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# Tuberculosis infection control knowledge and attitudes among health workers in Uganda: a cross-sectional study

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## Abstract

**Background:** The World Health Organization recommends TB infection control (TBIC) in health care facilities. In 2008, the Ministry of Health Uganda initiated efforts to implement TBIC by training of health care workers (HCWs). This study was carried out to assess knowledge and attitudes towards TBIC among HCWs.

**Methods:** We conducted a cross-sectional study among HCWs in health facilities in the districts of Mukono and Wakiso in Uganda, from October 2010 to February 2011. We assessed HCWs' knowledge of basic standards of TB diagnosis, treatment and TBIC and attitudes towards TBIC measures.

**Results:** Twenty four percent of the participants answered correctly all the basic TB knowledge questions. Overall, 62 % of the HCWs were judged to have adequate basic TB knowledge. At multivariable analysis, non-clinical cadres, were more likely to have poor basic TB knowledge, [adjusted odds ratio (aOR) 0.43; 95 % confidence interval (CI) 0.27–0.68]. Only 7 % of the respondents answered all the questions on TBIC correctly. Almost all the respondents (98 %; 529/541) knew that TB was transmitted through droplet nuclei, while only a third (34 %; 174/532) knew that masks do not protect the wearer from getting TB. Overall, 69 % (355/512) of the HCWs were judged to have adequate TBIC knowledge. At multivariable analysis, non-clinical cadres (aOR 0.61; 95 % CI 0.38–0.98) and having not attended TBIC training, (aOR 0.65; 95 % CI 0.42–0.99), were more likely to have poor TBIC knowledge. More than three quarters (77 %; 410/530) and 63 % (329/522) of the respondents had a high self-efficacy and perceived threat of acquiring TB at work, respectively. Having not attended a TBIC training was significantly associated with a low self-efficacy (aOR 0.52; 95 % CI 0.33–0.81) and low perceived threat of acquiring TB infection at work, (aOR 0.54; 95 % CI 0.36–0.81).

**Conclusions:** Our study finds moderate number of HCWs with correct knowledge and attitudes towards TBIC. Efforts should be put in place to train all HCWs in TBIC, with particular emphasis on the non-clinical staff due to their limited grasp of TBIC measures.

**Keywords:** Knowledge about TB infection control, Attitudes towards TB infection control, Health workers, Uganda

## Background

Transmission of tuberculosis (TB) to both patients and health care workers (HCWs) in health care settings has been reported from nearly every country, irrespective of local TB incidence [1, 2]. Transmission usually occurs from undiagnosed or inappropriately treated TB [3]. The risk for transmission varies by setting, occupational

group, local prevalence of TB, patient population, and TB infection control (TBIC) measures in health care facilities [4–6]. TB has long been known as occupational hazard among HCWs [2, 4, 7]. Specific groups are at disproportionate risk including morgue technicians, house-keeping staff, laboratory workers [8]. The key factors facilitating nosocomial TB transmission include: delayed diagnosis, ineffective treatment of patients, and lack or inadequate TBIC measures [3, 9].

Uganda is among 22 countries with a high burden of TB. Multi-drug resistant TB (MDR-TB) accounts for

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1.4 % among new patients and 12 % among retreatment [1, 10]. According to the WHO Global Report 2014, TB treatment success is 77 % [1]. Studies from Uganda found a high burden of TB among hospital staff, with a prevalence of 57 % for latent TB infection (LTBI), and 1.7 % compared to 0.3 % in the general population for active TB [11]. In addition, a high prevalence of LTBI was reported among medical students in Uganda [12]. The WHO recommends TBIC in health care institutions based on four levels: managerial, administrative, environmental and personal protective [3]. These measures have been found to minimize TB transmission [13, 14]. Therefore, it is recommended that all health facilities caring for TB patients or people presumed to have TB, implement TBIC [3]. In 2008, the Ministry of Health Uganda (MOH) and the Tuberculosis Assistance Programme (TBCAP) initiated efforts to implement TBIC by training of HCWs in selected districts, including Mukono district. In addition, the Uganda Ministry of Health produced TBIC guidelines [15] and rolled out the training in other districts in 2011.

