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KNOWLEDGE AND PRACTICE ON TUBERCULOSIS INFECTION CONTROL AMONG GOVERNMENT PRIMARY HEALTHCARE WORKERS IN A DISTRICT IN MALAYSIA

Waramlah Ramlan[1, 3], Huda Zainuddin[2*], Rozanim Kamarudin[4]

[1]DrPH Candidate, Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia
[2]Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia
[3]Training management Division, Ministry of Health, Putrajaya, Malaysia
[4]Health Department of Federal Territory Kuala Lumpur & Putrajaya, Ministry of Health, Malaysia

**Corresponding author: Huda binti Zainuddin, Department of Community Health, Faculty of Medicine, University of Putra Malaysia,43400 Serdang, Selangor. hidazai@upm.edu.my*

ABSTRACT

Background: Tuberculosis (TB) is the leading cause of mortality among infectious diseases in the world. Healthcare workers (HCWs) are among the high-risk group infected by TB with double prevalence than the general population due to inadequate TB infection control (TBIC). In Malaysia, TB cases among HCWs have increased, but the TBIC knowledge and practice remain poor. This research aimed to determine the TBIC knowledge and practice among HCWs and the predictors of good knowledge and practice of TBIC.

Materials and Methods: This study is a cross-sectional study with a random sampling of HCWs from 13 primary healthcare facilities in a district in Malaysia. A self-administered questionnaire was used in this study, adapted from similar studies in Ethiopia and Uganda. Simple and multiple logistic regressions were used as statistical analysis.

Result: The response rate of this study was 77% (320 respondents). The percentages of respondents having good TBIC knowledge and practice were 70.6% and 51.6% respectively. The significant predictors of good TBIC knowledge were the diploma educational level, (AOR=2.325, 95%CI=1.145-4.722), family history of TB infection (AOR=3.882, 95% CI=1.021-14.765), doctor (AOR=5.022, 95%CI=1.224-20.600) and worked in an outpatient clinic (AOR=4.504, 95%CI=2.050-9.892). Meanwhile, the diploma holder (AOR=2.055, 95%CI=1.065-3.964), married or widow (AOR=2.616, 95%CI=1.487-4.603) and working in maternal and child health clinic (AOR=3.479, 95%CI=1.700-7.118) were the predictors of good TBIC practice.

Conclusion: The practice of TBIC among the respondents was inadequate despite good knowledge. Training that emphasises on hands-on skill needs to be strengthened to ensure proper knowledge as well as practice on TBIC.

Keywords: Tuberculosis infection control, knowledge, practice, healthcare workers.

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1.0 Introduction

Tuberculosis (TB) is an infectious disease caused by Mycobacterium Tuberculosis. It spreads from person to person by air through the droplets coughed or sneezed out from an infected person (World Health Organization, 2019). In 2018, about 10 million people had TB worldwide, with 1.5 million deaths (World Health Organization, 2020a). In Malaysia, 92 people per 100,000 population were on TB treatment which comprised of 29,000 people infected in 2018 (World Health Organization, 2020b). Among the high-risk group of getting TB are healthcare workers (HCWs). Like any other occupations in the world, HCWs are also exposed to occupational hazards every day especially biological hazards such as Mycobacterium Tuberculosis (Occupational Safety and Health Administration (OSHA) and United States Department of Labor, 2016). Globally, the transmission of TB among patients and HCWs has been reported which occur in the healthcare facilities, irrespective of local TB incidence (Peters et al., 2020).

A systematic review done in 2019 showed that the prevalence of latent TB infection (LTBI) was 14.0 to 98.0% (mean 49.0%) in low and middle-income countries (LMIC) (Apriani et al., 2019). A study done in a hospital in Malaysia showed that the overall prevalence of LTBI among HCWs was 46.4% (Jaafar & Krishnan, 2016). TB information system has recorded that there was an increase in the estimated incidence of active TB in 2007 to 2010 with 80.59 to 97.86 incidence per 100,000 HCWs respectively (Occupational Health Unit Disease Control Division Ministry of Health Malaysia, 2012). The latest estimation of 134 cases of occupational lung infection, including TB, were also reported among HCWs in Malaysia in the year 2017 (Ministry of Health Malaysia, 2018). Among the key factors that favour the TB transmission is a delay in diagnosing the disease, the ineffectiveness of treatment, and poor practice of TBIC measures (Kuyinu et al., 2016). A systematic review reported limited implementation of TBIC measures in healthcare facilities contributed to high TB infections among HCWs (Apriani et al., 2019). It is crucial to assess and strengthen the practice of TBIC among HCWs to prevent TB transmission among them.

