to keep track of the injection location. The diameter of skin induration was measured after 48–72 hours by experienced staff (19). The diameter of the indurated area should be measured across the forearm. The induration size of 10 mm and above was considered positive (20).

QuantiFERON-TB Gold Plus (QFT-Plus)

Interferon-gamma Assays (IGRA) evaluate an individual's immunological response to Mycobacterium tuberculosis that causes tuberculosis (TB). QuantiFERON-TB Gold (QFT) is a simple blood test that aids in detecting Mycobacterium tuberculosis. QFT is an interferon-gamma (IFN-γ) release assay known as an IGRA. This method measures interferon-gamma production by circulating T cells in the whole blood against specific Mycobacterium tuberculosis antigens (6). This test requires 1 ml of whole blood in each of the three tubes. The tests involve combining fresh blood samples with antigens and controls. Antigens, testing procedures, and interpretation standards for IGRAs vary. IFN-g release rates or the number of cells that release IFN-g are used to interpret IGRA results. Following the manufacturer's instructions, the test was carried out. It is essential to provide both the quantitative assay data (Nil, TB, and Mitogen concentrations or spot counts) and the conventional qualitative test interpretation (positive, negative, or indeterminate) (20).

Ethical approval

The study protocol was approved by USIM Research Ethics Committee and Faculty of Medicine and Health Sciences Research Committee on August 10, 2020 (USIM/JKEP/2020-106) and June 4, 2020, respectively. The study was also carried out per the Good Clinical Practise (GCP) guidelines, established by the Declaration of Helsinki (21). All information gathered was treated in confidence. It was voluntary to take part in the study. All participants gave their informed consent before beginning the questionnaire, which came after a thorough description of the study's objectives. They were then required to respond anonymously to a questionnaire. Since the study was conducted during the COVID-19 pandemic in Malaysia, all infection prevention guidelines and standard operating procedures were followed.

Data analysis

The data generated was organized in Microsoft Excel, and statistical analysis was carried out using IBM Statistical Package for the Social Sciences (SPSS) for Windows version 27.0 (Armonk, NY, USA). Categorical variables were displayed as frequencies and percentages in the tables and as percentages in the text, while continuous variables were expressed as mean (standard deviation). The normality of the data was assessed using the Kolmogorov-Smirnov test, which indicated that the data were not normally distributed. The cutoff score for the KAP assessment was determined using the median. Participants with scores above the median were considered to have good KAP. Consequently, a non-parametric test was used for inferential analysis. To compare KAP scores between genders or program years, the Mann-Whitney U and Kruskal-Wallis H tests were employed. The Spearman correlation coefficient was used to examine the relationships between age, weekly

hours of clinical exposure, knowledge, attitude, and practice. All significance tests were two-sided, and a P-value below 0.05 was deemed statistically significant.

RESULTS

One hundred and seventy-five (175) medical students from the university in Negeri Sembilan, Malaysia, were approached to participate in this study. From that, 171 respondents responded to this study to answer the questionnaire, giving a response rate of 97.7%. This study had no missing data, as all participating students completed the questionnaire. The flowchart of the study was presented in Figure 1. Six (3.5%) of 171 respondents showed positive TST with an induction diameter response of more than 10mm. A QFT-Plus QuantiFERON-TB Gold Plus was conducted on all six respondents with positive TST. From that, one (16.7%) showed positive IGRA, indicating the presence of LTBI. Thus, this study's prevalence of LTBI among medical students was 0.6% (95% CI 0.000, 0.032).

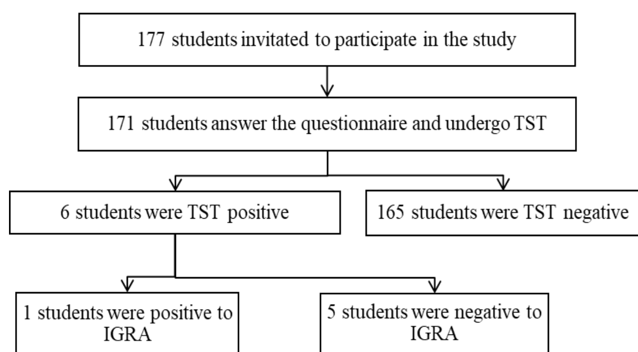

Figure 1: Study flow chart. TST Tuberculin Skin Test; QFT QuantiFERON® TB-Gold Test.