Correct knowledge of a health problem, accompanied by the right attitude towards prevention, may result in healthy practices and behaviour [16, 17]. Previous research among HCWs in other countries has found that HCWs often lack knowledge about TB and infection control, which contributes to their increased risk [5]. This study was carried out to assess knowledge and attitudes towards TBIC among HCWs, in order to identify barriers to TBIC practices and to pinpoint specific groups who would benefit from mentoring and support on TBIC.

## Methods

### Study design, setting and population

We conducted a cross-sectional study among HCWs in health facilities in the districts of Mukono and Wakiso in central Uganda, from October 2010 to February 2011. These two districts surrounding Kampala, the capital city are semi-urban but predominantly rural. The HIV prevalence among the general population is estimated at 12.5 % among women and 8.4 % among men in Mukono and Wakiso [18]. In the two districts, training in TBIC was conducted 1–2 years preceding this survey. Health care in Uganda is provided by both public and private sector (private-not-for-profit - PNFP and private for profit). Uganda has a decentralised public health care system. At the lowest level is the Village Health Committee which acts as an outpost for outreach services at the village level, followed by health centre (HC) II at parish level (serving about 5000 people), HC III at a sub-county level (serving about 25,000 people), HC IV at the sub-district level (about 100,000 people) and the District Hospital. Each level offers services that the lower

level provides in addition to services for its own level. TB services are offered at HC IIIs and above. For the purpose of this study, only public and PNFP health facilities from sub-county health facility (HC III) to hospital level (excluding those located on islands because of accessibility challenges) were included in the study. This is because TBIC training had only been conducted in the public and PNFPs health facilities. In Mukono district, the training was carried out by TBCAP, while in Wakiso district, the MOH Uganda did the training using the same training materials, with different facilitators and support. The objectives of the training in both districts were to teach HCWs a) how to conduct a TBIC assessment in a health facility and b) to develop and implement a TBIC plan in their facilities. Health facilities were asked to send to two people (usually a TB focal person and a laboratory technician) to attend the training. The trained individuals were supposed to transfer what they learnt to other HCWs through continuous medical education (CMEs) sessions in their respective health facilities. These CMEs are mainly geared towards (and attended by) HCWs who are directly involved in the management of patients.

### Sample size and sampling

A list of all health facilities within each district and the list of HCWs were obtained from the district health offices. Fifty-two health facilities were included in the study and the number of respondents from each health facility was proportional to the size of the facility in order to guarantee an equal probability of selection. HCWs were stratified by cadre in order to obtain a proportional representation of each staff category (doctors, clinical officers, nursing, midwifery, nursing aid, laboratory and radiographers). However, in facilities without all cadres represented, simple random sampling of all the HCWs in that facility was done. HCWs who were not present on the day of the study, for any reason were excluded from the study. Our calculated sample size was 551 HCWs. Full details of the methodology, including sample size calculation can be found in our previous publication [19].

### Data collection

A pre-tested self-administered questionnaire was used to collect data. We evaluated health workers' knowledge of basic standards of TB diagnosis, and treatment as well as TBIC (knowledge about TBIC measures such as use of masks/respirators, triaging and ventilation) and attitudes towards TBIC measures. The questionnaire consisted of 20 questions in total, 7 for basic TB knowledge, 7 for knowledge on TBIC and 6 for attitudes towards TBIC. All the knowledge questions were true/false/ don't know options ('do not know' answers were scored as