A study on knowledge and practice of TBIC, done in Addis Ababa, Ethiopia showed that there was unsatisfactory TBIC knowledge and practice among HCWs. The percentage of HCWs with good knowledge and practice on TBIC was only 36.1% and 51.7% respectively (Demissie Gizaw et al., 2015). In Malaysia, a similar study on the central nervous system (CNS) TB showed only 60% of the HCWs have good TBIC knowledge while 60% have good TBIC practice (Farhanah et al., 2015). These are not satisfactory as inadequacy in good practice will lead to an increase in TB transmission among the HCWs as well as the population. The infected HCWs will in turn be the source of infection that can transmit the disease to other HCWs and also patients under their care (Baussano et al., 2011). The increase of TB infection among HCWs has caused an increase in financial burden at the country and household level. Furthermore, this will also lead to the work loss day, reduce productivity and stigmatisation among the HCWs who were infected (Courtwright & Turner, 2010; Mitchell & Bates, 2011).

Most of the studies on TBIC were done at the hospital level. Even though most of TB patients were treated at the outpatient clinic, a scarce study on TBIC was conducted at the primary healthcare settings, thus, warrant for research to be done. The objective of this study is to assess the knowledge and practice of TBIC among HCWs in government primary healthcare

facilities in a district in Malaysia and to determine the predictors of good knowledge and practice on TBIC.

2.0 Materials and Methods

This is a cross-sectional study conducted among HCWs in 13 government primary healthcare facilities in a district in Malaysia in 2017. The calculation of sample size was based on the formula for testing differences between two independent proportions. In this study, the proportions of good knowledge among HCWs with TBIC training (P_1=60%) and without training (P_2=45%) has been used (Demissie Gizaw et al., 2015). The alpha value of 0.05 and the power of 0.80 were implemented in the analysis. The total sample size calculated was 415, including 20% non-response rate. The list of HCWs from each healthcare facility was obtained from the district health office. In total, the district consists of 446 HCWs. All clinical and non-clinical HCWs who were dealing directly with patients were included in this study. Those on extended leave during data collection were excluded. Initially, purposive sampling of the district with the highest tuberculosis infection among HCWs was chosen as the study location. The sample size of 415 was allocated proportionally to 13 healthcare facilities. The respondents from different healthcare facilities were stratified to their job position and randomly selected by using a random number generator (Stat Trek, 2017). The questionnaire was adapted from similar studies done in Ethiopia and Uganda and also from the ministry of health guideline (Buregyeya et al., 2016; Demissie Gizaw et al., 2015; Occupational Health Unit Disease Control Division Ministry of Health Malaysia, 2012; Tenna et al., 2013). The value of Cronbach's alpha of the questionnaire range from 0.75 to 0.78, indicating moderate reliability. The questionnaire is divided into three parts. The first part was on sociodemographic and employment characteristics such as age, gender, educational and marital status, job position, duration of employment, workplace and training on TBIC. It consists of 11 questions. The second part was to measure the TBIC knowledge and consists of 25 questions. The answer choices were 'yes', 'no' or 'do not know'. One mark has been given to the right answer and zero marks for wrong and `don't know' answers. The total marks were presented in percentage. The third part was on TBIC practice. This part consists of 11 questions with four-point scale answers; always, sometimes, seldom and never. The marks were given from three to zero marks according to the best, right, acceptable and wrong practice, respectively. Subsequently, the total marks were calculated as a percentage. The self-administered questionnaires were distributed to the respondents through their superior at the facilities after detail explanation given to them. The questionnaires were collected back after one to two weeks from the superior of each clinic. The data has been analysed using SPSS (version 23.0). The descriptive analysis has been presented as the median (interquartile range) and frequency (percentage). The respondents were categorised into good and poor knowledge and practice on TBIC by using the median cut off point (80%). The score of median and above was categorised as good knowledge and practice while the score below the median indicated poor TBIC knowledge and practice. Initially, the data were analysed by using simple logistic regression. The variables with $p \leq 0.25$ were included in the preliminary model of multiple logistic regressions (Hosmer & Lemeshow, 2000). There was no multicollinearity between the variables. The confounders were controlled using the multivariate regression model.

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3.0 Result

3.1 Sociodemographic and employment characteristics of the respondents

Table I Sociodemographic and employment characteristics of the respondents (n=320)

Characteristics	Median (IQR)	n	(%)
Age	31 (9.0)		
18-24		25	7.8
25-34		202	63.1
35-44		70	21.9
>44		23	7.2
Gender			
Male		70	21.9
Female		250	78.1
Race			
Malay		261	81.6
Chinese		15	4.7
India		24	7.5
Others		20	6.3
Educational Level			
Primary/Secondary		53	16.6
Diploma		188	58.8
Degree/higher		79	24.7
Marital Status			
Single		76	23.8
Married		239	74.7
Widow/Widower		5	1.6
TB History			
Yes		3	0.9
No		317	99.1
TB History in Family			
Yes		24	7.5
No		296	92.5
Job Position			
Doctors		54	16.9
Nurse, Medical Assistant		170	53.1
Health Inspector		32	10.0
Pharmacy, laboratory, radiology personnel		36	11.3
Nutritionist, health attendant, clerk, others		28	8.8
Duration of Employment (years)	7 (8.0)		
<6		138	43.1
6-<11		97	30.3
11-<21		66	20.6
≥21		19	5.9
Workplace			
DHO		56	17.5
OPC		138	43.1
MCHC		108	33.8
1MC		18	5.6
Experience in TB Clinic			
Yes		77	24.1
No		243	75.9
Training			
Yes		63	19.7
No		257	80.3
TBIC knowledge			