Characteristics of the study population

Table I provides a summary of the study population's characteristics. The medical students had a mean age of 24.18 (SD = 0.91), ranging from 23 to 26 years. More than half of the respondents were female (65.5%). For the year of the medical program, all the respondents were in the clinical year, with a year 4: year 5: year 6 ratio of 1:1:1. All the respondents were of Malay ethnicity. The mean clinical exposure was 10.88 (SD = 11.707) hours per week. Regarding smoking habits, none of the respondents were smokers, with 1.8% being ex-smokers. For vaping habits, 1.2% of respondents were vapers.

Table I: Characteristics of respondents (n=171).

Characteristics		n	%
Age (year)	23	45	26.3
	24	64	37.4
	25	49	28.7
	26	13	7.6
Gender	Male	59	34.5
	Female	112	65.5
Year of program	Year 4	57	33.3
	Year 5	57	33.3
	Year 6	57	33.3
Clinical exposure (hours per week)	Median (IQR)	8 (20)	
Clinical exposure category	0 hour	61	35.7
	1-19 hours	60	35.1
	20-39 hours	47	27.5
	40-59 hours	3	1.8
Smoking status	Non-smoker	168	98.2
	Ex-smoker	3	1.8
Vaping status	Non-vaper	169	98.8
	Currently vaper	2	1.2

CONTINUE

Table I: Characteristics of respondents (n=171). (CONT.)

Tuberculosis exposure

Figure 2 indicates the tuberculosis exposure characteristics of the respondents. The majority of the students have heard about LTBI (91.8%). Only 0.6% of the respondents have been diagnosed with TB before. For the contact of TB among close contacts, 6.4%, 30.4%, and 48.0% have a family member with a history of TB, friends with a history of TB, and have been exposed to TB patients, respectively. Most are immunized against tuberculosis with the BCG vaccine (97.7%) and have a BCG scar (91.8%). Most students stated they had previously received the Mantoux test (90.1%).

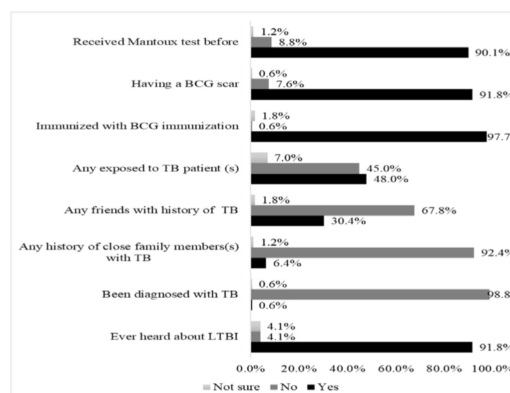

Figure 2: Tuberculosis exposure among students (n=171).

Knowledge about LTBI

The mean total scores for knowledge question 10.63, SD=2.064 (range: 5-15). Only 36.8% of the students scored higher than the median score of 11 which is in the good knowledge category. The responses to each knowledge question are presented in Table II. Majorities of the students knew that LTBI is an asymptomatic Mycobacterium Tuberculosis infection (91.2%), the mode of TB transmission is airborne (87.7%), the Mantoux test is a screening test for LTBI (91.8%), LTBI can progress to active TB (83.0%), BCG is a TB vaccine (96.5%), and healthcare workers and students working in the respiratory ward are at risk of TB infection (97.7%) and at risk of developing LTBI (81.3%).

Table II: Knowledge of LTBI among the medical students (n=171)