**Table 1** Socio-demographic characteristics of the respondents in Mukono and Wakiso districts

| Variable                  | n/N (%)        |
|---------------------------|----------------|
| District                  |                |
| Mukono                    | 275/543 (51 %) |
| Wakiso                    | 268/543 (49 %) |
| Facility level            |                |
| Hospital                  | 253/543 (47 %) |
| HCIV                      | 119/543 (22 %) |
| HC III                    | 171/543 (31 %) |
| Facility ownership        |                |
| Government                | 351/543 (65 %) |
| PNFP                      | 192/543 (35 %) |
| Sex                       |                |
| Male                      | 145/538 (27 %) |
| Female                    | 393/538 (73 %) |
| Job category              |                |
| Doctor                    | 18/540 (3 %)   |
| Clinical officer          | 75/540 (14 %)  |
| Registered nurse          | 83/540 (16 %)  |
| Enrolled nurse            | 115/540 (21 %) |
| Midwife                   | 75/540 (14 %)  |
| Lab staff                 | 69/540 (13 %)  |
| Nursing assistants        | 81/540 (15 %)  |
| Others                    | 19/540 (4 %)   |
| Age                       |                |
| 15–24                     | 71/543 (13 %)  |
| 25–34                     | 192/543 (35 %) |
| 35–44                     | 129/543 (24 %) |
| 44 and above              | 151/543 (28 %) |
| Cadre                     |                |
| Clinical                  | 435/540 (81 %) |
| Non-clinical              | 105/540 (19 %) |
| Received training in TBIC |                |
| Yes                       | 241/534 (45)   |
| No                        | 293/534 (55)   |
| Department                |                |
| Outpatient <sup>a</sup>   | 456/536 (85 %) |
| Medical ward              | 80/536 (15 %)  |

<sup>a</sup>Outpatient included the general outpatient department (OPD), HIV clinic, laboratory, pharmacy, records, and maternal child health services  
Denominators vary for different variables because not all respondents answered all the questions

incorrect), while those on attitudes were scored on five and three point likert scales, but were collapsed to two. The questions were adapted from the [www.ghdonline.org/tbic-baseline-assessment-tool-version-10-April-8-2009](http://www.ghdonline.org/tbic-baseline-assessment-tool-version-10-April-8-2009) with some modifications. One point was awarded for

**Table 2** Basic knowledge about tuberculosis and infection control among health workers in Mukono and Wakiso districts

| Question   | n/N  | Percentage (%) |
|--|--|----------------|
| Basic TB knowledge   |  |                |
| TB is the most common opportunistic infection affecting PLWHA  | Yes 515/5415<br>No 26/54                             | 95<br>5        |
| HIV infection increases the risk of developing TB  | Yes 527/541<br>No 14/541                             | 97<br>3        |
| There is no difference between TB infection and TB disease   | Yes 222/533<br>No 311/533                            | 42<br>58       |
| A patient with suspected infectious TB should first be treated with broad-spectrum antibiotics before doing any investigations     | Yes 192/540<br>No 348/540                            | 36<br>64       |
| The first step in assessing a TB suspect is to send for a chest X-ray  | Yes 104/537<br>No 433/537                            | 19<br>81       |
| Sputum smear microscopy for AFB (Acid Fast Bacilli) is the quickest and cheapest way of identifying infectious TB patients         | Yes 510/540<br>No 30/540                             | 94<br>6        |
| All patients who have suspected infectious TB for the second time should have a sputum sent for culture and susceptibility testing | Yes 414/535<br>No 121/535                            | 77<br>23       |
| TBIC knowledge   |  |                |
| How is TB transmitted?   | Droplet 529/541<br>Utensils and shaking hands 12/541 | 98<br>2        |
| Covering the mouth when coughing has no effect on how many TB bacilli are expelled from an infectious TB Patient                   | Yes 154/535<br>No 381/535                            | 29<br>71       |
| TB is more likely to be transmitted on TB wards as opposed to out-patient departments  | Yes 236/538<br>No 302/538                            | 44<br>56       |
| Is ventilation important in the implementation of TB infection control?  | Yes 520/538<br>No 18/538                             | 98<br>2        |
| A TB suspect should be placed in front of the queue in order to access services quickly  | Yes 348/533<br>No 85/533                             | 65<br>35       |
| Surgical masks do not protect the wearer against TB infection  | Yes 174/532<br>No 353/532                            | 34<br>66       |
| Sputum induction puts health workers at an increased risk of getting infected with TB  | Yes 406/533<br>No 127/533                            | 76<br>24       |

each correct answer. Thus the basic knowledge on basic TB and TBIC was allocated a minimum score of zero and a maximum of 7 each. Data were also collected on HCWs background characteristics including age, sex, qualifications, level of facility they were working in and

type of facility in terms of ownership (public or private) and district of origin.