Good	226	70.6
Poor	94	29.4
TBIC practice		
Good	165	51.6
Poor	155	48.4

DHO: district health office, OPC: outpatient clinic, MCHC: maternal and child health clinic, 1MC: 1Malaysia clinic

A total of 320 out of 415 consented and completed the questionnaire with 77.0% response rate. Table I shows the sociodemographic and employment characteristics among the respondents. The youngest respondent aged 22 years old, while the eldest was 59 years old. Most (78.1%) of the respondents were female, Malay (81.6%) and married (74.7%). The majority (99.1% and 92.5%) of the respondents reported that they have neither previous history of TB nor family history of TB, respectively. Most (75.9%) of the respondents have no working experience in the TB clinic/ward, and 80.3% reported that they had never attended training on TBIC. The level of knowledge and practice were determined according to the median cut off point. Only 70.6% of the respondents had good knowledge. Meanwhile, 51.6% of them had a good practice of TBIC.

3.2 Knowledge and practice of TBIC among the respondents

Table II The correct and incorrect answer of the knowledge on TBIC (n=320)

Knowledge item on TBIC	Correct n(%)	Incorrect n(%)
What are the TB symptoms?		
- Prolonged cough > 2 weeks	312(97.5)	8(2.5)
- Bloodstained sputum	269(84.1)	51(15.9)
- Vomiting blood	218(68.1)	102(31.9)
- Night sweat	278(86.9)	42(13.1)
- Pain with urination	270(84.4)	50(15.6)
PTB spread through coughing	316(98.7)	4(1.3)
PTB spread via sexual intercourse	301(94.1)	19(5.9)
PTB spread through sharing food	205(64.1)	115(35.9)
Differences: Surgical and N95 mask	295(92.2)	25(7.8)
N95 mask can prevent TB	300(93.7)	20(6.3)
Surgical mask can prevent TB	111(34.7)	209(65.3)
TB patient must wear a surgical mask	310(96.9)	10(3.1)
Good ventilation is important	305(95.3)	15(4.7)
Open doors and windows	311(97.2)	9(2.8)
Sunlight is an effective TB control measure	258(80.6)	62(19.4)
Duration of exposure	199(62.2)	121(37.8)
Separation of TB patient from public	299(93.4)	21(6.6)
Different waiting area for TB	241(75.3)	79(24.7)
HIV is a high-risk group to get TB	294(91.9)	26(8.1)
Educate cough etiquette	316(98.7)	4(1.3)
What is cough etiquette?		
- Cover mouth with a tissue	307(95.9)	13(4.1)
- Cover mouth with a bare hand	203(63.4)	117(36.6)
- Cover mouth with a shirt sleeve	178(55.6)	142(44.4)
Do immediate direct sputum smear	312(97.5)	8(2.5)
Cannot induce sputum in the toilet	201(62.8)	119(37.2)

Table II shows the distribution of correct and incorrect answers for knowledge on TBIC. Almost all (98.7%) respondents know that TB can be spread through coughing and that they need to educate cough etiquette to the patients. However, more than half (65.3%) of the respondents have answered incorrectly that the surgical mask can prevent them from getting TB. About more than one third of the respondents answered incorrectly regarding the mode of transmission (35.9%) and duration of exposure to TB patient (37.8%). Almost half of the respondent answered incorrectly regarding the use of shirt sleeve in cough etiquette (44.4%). About 37.2% of respondents have answered the question on sputum induction incorrectly.

Table III The distribution of practice on TBIC (n=320)

Practice on TBIC	Always n(%)	Sometimes n(%)	Seldom n(%)	Never n(%)
Open doors and windows	286(89.4)	22(6.9)	6(1.9)	6(1.9)
N95 mask to prevent TB	132(41.3)	79(24.7)	52(16.3)	57(17.8)
Surgical mask to prevent TB	232(72.5)	41(12.8)	16(5.0)	31(9.7)
TB screening if suspected TB	281(87.8)	22 (6.9)	9(2.8)	8(2.5)
Separation of TB patient	204(63.8)	50(15.6)	12(3.8)	54(16.9)
Fit test for N95	150(46.9)	45(14.1)	49(15.3)	76(23.8)
Surgical mask for TB patients	274(85.6)	19(5.9)	10(3.1)	17(5.3)
Cough etiquette education	223(69.7)	50(15.6)	30(9.4)	17(5.3)
Reduce the exposure duration	232(72.5)	56(17.5)	12(3.8)	20(6.3)
TB screening if symptomatic	262(81.9)	27(8.4)	11(3.4)	20(6.3)
I practise cough etiquette	295(92.2)	17(5.3)	7(2.2)	1(0.3)

Table III shows the distribution of practices on TBIC among the respondents. A majority (72.5%) of the respondents had always worn surgical masks rather than N95 masks when dealing with TB or suspected TB patients. About 17.8% never use N95 when dealing with TB patients. Almost one third (23.8%) respondents never do the fit test for N95. As for the separation of TB patient at the designated area away from other patients in the clinic, 16.9% of respondents never practise the measure.