Knowledge of LTBI statements	Responses, n (%)		
	Yes	No	Not Sure
1. LTBI is an asymptomatic *Mycobacterium Tuberculosis* infection.	156 (91.2)	9 (5.3)	6 (3.5)
2. LTBI is infectious. *	56 (29.2)	106 (62.0)	15 (8.8)
3. The mode of TB transmission is via airborne.	150 (87.7)	16 (9.4)	5 (2.9)
4. LTBI is caused by a virus. *	17 (9.9)	153 (89.5)	1 (0.6)
5. Mantoux test is a screening test for LTBI.	157 (91.8)	5 (2.9)	9 (5.3)
6. The symptom of LTBI is prolonged coughing. *	83 (48.5)	69 (40.4)	19 (11.1)
7. LTBI cannot progress to active TB. *	12 (7.0)	142 (83.0)	17 (9.9)
8. BCG is a TB vaccine.	165 (96.5)	4 (2.3)	2 (1.2)
9. Interferon Gamma Release Assay (IGRA) is the confirmatory test for LTBI.	69 (40.4)	16 (9.4)	86 (50.3)
10. The chest X-ray is normal for LTBI.	85 (49.7)	55 (32.2)	31 (18.1)
11. The period of LTBI treatment is 12 months. *	43 (25.1)	49 (28.7)	79 (46.2)
12. LTBI treatment regime consists of Ethambutol, Isoniazid dan Rifampicin.	120 (70.2)	24 (14.0)	27 (15.8)
13. Healthcare workers and students working in the respiratory ward are at risk of TB infection.	167 (97.7)	1 (0.6)	3 (1.8)
14. Healthcare workers and students working in the respiratory ward are at risk of developing LTBI.	139 (81.3)	17 (9.9)	15 (8.8)
15. LTBI patient needs to be isolated. *	53 (31.0)	90 (52.6)	28 (16.4)

* Negative statements

However important knowledge gaps were noted. Only about half of students knew that LTBI is not infectious (62.0 %), the symptom of LTBI is not prolonged coughing (48.5%), the chest X-ray is normal for LTBI patients (49.7%), and LTBI patients do not need to be isolated (52.6%). Also, there is a high number of students who are not sure if the Interferon Gamma Release Assay (IGRA) is the confirmatory test for LTBI (50.3 %) and if the period of LTBI treatment is 12 months (46.2%).

Attitude towards LTBI

Table III displays the responses to each attitude question. Approximately half of the medical students exhibited an above-average attitude towards TB (overall mean attitude score = 36.59, SD = 3.362, range = 16–40), with 49.1% falling into the high attitude category, as indicated by a score above the median (median = 37). Most of the students strongly agree to wear a mask when having a severe cough (84.2%), are willing to wear masks even if their patients do not like it (89.5%) and will advise any LTBI patient to go for treatment (80.1%). However, some poor attitudes were identified. Only 51.5% strongly agree that they will use a handkerchief or tissue to cover their nose and mouth when coughing, and only 40.4% will wash their hands with soap after sneezing and coughing.

Table III: Attitude towards LTBI among medical students (n=171)

Attitude towards LTBI statements	Responses, n (%)				
	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. If I have a severe cough, I will not wear a mask. *	144 (84.2)	16 (9.4)	3 (1.8)	5 (2.9)	3 (1.8)
2. When I cough, I use a handkerchief or tissue to cover my nose and mouth.	3 (1.8)	9 (5.3)	19 (11.1)	52 (30.4)	88 (51.5)
3. I wash my hands with soap after sneezing and coughing.	3 (1.8)	13 (7.6)	25 (14.6)	61 (35.7)	69 (40.4)
4. I do not wear masks as my patient does not like me to wear them. *	153 (89.5)	15 (8.8)	2 (1.2)	0	1 (0.6)
5. I would not undergo LTBI screening.	133 (77.8)	26 (15.2)	7 (4.1)	3 (1.8)	2 (1.2)
6. I agree to be treated if I have been diagnosed with LTBI.	4 (2.3)	1 (0.6)	6 (3.5)	27 (15.8)	133 (77.8)
7. I will advise any LTBI patient to go for treatment.	5 (2.9)	0	3 (1.8)	26 (15.2)	137 (80.1)
8. I will ignore LTBI patients. *	132 (77.2)	29 (17.0)	8 (4.7)	0	2 (1.2)

*Negative statements

Practice towards prevention of LTBI

Table IV outlines the responses to each practice question. Medical students demonstrated a good practice in LTBI management and infection prevention, as reflected in an overall mean practice score of 22.86 (SD = 1.31, range = 15–24). Sixty-two medical students (36.3%) answered 'always' to all the practice questions, with more than 90% of them reporting always washing hands before and after examining patients (97.7%), wearing a face mask when handling TB patients (98.8%), and undergoing the TB Mantoux test as required by their institution (98.2%). Nevertheless, the percentage of students who agreed that TB patients should isolated from other patients was lower at 84.2%, and 5.8% never did that. In addition, only 46.8% would always educate patients on cough etiquette, while 5.8% never did that.