### Data management and analysis

Data were entered in Epi-Info Version 3.2.2 software and cleaned before being exported to STATA version 10 for analysis. Respondents were further categorized into clinical and non-clinical cadres. Clinical cadres included professionally qualified health providers (doctors/pharmacists, clinical officers, midwives, registered and certified nurses), while the rest were classified as non-clinical (nursing assistants and health management information system focal persons). Regarding basic knowledge on TB and TBIC, composite variables were created for each. These two variables were the outcome variables, while the explanatory ones were, age, sex, cadre, level of facility, district where the facility is located and ownership of

the facility. For each outcome variable we computed a total score for every participant on the attributes, then the percentage by multiplying the total score by 100%. Respondents answering >85 % of the basic TB knowledge questions were considered to have good basic TB knowledge and others poor knowledge. Those answering >70 % of the TBIC knowledge questions were considered to have good TBIC knowledge and others poor knowledge. We used a lower cut off for TBIC knowledge (>70 %) compared to >85 % for basic TB knowledge, because TBIC is a new concept and not many of the HCWs may know it compared to basic TB knowledge.

Regarding attitudes towards TBIC, two separate composite variables were created; HCWs' self-efficacy and HCWs' perceived threat of acquiring LTBI at work. HCWs' self-efficacy composed of the following three questions; i) There are things that I can do as a health

**Table 3** Bivariate and multivariable analysis of basic knowledge of TB among health care workers in Wakiso and Mukono districts in Uganda

| Variable               | Basic knowledge of TB |              | Univariate analysis<br>Crude OR 95 % CI | Multivariate analysis<br>Adjusted OR 95 % CI | P      |
|------------------------|-----------------------|--------------|---|--|--------|
|                        | Good                  | Poor         |   |  |        |
| District               |                       |              |   |  |        |
| Mukono                 | 168/255 (66)          | 87/255 (34)  | 1                                       | 1  |        |
| Wakiso                 | 154/262 (59)          | 108/262 (41) | 0.73 (0.51–1.05)                        | 0.83 (0.56–1.24)                             | 0.37   |
| Sex                    |                       |              |   |  |        |
| Male                   | 96/138 (70)           | 42/138 (30)  | 1                                       | 1  |        |
| Female                 | 226/376 (60)          | 150/376 (40) | 0.65 (0.43–1.00)                        | 0.72 (0.47–1.11)                             | 0.14   |
| Age                    |                       |              |   |  |        |
| 15–24                  | 39/67 (58)            | 28/67 (42)   | 1                                       | -  |        |
| 25–34                  | 117/185 (63)          | 68/185 (37)  | 1.23 (0.69–2.18)                        | -  |        |
| 35–44                  | 77/124 (62)           | 47/124 (38)  | 1.17 (0.64–2.15)                        | -  |        |
| 44 and above           | 89/141 (63)           | 52/141 (37)  | 1.22 (0.67–2.22)                        | -  |        |
| Facility level         |                       |              |   |  |        |
| HCIII                  | 108/167 (65)          | 59/167 (35)  | 1                                       | -  | -      |
| HCIV                   | 66/112(59)            | 46/112 (41)  | 0.78 (0.47–1.28)                        | -  |        |
| Hospital               | 148/238 (62)          | 90/238 (38)  | 0.89 (0.59–1.35)                        | -  | -      |
| Facility ownership     |                       |              |   |  |        |
| Government             | 208/337 (62)          | 129/337 (38) | 1                                       | -  | -      |
| PNFP                   | 114/180 (63)          | 66/180 (37)  | 1.07 (0.73–1.55)                        | -  | -      |
| Cadre                  |                       |              |   |  |        |
| Clinical               | 278/416 (67)          | 138/416 (33) | 1                                       | 1  |        |
| Non-clinical           | 43/100 (43)           | 57/100 (57)  | 0.37 (0.23–0.58)                        | 0.43 (0.27–0.68)                             | <0.001 |
| Attended TBIC training |                       |              |   |  |        |
| Yes                    | 160/230 (70)          | 70/230 (30)  | 1                                       | 1  |        |
| No                     | 160/280 (57)          | 120/280 (43) | 0.58 (0.40–0.84)                        | 0.70 (0.47–1.05)                             | 0.08   |
| Workplace              |                       |              |   |  |        |
| In-patient             | 49/79 (62)            | 30/79 (38)   | 1                                       | -  |        |
| Outpatient             | 272/434 (63)          | 162/434 (37) | 1.02 (0.62–1.68)                        | -  |        |