3.3 The predictors of good knowledge and practice on TB infection control

Table IV The predictors of good knowledge on TBIC (n=320)

Variables	Crude Odds Ratio (95%CI)	Adjusted Odds Ratio (95%CI)	p-value
Age			
18-24	1	1	
25-34	3.208 (1.376, 7.477)	1.518 (0.574, 4.015)	0.401
35-44	3.130 (1.210, 8.094)	1.165 (0.274, 4.959)	0.836
>44	0.993 (0.320, 3.085)	0.349 (0.063, 1.929)	0.228
Gender			
Male	1		
Female	2.180 (1.255, 3.786)		
Races			
Malay	1		
Non-Malay	1.794 (0.904, 3.562)		
Educational level			
Primary/Secondary	1	**1**	
Diploma	2.270 (1.218, 4.231)	2.325 (1.145, 4.722)	0.020*

Degree/higher	5.377 (2.375,12.171)	1. 987 (0.624, 6.328)	0.245
Marital status			
Single	1		
Married/widowed	1.608 (0.943, 2.744)		
History of TB			
Yes	0.830 (0.074, 9.269)		
No	1		
Family History of TB			
Yes	3.107 (0.904,10.680)	3.882 (1.021,14.765)	0.047*
No	1	1	
Job Position			
Doctor	8.929 (2.983,26.723)	5.022 (1.224,20.600)	0.025*
Nurse/Medical Assistant	1.714(1.016, 2.892)	1. 093 (0.519, 2.301)	0.816
Others	1	1	
Employment duration (years)			
<6	1	1	
6-10	2.591 (1.381, 4.859)	1.896 (0.897, 4.005)	0.094
>10	1.121 (0.633, 1.984)	2.080 (0.649, 6.669)	0.218
Workplace			
DHO	1	1	
OPC	5.098 (2.598,10.004)	4.504 (2.050, 9.892)	0.001*
MCHC	2.818 (1.446, 5.492)	2.979 (1.198, 7.407)	0.019*
1MC	6.200 (1.612,23.842)	7.293 (1.680,31.662)	0.008*
Experience in TB clinic			
Yes	1.991 (1.066, 3.718)		
No	1		
Training on TBIC			
Yes	0.954 (0.523, 1.741)		
No	1		

*Significant p<0.05, DHO: district health office, OPC: outpatient clinic, MCHC: maternal and child health clinic, 1MC: 1Malaysia clinic

Table IV shows the significant predictors of good knowledge on TBIC among the respondents. Among them are doctors (AOR: 5.022, 95%CI: 1.224-20.600, p=0.025), OPC (AOR: 4.504, 95%CI: 2.050-9.892, p=0.001), MCHC (AOR: 2.979, 95%CI: 1.198- 7.407, p=0.019), 1MC (AOR: 7.293, 95%CI: 1.680-31.662, p=0.008) and family history of TB (AOR: 3.882, 95%CI: 1.021-14.765, p=0.047).

Table V The predictors of good practice of TBIC (n=320)

Variables	Crude Odds Ratio (95%CI)	Adjusted Odds Ratio (95%CI)	p-value
Age			
18-24	1		
25-34	1.689 (0.725, 3.939)		
35-44	1.338 (0.529, 3.383)		
>44	2.812 (0.870, 9.091)		
Gender			
Male	1		
Female	1.453 (0.853, 2.477)		
Races			
Malay	1		
Non-Malay	0.584 (0.329, 1.036)		
Educational level			
Primary/Secondary	1	1	
Diploma	1.821 (0.985, 3.366)	2.055 (1.065, 3.964)	0.032*

Degree/higher	0.663 (0.326, 1.350)	0.779 (0.366, 1.660)	0.518
Marital status			
Single	1	1	
Married/widow	2.733 (1.611, 4.636)	2.616 (1.487, 4.603)	0.001*
History of TB			
Yes	1.890 (0.170,21.050)		
No	1		
Family History of TB			
Yes	1.120 (0.486, 2.580)		
No	1		
Job Position			
Doctor	1.123 (0.561, 2.249)		
Nurse/Medical Assistant	3.687 (2.176, 6.245)		
Others	1		
Employment duration (years)			
<6	1		
6-10	0.980 (0.583, 1.647)		
>10	1.297 (0.753, 2.234)		
Workplace			
DHO	1	1	
OPC	1.344 (0.707, 2.555)	1.425 (0.726, 2.798)	0.303
MCHC	4.091 (2.066, 8.099)	3.479 (1.700, 7.118)	0.001*
1MC	2.829 (0.947, 8.446)	2.994 (0.936, 9.573)	0.065
Experience in TB clinic			
Yes	1.171 (0.700, 1.958)		
No	1		
Training on TBIC			
Yes	1.128 (0.649, 1.959)		
No	1		
Knowledge level			
Good	1.571 (0.968, 2.551)		
Poor	1		

* Significant p<0.05, DHO: district health office, OPC: outpatient clinic, MCHC: maternal and child health clinic, 1MC: 1Malaysia clinic

Table V shows the significant predictors of good practice on TBIC among the respondents; the diploma educational level (AOR: 2.055, 95%CI: 1.065-3.964, p=0.032), married/widowed status (AOR: 2.616, 95%CI: 1.487-4.603, p=0.001) and MCHC (AOR: 3.479, 95%CI: 1.700-7.118, p=0.001).