Table IV: Practices on prevention of LTBI among medical student (n=171)

Practices on Prevention of LTBI	Responses, n (%)		
	Never	Sometimes	Always
1. I educate patient on cough etiquette.	10 (5.8)	81 (47.4)	80 (46.8)
2. I wash my hands/use hand sanitiser before handling patient.	0	4 (2.3)	167 (97.7)
3. I wash my hands/ use hand sanitiser after handling patient.	0	4 (2.3)	167 (97.7)
4. I do not mix TB patient with other patients.	10 (5.8)	17 (9.9)	144 (84.2)
5. I wear face mask when handling TB patient.	0	2 (1.2)	169 (98.8)
6. I advise TB patient to take medication regularly as prescribed.	2 (1.2)	15 (8.8)	154 (90.1)
7. I will undergo TB investigations if I have prolonged cough.	1 (0.6)	23 (13.5)	147 (86.0)
8. I will undergo TB Mantoux test as required by my institution.	0	3 (1.8)	168 (98.2)

*Negative statements

Association between demographic factors and KAP

A comparison of the total Knowledge, Attitude, and Practice (KAP) scores was conducted across different gender and year of study groups. The associations between age, hours of clinical exposure, and various KAP scores, including knowledge and attitude, knowledge and practice, were examined using Spearman's correlation coefficient (rs) as detailed in Table V. Notably, there was a significant differents in the knowledge score based on the year of study, with a noticeable increase in knowledge scores corresponding to higher study years, although no such differences were observed in attitude and practice scores. There was a weak positive but significant correlation between the clinical exposure by hours per week among students with attitude scores (rs = 0.180, 95% CI 0.026 - 0.325, p < 0.019) and practice scores (rs = 0.179, 95% CI 0.025, 0.324, p < 0.019). There was also a weak positive but significant correlation between knowledge score and age (rs = 0.299, 95% CI 0.152 - 0.434, p < 0.001), as well as between knowledge and practice scores (rs = 0.267, 95% CI 0.117, 0.404, p < 0.001). Finally, total attitude score also showed a weak positive but significant correlation with practice score (rs = 0.218, 95% CI 0.065, 0.360, p = 0.004).

Table V: Demographic variables associated with total LTBI KAP score

Demographic variables	Knowledge score		Attitude score		Practice score	
	Median (IQR)	p	Median (IQR)	p	Median (IQR)	p
Gender						
Male	11 (3)	0.262	37 (5)	0.257	23 (2)	0.204
Female	11 (3)		38 (4)		23 (1)	
Program year						
Year 4	10 (4)	**<0.001**	38 (4)	0.706	23 (2)	0.801
Year 5	10 (3)		38 (5)		23 (2)	
Year 6	12 (3)		37 (3)		23 (2)	
	r_s	p	r_s	p	r_s	p
Age (year)	0.299	**<0.001**	0.002	0.977	0.131	0.089
Clinical exposure (hours/ week)	-0.024	0.754	0.180	**0.019**	0.179	0.019
Total knowledge score	1		0.042	0.588	0.267	**<0.001**
Total attitude score	0.042	0.588	1		0.218	**0.004**
Total practice score	0.267	**<0.001**	0.218	**0.004**	1	

Statistically significant at p<0.05 in bold

DISCUSSION

Due to their clinical training, medical students may be at higher risk of acquiring LTBI due to their exposure to TB patients in the hospital or clinic. Therefore, it becomes essential to take action to protect these susceptible groups of people from infection. Understanding their KAP for LTBI can help them lower their occupational risk. Only then could an intervention program be implemented to improve the students' knowledge, attitudes, and preventative practices to safeguard medical students. While KAP surveys on TB have been conducted among medical students in Malaysia (8) and on LTBI in different countries (7, 22), this descriptive cross-sectional study uniquely measured LTBI-related KAP among medical university students in Malaysia.

The overall positivity of LTBI using the QFT-Plus test among medical students detected in this study (0.6%) was slightly lower than the reported LTBI among medical

students from East Malaysia (8.0%) (8). Nevertheless, the findings of our study are also lower than those of a systematic review by Ismail et al. (5) which reported that the average positivity of LTBI among medical and nursing students in intermediate-burden countries was 16.7% and 4.7 %, by TST and IGRA. Early diagnosis of LTBI requires screening, which is not currently done in Malaysia (2, 4, 8). Thus, even though the positivity of the LTBI among medical students in this study was low, due to occupational risk, continuous screening among this risk population with TST and IGRA or a combination of both tests may be helpful to diagnose LTBI, in line with WHO recommendations, which aim to "end the global TB epidemic" by 2035 (23).