**Table 4** Bivariate and multivariable analysis of TBIC knowledge among health care workers in Wakiso and Mukono districts in Uganda

| Variable               | TBIC knowledge |              | Univariate analysis<br>Crude OR 95 % CI | Multivariate analysis<br>Adjusted OR 95 % CI | P     |
|------------------------|----------------|--------------|---|--|-------|
|                        | Good           | Poor         |   |  |       |
| District               |                |              |   |  |       |
| Mukono                 | 188/254 (74)   | 66/254 (26)  | 1                                       | 1  |       |
| Wakiso                 | 167/258 (65)   | 91/258 (35)  | 0.64 (0.44–0.94)                        | 0.71 (0.47–1.07)                             | 0.10  |
| Sex                    |                |              |   |  |       |
| Male                   | 103/137 (75)   | 34/137 (25)  | 1                                       | 1  |       |
| Female                 | 252/372 (68)   | 120/372 (32) | 0.69 (0.44–1.08)                        | 0.77 (0.49–1.23)                             | 0.28  |
| Age                    |                |              |   |  |       |
| 15–24                  | 40/63 (63)     | 23/63 (37)   | 1                                       | -  |       |
| 25–34                  | 136/186 (73)   | 50/186 (27)  | 1.56 (0.85–2.87)                        | -  |       |
| 35–44                  | 87/123 (71)    | 36/123 (29)  | 1.39 (0.73–2.64)                        | -  |       |
| 44 and above           | 92/140 (66)    | 48/140 (34)  | 1.10 (0.59–2.05)                        | -  |       |
| Facility level         |                |              |   |  |       |
| HCIII                  | 112/166 (67)   | 54/166 (33)  | 1                                       | -  |       |
| HCIV                   | 75/112 (67)    | 37/112 (33)  | 0.98 (0.59–1.63)                        | -  |       |
| Hospital               | 168/234 (72)   | 66/234 (28)  | 1.22 (0.79–1.89)                        | -  |       |
| Facility ownership     |                |              |   |  |       |
| Government             | 228/332 (69)   | 104/332 (31) | 1                                       | -  | -     |
| PNFP                   | 127/180 (71)   | 53/180 (29)  | 1.09 (0.74–1.62)                        | -  | -     |
| Cadre                  |                |              |   |  |       |
| Clinical               | 297/411 (72)   | 114/411 (28) | 1                                       | 1  |       |
| Non-clinical           | 58/99 (59)     | 41/99 (41)   | 0.54 (0.34–0.86)                        | 0.61 (0.38–0.97)                             | 0.04  |
| Workplace              |                |              |   |  |       |
| In-patient             | 53/75 (71)     | 22/75 (29)   | 1                                       | -  | -     |
| Outpatient             | 299/432 (69)   | 133/432 (31) | 0.93 (0.54–1.59)                        | -  |       |
| Attended TBIC training |                |              |   |  |       |
| Yes                    | 174/225 (77)   | 51/225 (27)  | 1                                       | 1  |       |
| No                     | 180/282 (64)   | 102/282 (36) | 0.51 (0.34–0.76)                        | 0.64 (0.42–0.99)                             | 0.047 |