4.0 Discussion

Out of 415 HCWs, 320 respondents have consented and completed the questionnaires with 77.0% response rate. Twenty-five HCWs were being transferred to a newly operated outpatient clinic in another district. Another 23 HCWs were on maternity and study leave, and the remaining 25 either refused to participate in the study or did not return the questionnaires.

4.1 Knowledge of TB infection control

Majority of the respondents have a good level of knowledge (70.6%) most probably due to the compulsory continuous medical education (CME) that has been conducted at the workplace, including on TBIC. The good knowledge was also explained by the dissemination of guideline on prevention and management of Tuberculosis for HCWs to healthcare facilities.

Besides, close supervision and monitoring by the national, state and district TB control unit also contributed to good TBIC knowledge among the HCWs (Occupational Health Unit Disease Control Division Ministry of Health Malaysia, 2012). This finding is higher than the result reported in a study in two tertiary hospitals in Malaysia that have found only 60% of the HCWs had good knowledge on TBIC (Farhanah et al., 2015). Meanwhile, similar studies in Ethiopia and Uganda reported that 63% and 69% respondents were found to have good TBIC knowledge, respectively (Buregyeya et al., 2016; Demissie Gizaw et al., 2015). Although only 29.4% of respondents have poor knowledge of TBIC, about half of them were younger age (18-24 years old), lower educational level (primary and secondary education), working as a health inspector or general health assistant and working in the district health office. This situation cannot be ignored since the group of HCWs are also at risk of getting TB infection. Periodical intensive training and education on TB infection control should focus more on these groups.

Almost all of the respondents answered correctly on the transmission of TB through coughing and know that they have to educate patients on cough etiquette. However, not all respondents know how to educate cough etiquette to their patients. Some have answered cough etiquette by covering mouth with a bare hand which is not the correct answer, and only half of the respondents answered correct cough etiquette by covering mouth with shirt sleeve (55.6%) during coughing. Cough etiquette knowledge was still poor among the community, as reported in the general population in Korea due to lack of awareness and prior education on respiratory hygiene (Choi & Kim, 2016). Therefore, HCWs need to have good knowledge to enable them to educate the population. One-third of respondents did not know the usage of surgical mask. A similar finding in Russia also reported that only 43% of HCWs know when to use respirator such as N95 (Woith et al., 2010). This may be because of the unavailability of N95 mask due to its higher cost as compared to surgical masks, and the discomfort it caused has led to wrong perception on the correct mask to be used to prevent TB infection (Mahony et al., 2009). The similar finding was also reported in Addis Ababa, Ethiopia where 61.2% of the respondents wrongly believed that the surgical mask could protect them from inhaling TB germ containing droplets (Demissie Gizaw et al., 2015).

4.2 Practice of TB infection control

The practices of TB infection control are still poor, with only 53.6% of the respondents have a good practice. This value is slightly lower than the studies in Malaysia and North West, Ethiopia in which about 60% and 63.3% of the HCWs were reported to have a good practice of TBIC, respectively (Farhanah et al., 2015; Temesgen & Demissie, 2014). However, if compared to the study in West Gojjam, Ethiopia, the percentage of good practice (38.0%) is much lower (Tamir et al., 2016). This poor practice of TBIC among HCWs is an alarming problem and can lead to the spread of TB in the population. HCWs are supposed to protect and educate the community on TB. However, they seem to be incompetent. Many of the respondents (72.5%) reported that they always use the surgical mask when dealing with TB patients, while only 41.3% of them reported that they always use the N95 mask. The percentage was slightly higher than a study in Southern Africa and Northwest, Ethiopia that reported only 38.8% and 23.5% of the HCWs had been using the appropriate N95 respirator when dealing with TB patients respectively (Mugomeri et al., 2015; Temesgen & Demissie, 2014). However, a study in Kwa-Zulu, Natal, South Africa reported higher usage of respirator with 54.7% as compares to the current study (Kanjee et al., 2011). Surprisingly, only 46.9% of the respondents in this study reported that they always do the fit test for N95 mask, which

is similar to the finding found in Kwa-Zulu, Natal, South Africa, about 43.6%. However, the study in Addis Ababa has documented a slightly higher percentage (53.7%) of respondents who always did airtight testing for their masks (Demissie Gizaw et al., 2015). Fit testing determines the effectiveness of protection. Therefore, it is imperative to ensure that all HCWs do the test regularly.