While the KAP scores pertaining to LTBI among medical students were deemed satisfactory, this study unveiled gap in knowledge concerning LTBI diagnosis, isolation procedures, and treatment. This aligns with the systematic review by Wong et al. (24), which summarizes the physiological capabilities of knowledge about LTBI characteristics, including diagnosis and treatment among the barriers to LTBI management among healthcare providers, including medical students. A previous study among medical students in India found that a TB education session positively influenced their knowledge, attitude and preventive practices about TB (7).

Our study showed a low attitude and practice among the medical students toward washing hands and cough etiquette. Poor implementation of safety measures in healthcare settings will increase occupational hazards, including biological hazards such as blood and airborne pathogens, including tuberculosis (25). According to the World Health Organization (WHO) guidelines on tuberculosis infection prevention and control, respiratory hygiene is described as “the act of covering the mouth and nose during breathing, coughing, or sneezing. This can be achieved through the use of a surgical mask, cloth mask, or by covering the mouth with tissues, a sleeve, or a flexed elbow or hand. Subsequent hand hygiene is recommended to minimize the dissemination of airborne respiratory secretions that may contain M. tuberculosis bacilli” (26). Hand hygiene is a broad term that refers to any activity involving hand washing to limit the spread of harmful germs to patients and healthcare workers (27).

In previous studies, clinical-year medical students reported good knowledge about hand hygiene, cough etiquette and respiratory hygiene (28). In another study, being a medical student was related to a higher rate of hand hygiene compliance in healthcare facilities when compared to other healthcare worker groups (29). Nevertheless, a study among nurses in Malaysia found that the perception of biological hazards at their healthcare center was moderate (30). In addition, an observatory study on hand hygiene compliance conducted in four countries, Finland, Sweden, Australia and Denmark, reported deficient compliance with hand hygiene among healthcare professionals (31). Thus, a range of strategies shall be in place to promote medical students' compliance with hand hygiene and cough etiquette and to guarantee that they continue to comply with good safety practices after completing their clinical training.

Furthermore, the presence of airborne infections in confined spaces, especially in healthcare facilities, can present a significant risk to individuals susceptible to such infections when in proximity to tuberculosis (TB) patients (32). Consequently, both the WHO and the U.S. Centers for Disease Control and Prevention (CDC) recommend isolating infectious TB patients from others. This precautionary measure aims to shield non-infected patients from the potentially contagious droplet nuclei emitted by infectious individuals (33, 34).Our study found the isolation practices among the medical students were low compared to the other practices of LTBI prevention. Previous studies among health science students, including from medical programs, reported poor implementation of TB infection control, including airborne precaution signage and patient isolation (35). Hence, ongoing educational initiatives regarding airborne infections should be implemented. This is supported by previous findings that indicated an enhancement in students' understanding of the necessity for isolation following the intervention (7).

In our study, we found that incremental knowledge score with more years of study and age is in line with previous studies, which show an increase in knowledge score with an increase in the year of study but not for the attitudes and practices scores towards TB (8, 22). While an increase in clinical hours was correlated with an increase in attitude and practice scores towards LTBI due to an increase in working and exposure hours in the clinical settings allied to a study by Sharma et al. (36). Finally, increased knowledge and attitudes scores were correlated with positive practice behaviour towards LTBI prevention. Therefore, this study is an opportunity for essential interventions to improve medical students' awareness of LTBI. This educational program can be delivered before their clinical placement through courses and professional training to reduce occupational hazards when they go through clinical training.

CONCLUSION

In summary, this study was able to assessed the Knowledge, Attitude, and Practice (KAP) regarding Latent Tuberculosis Infection (LTBI) among clinical year medical students in Malaysian universities. Overall, the KAP on LTBI was satisfactory, as most students got higher scores. The findings also showed associations between the knowledge scores and the clinical year and age, where the participants from the latter clinical year

and increased age had the highest knowledge scores regarding LTBI. The findings also showed positive correlations between the students' level of knowledge on LTBI with their attitude and practice. We also identified gaps in knowledge, attitudes and practices of LTBI among medical students. Thus, this presents a source that is amenable to institutional interventions, including education, to increase their awareness.

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