worker to protect myself from TB, ii) 2. How much impact do you think you have to influence implementation of LTBI control measures in your facility; and iii) It is my responsibility to help identify TB suspects. “HCWs’ perceived threat of acquiring LTBI at work” composed of; i) My risk of contracting TB is NOT the same whether windows are open or closed; ii) There is need to screen health workers for TB; iii) How concerned are you about getting TB at your work. For each outcome variable we computed a total score for every participant on the attributes. These two variables were treated as ordinal variables with “0” meaning zero correct answer, “1” meaning one correct answer, “2” meaning two correct answers, and “3” meaning three correct answers. However, because of small numbers in the cells of “0” and “1” levels, respondents who answered zero to two correct answers were considered to have low self-efficacy/perceived threat, while those that answered correct all the 3

questions, as high self-efficacy/perceived threat. Bivariate analysis using Chi-square test and odds ratios (OR) were performed for basic TB knowledge, knowledge about TBIC, HCWs’ self-efficacy and HCWs’ perceived threat of acquiring LTBI at work. Logistic regression was used for multivariable analysis to explore the factors associated with all the four outcome. In addition, TBIC knowledge was used to predict self-efficacy and basic TB knowledge for perceived threat of acquiring B infection at work. Variables with  $p < 0.2$  at bivariate level were included in the multivariable analysis model. An association was considered significant at  $P < 0.05$ .

## Results

### General characteristics

543 out of 551 HCWs (98.5 %) completed the questionnaire. The majority of the respondents (73 %) were

**Table 5** Bivariate and multivariable analysis of HCWs self-efficacy towards TBIC in Wakiso and Mukono districts in Uganda

| Variable               | HCWs Self-efficacy towards TBIC |              | Univariate analysis<br>Crude OR 95 % CI | Multivariate analysis<br>Adjusted OR 95%CI | P     |
|------------------------|---------------------------------|--------------|---|--|-------|
|                        | High, (n%)                      | Low (n,%)    |   |  |       |
| District               |                                 |              |   |  |       |
| Mukono                 | 209/266 (79)                    | 57/266 (21)  | 1                                       |  |       |
| Wakiso                 | 201/264 (76)                    | 63/264 (24)  | 0.87 (0.58–1.31)                        | -  |       |
| Sex                    |                                 |              |   |  |       |
| Male                   | 108/142 (76)                    | 34/142 (24)  | 1                                       |  |       |
| Female                 | 299/383 (78)                    | 84/383 (22)  | 1.12 (0.71–1.77)                        | -  |       |
| Age                    |                                 |              |   |  |       |
| 15–24                  | 53/70 (76)                      | 17/70 (24)   | 1                                       |  |       |
| 25–34                  | 153/192 (80)                    | 39/192 (20)  | 1.25 (0.66–2.41)                        | -  |       |
| 35–44                  | 95/124 (77)                     | 29/124 (23)  | 1.05 (0.53–2.08)                        |  |       |
| 44 and above           | 109/144 (76)                    | 35/144 (24)  | 0.99 (0.51–1.94)                        |  |       |
| Facility level         |                                 |              |   |  |       |
| HCIII                  | 129/169 (76)                    | 40/169 (24)  | 1                                       |  |       |
| HCIV                   | 90/116 (78)                     | 26/116 (22)  | 1.07 (0.61–1.88)                        | -  |       |
| Hospital               | 191/245 (78)                    | 54/245 (22)  | 1.09 (0.69–1.75)                        |  |       |
| Facility ownership     |                                 |              |   |  |       |
| Government             | 263/344 (76)                    | 81/344 (24)  | 1                                       |  |       |
| PNFP                   | 147/186 (79)                    | 39/186 (21)  | 1.16 (0.75–1.78)                        | -  |       |
| Cadre                  |                                 |              |   |  |       |
| Clinical               | 338/425 (80)                    | 87/425 (20)  | 1                                       | 1  |       |
| Non-clinical           | 70/102 (69)                     | 32/102 (31)  | 0.56 (0.34–0.91)                        | 0.63 (0.38–1.04)                           | 0.07  |
| Workplace              |                                 |              |   |  |       |
| In-patient             | 60/78 (77)                      | 18/78 (23)   | 1                                       |  |       |
| Out-patient            | 345/445 (78)                    | 100/445 (22) | 1.03 (0.58–1.83)                        | -  |       |
| Attended TBIC training |                                 |              |   |  |       |
| Yes                    | 197/232 (85)                    | 35/232 (15)  | 1                                       | 1  |       |
| No                     | 209/292 (72)                    | 83/292 (23)  | 0.44 (0.28–0.69)                        | 0.52 (0.33–0.81)                           | <0.01 |
| TBIC knowledge         |                                 |              |   |  |       |
| Poor                   | 111/155 (72)                    | 44/155 (28)  | 1                                       | 1  |       |
| Good                   | 276/347 (80)                    | 71/347 (20)  | 1.54 (0.99–2.38)                        | 1.27 (0.81–2.00)                           | 0.29  |