The inadequate practice on TB infection control was due to the lack of knowledge on TBIC as many (80.3%) of the respondents have not attended any TBIC training. Many of the training has not focused on a hands-on skill such as N95 fit test (Demissie Gizaw et al., 2015). The unavailability of the N95 mask at the workplace also contributed to this problem which is consistent with the finding in a study in Henan, China (He et al., 2010) and Northwest Ethiopia (Temesgen & Demissie, 2014). The discomfort caused by the mask also reduced the compliance of HCWs to it (Mahony et al., 2009). A study in Russia has identified several barriers in practising TBIC, such as lack of knowledge, negative attitudes related to the discomfort of the respirators and also the practices concerning the quality and care of respirators (Woith et al., 2012). They have also identified the motivators in practising TBIC such as periodical education and training, fear of infecting family members and the punishment by the administrator if a proper infection control measures were not implemented (Woith et al., 2012). Only 63% of respondents reported that they did the separation of TB patient from waiting at the common area together with other patients. A similar finding was reported in Nigeria and South Africa in which 65.0% of the HCWs practising the segregation of TB patients and 46.9% did not separate the suspected TB patient respectively (Hara, 2016; Kuyinu et al., 2016). According to the guideline, HCWs need to fast-track and prioritise TB patients and suspected TB patient in receiving medical care at the clinic and separate them from other patients to minimised TB exposure and its transmission (Occupational Health Unit Disease Control Division Ministry of Health Malaysia, 2012). The failure in separating TB patients from other patients was due to poor funding, building structural inadequacy, shortage of workforce and weak managerial support as reported in a qualitative study in Nigeria (Kuyinu et al., 2016).

4.3 Predictors of good knowledge on TB infection control

The diploma educational level was significantly a predictor of good knowledge of TBIC. This finding was not consistent with a similar study in Addis Ababa which reported that degree and higher educational level was more knowledgeable than diploma holder (AOR: 1.49, 95%CI: 1.47-2.19) (Demissie Gizaw et al., 2015). In this study, diploma holder comprised the majority of the respondent as compared to degree and higher educational level As for the job position, being a doctor was a significant predictor of good knowledge, the reason is obvious. However, a similar study in Addis Ababa showed that the job position was not an important predictor of good TBIC knowledge (Demissie Gizaw et al., 2015). The OPC, MCHC and 1MC have shown a statistically significant finding as the predictors of good knowledge, as compared to the DHO staffs. All the clinics were dealing with client clinically. Therefore they should be well versed about TBIC as compared to DHO staff who was mainly dealing with administrative work. However, in other similar studies, workplace or working unit were not associated with good TBIC knowledge (Buregyeya et al., 2016; Demissie Gizaw et al., 2015; Temesgen & Demissie, 2014). Besides, the family history of TB infection was also one of the predictors of good TBIC knowledge. Those with a family history of TB become more aware and have more knowledge and experience on TBIC as they were the one who was taking care of their infected family member. However, this finding is not yet reported in any similar study

before though a study in Sabah, Malaysia has found that family history of TB is not a significant risk factor of TB among HCWs (AOR: 1.9967, 95%CI: 0.6392-6.3881, p=0.2341) (Jelip et al., 2004).

4.4 The predictors of good practice on TB infection control

The diploma educational level has been proved as a predictor of good knowledge of TBIC. Thus the significant finding as a predictor of good practice has met the expectation. A study has shown a significant similar finding that the degree holder practice less satisfactory TBIC than the diploma holder (AOR:0.64, 95%CI: 0.47-0.88) (Demissie Gizaw et al., 2015). Even though the higher the education indicates the higher the knowledge, however, the level of practice cannot be predicted from it. The complexity of compliance issue involving individual beliefs, the perception of infection control measures as well as the existing barriers lead to a difference between knowledge and practice of an individual (Ott & French, 2009). Meanwhile, being married/widowed is a significant predictor of good practice on TB infection control. This significant finding was due to fear that TB infection can lead to a social or medical problem to other family members (Woith et al., 2012). However, other similar studies have found that marital status is not a significant predictor of good practice (Demissie Gizaw et al., 2015). The MCHC has proved to be the predictor of good practice. Better supervision from the infection control committee at the clinic is expected due to the clients of this clinic are mainly the vulnerable group of getting TB (Malaysian Thoracic Society, 2012). However, Tamir et al., (2016) in their study reported that instead of MCHC, TB clinic (AOR: 10.17, 95%CI: 3.81-27.17) and Anti-Retroviral Therapy (ART) clinic (AOR: 2.74, 95%CI: 1.13-6.63) were found to be the significant predictors of good practice. TB and ART clinic were well trained in managing infectious diseases as well as TBIC as they dealt with TB patients every day.

There were some limitations to this study. The cross-sectional study design is lack of temporal and causal relationship. Besides, the self-reporting practice might expose the respondents to response bias. They provide the answers they think the researchers were looking for, thus not representing their true response. The strength of the study is that it involved all HCWs dealing with patients throughout the whole spectrum of process and services in the clinic.

5.0 Conclusion and recommendation

Findings of this study revealed that proportions of good knowledge and good practice on TBIC among HCWs in this district are still inadequate. Diploma education level, family history of TB infection, job position as doctor and workplace (OPC, MCHC and 1MC) are the predictors of good knowledge on TBIC. Meanwhile, for practice on TBIC, diploma education level, married or widowed and working in maternal and child health clinic are the predictors of good practice. The existing TBIC training in providing knowledge to the respondents is inadequate. In addition, the lack of skill-based components in training has lead to poor practice on TBIC among HCWs in this district, especially among the non-clinical staffs. Training and hands-on session that emphasis on the practical aspect of TBIC measures need to be strengthened to ensure the implementation of good TBIC practice among the HCWs in this district. Cough etiquette education and hands-on skills on fit-testing must be emphasised.

Further study involving observational analysis needs to be done to assess the level of practice among the HCWs. Studies using focus group discussion can also be done to get in-depth information about the barriers in implementing good TBIC practice. Further research to investigate the effectiveness of training modules on TBIC in providing knowledge and acquiring practice on TBIC is highly recommended.

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Declaration

Authors declare that there is no conflict of interest in publication on this article.

Authors contribution

Author 1: data collection, analysis and drafting the article

Author 2 & 3: supervising the research concept and critical revision of the article

References

Apriani, L., Mcallister, S., Sharples, K., Alisjahbana, B., Ruslami, R., & Hill, P. C. (2019). Latent tuberculosis infection in health care workers in low and middle-income countries : an updated systematic review. *European Respiratory Journal*, *February*. https://doi.org/10.1183/13993003.01789-2018

Baussano, I., Nunn, P., Williams, B., Pivetta, E., Bugiani, M., & Scano, F. (2011). Tuberculosis among health care workers. *Emerging Infectious Diseases*, *17*(3), 488–494. https://doi.org/10.3201/eid1703.100947

Buregyeya, E., Kasasa, S., & Mitchell, E. M. H. (2016). Tuberculosis infection control knowledge and attitudes among health workers in Uganda: a cross-sectional study. *BMC Infectious Diseases*, *16*(1), 416. https://doi.org/10.1186/s12879-016-1740-7

Choi, J. S., & Kim, K. M. (2016). Predictors of respiratory hygiene/cough etiquette in a large community in Korea: A descriptive study. *American Journal of Infection Control*,

44(11), e271–e273. https://doi.org/10.1016/j.ajic.2016.04.226

Courtwright, A., & Turner, A. N. (2010). Tuberculosis and stigmatization: pathways and interventions. *Public Health Reports (Washington, D.C. : 1974)*, *125*(Suppl 4), 34–42. https://doi.org/10.2307/41434918

Demissie Gizaw, G., Aderaw Alemu, Z., & Kibret, K. T. (2015). Assessment of knowledge and practice of health workers towards tuberculosis infection control and associated factors in public health facilities of Addis Ababa, Ethiopia: A cross-sectional study. *Archives of Public Health = Archives Belges de Santé Publique*, *73*(1), 15. https://doi.org/10.1186/s13690-015-0062-3

Farhanah, A. W., Sarimah, A., & Jafri Malin, A. (2015). Self-Perception of CNS Tuberculosis prevention among healthcare workers in Malaysia. *World Journal of Medical Sciences*, *12*(3), 220–225. https://doi.org/10.5829/idosi.wjms.2015.12.3.9321

Hara, L. M. O. (2016). *Incidence and Determinants of Tuberculosis Among Healthcare Workers in Free State , South Africa : a Historical Prospective a Dissertation Submitted in Partial Fulfillment of the*. *April*.

He, G. X., Susan, van den H., Marieke J, van der W., Wang, G. J., Ma, S. W., Zhao, D. Y., Hu, Y. L., Yu, S. C., & Martien W, B. (2010). Infection control and the burden of tuberculosis infection and disease in health care workers in china: a cross-sectional study. *BMC Infectious Diseases*, *10*(1), 313. https://doi.org/10.1186/1471-2334-10-313

Hosmer, D. W., & Lemeshow, S. (2000). Applied Logistic Regression. In *Wiley Series in Probability and Sattistics* (Issue 1). https://doi.org/10.2307/2074954

Jaafar, M. H., & Krishnan, K. (2016). Prevalence of Latent Tuberculosis among Hospital Administrative Staff in Kuala Lumpur. *International Journal of Public Health Science*, *5*(3), 228–232.

Jelip, J., Mathew, G. G., Yusin, T., Dony, J. F., Singh, N., Ashaari, M., Lajanin, N., Ratnam, C. S., Ibrahim, M. Y., & Gopinath, D. (2004). Risk factors of tuberculosis among health care workers in Sabah, Malaysia. *Tuberculosis*, *84*(1–2), 19–23. https://doi.org/10.1016/j.tube.2003.08.015

Kanjee, Z., Catterick, K., Moll, A. P., Amico, K. R., & Friedland, G. H. (2011). Tuberculosis infection control in rural South Africa: Survey of knowledge, attitude and practice in hospital staff. *Journal of Hospital Infection*, *79*(4), 333–338. https://doi.org/10.1016/j.jhin.2011.06.017

Kuyinu, Y. A., Mohammed, A. S., Adeyeye, O. O., Odugbemi, B. A., Goodman, O. O., & Odusanya, O. O. (2016). Tuberculosis infection control measures in health care facilities offering tb services in Ikeja local government area, Lagos, South West, Nigeria. *BMC Infect Dis*, *16*(1), 126. https://doi.org/10.1186/s12879-016-1453-y

Mahony, J., John, M., Sarabia, A., Glavin, V., Chong, S., Webb, A., & Walter, S. D. (2009). *Surgical Mask vs N95 Respirator Among Health Care Workers*. *302*(17), 1865–1871.

Malaysian Thoracic Society. (2012). *clinical practice guidelines : management of tuberculosis* (Vol. 12, Issue November). Ministry of Health Malaysia. http://www.moh.gov.my/penerbitan/CPG2017/8612.pdf

Ministry of Health Malaysia. (2018). *Annual Report Ministry of Health Malaysia 2017*.

Mitchell, R. J., & Bates, P. (2011). Measuring Health-Related Productivity Loss. *Population Health Management*, *14*(2), 93–98. https://doi.org/10.1089/pop.2010.0014

Mugomeri, E., Chatanga, P., Lefunyane, M., Ruhanya, V., Nyandoro, G., & Chin'ombe, N. (2015). Adherence to tuberculosis infection control guidelines by nurses in Lesotho. *American Journal of Infection Control*, *43*(7), 735–738. https://doi.org/10.1016/j.ajic.2015.03.016

Occupational Health Unit Disease Control Division Ministry of Health Malaysia. (2012). *Guidelines on Prevention and Management of Tuberculosis for Health Care Workers in Ministry of Health Malaysia*. http://www.moh.gov.my/images/gallery/Garispanduan/Guidelines On Prevention And Management of Tuberculosis For HCWs In MOH.pdf

Occupational Safety and Health Administration (OSHA) and United States Department of Labor. (2016). *Report on the general types of Hazards in a Work place*. https://www.osha.gov/dte/grant_materials/fy10/sh-20839-10/circle_chart.pdf

Ott, M., & French, R. (2009). Hand hygiene compliance among health care staff and student nurses in a mental health setting. *Issues in Mental Health Nursing*, *30*(11), 702–704. http://www.ncbi.nlm.nih.gov/pubmed/19874098

Peters, C., Kozak, A., Nienhaus, A., & Schablon, A. (2020). Risk of Occupational Latent Tuberculosis Infection among Health Personnel Measured by Interferon-Gamma Release Assays in Low Incidence Countries — A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, *17*(581), 1–16. https://doi.org/10.3390/ijerph17020581

Stat Trek. (2017). *Random Number Generator*. StatTrek.Com. http://stattrek.com/statistics/random-number-generator.aspx

Tamir, K., Wasie, B., & Azage, M. (2016). Tuberculosis infection control practices and associated factors among health care workers in health centers of West Gojjam zone, Northwest Ethiopia: a cross-sectional study. *BMC Health Services Research*, *16*, 359. https://doi.org/10.1186/s12913-016-1608-y

Temesgen, C., & Demissie, M. (2014). Knowledge and practice of tuberculosis infection control among health professionals in Northwest Ethiopia. *BMC Health Services Research*, *14*(1), 593. https://doi.org/10.1186/s12913-014-0593-2

Tenna, A., Stenehjem, E. A., Margoles, L., Kacha, E., Blumberg, H. M., & Kempker, R. R. (2013). Infection control knowledge, attitudes and practices among healthcare workers in Addis Ababa, Ethiopia. *Infect Control Hosp Epidemiol*, *34*(12), 1289–1296. https://doi.org/10.1086/673979.Infection

Woith, W. M., Volchenkov, G., & Larson, J. L. (2010). Russian healthcare workers' knowledge of tuberculosis and infection control. *The International Journal of Tuberculosis and Lung Diseases*, *14*(11), 1489–1492. https://doi.org/10.1016/j.pestbp.2011.02.012.Investigations

Woith, W., Volchenkov, G., & Larson, J. (2012). Barriers and motivatorss affecting tuberculosis infection control practices of Russian Health Care Workers. *The International Journal of Tuberculosis and Lung Diseases*, *16*(8), 1092–1096. https://doi.org/10.5588/ijtld.10.0779

World Health Organization. (2019). *Global Tuberculosis Report*. WHO Library Cataloguing-in-Publication Data World.

World Health Organization. (2020a). *Key facts: Tuberculosis*. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/tuberculosis

World Health Organization. (2020b). *Tuberculosis profile : Malaysia*. World Health Organization. https://worldhealthorg.shinyapps.io/tb_profiles/?_inputs_&lan=%22EN%22&iso2=%22MY%22