females. The mean age of the respondents was 35.6 (10 standard deviation) years and median of 34 years [interquartile range (IQR) 27 to 43]. Over 80 % of the respondents belonged to the clinical cadre, as opposed to non-clinical. Among the clinical cadre, the majority were nurses (51 %), Table 1. The majority of the respondents worked in outpatient department (i.e., general outpatient department, maternal and child health services, pharmacy, HIV/ART clinic and laboratory). Less than half (45 %; 241/534) of the participants reported attending a TBIC training, with a significant difference by cadre (clinical and non-clinical;  $p = 0.002$ ).

#### Basic TB knowledge and determinants

The majority of the respondents (95 %; 515/541) knew that TB is the most common opportunistic infection affecting people living with HIV infection. Almost all (97 %; 527/541) of the respondents were aware that HIV increases the risk of developing TB disease, Table 2. The minimum knowledge score attained by the HCWs was 2 (28.5 %) of the expected maximum of 7 (100 %), with a median of 6 (85.7 %; IQR = 14.3). Twenty four percent (123/517) of the participants answered correctly all the questions about basic TB knowledge. Overall, 62 % (322/517) of the HCWs were judged to have adequate basic TB knowledge, based on the cut off >85.7 % (i.e., median



score). At bivariate analysis, poor basic TB knowledge was significantly associated with female sex (OR 0.65; 95 % CI 0.43–1.00); not attending TBIC training (OR 0.58; 95 % CI 0.40–0.84) and being a non-clinical cadre (OR 0.37; 95 % CI 0.23–0.58). However, basic TB knowledge was not associated with age category, facility ownership, level of facility and where the HCW worked i.e., Wakiso or Mukono district and medical ward or outpatient, Table 3. At multivariable analysis, non-clinical cadres, were more likely to have poor basic TB knowledge, adjusted OR (aOR) 0.43; 95 % CI 0.27–0.68.

#### Knowledge about TBIC and determinants

The minimum score on knowledge about TBIC attained by the respondents was 0 points (0 %) of the expected maximum 7 points (100 %), with a median of 5 points (71 %; interquartile range = 28.6). Only 7 % (35/512) of the respondents answered all the questions on TBIC correctly. Almost all the respondents (98 %; 529/541) knew that TB was transmitted through droplet nuclei, while a third (34 %; 174/532) knew that masks do not protect the wearer from getting TB, Table 2. Overall, 69 % (355/512) of the HCWs were judged to have adequate TBIC knowledge, based on the cut of >70 %. At bivariate analysis, poor TBIC knowledge was significantly associated with coming from Wakiso district (OR 0.64; 95 % CI 0.44–0.94); not attending TBIC training (OR 0.51; 95 % CI 0.34–0.76) and being non-clinical (OR 0.54; 95 % CI 0.34–0.86). However, knowledge about TBIC was not associated with age category, sex, facility ownership, level of facility and where the HCW worked i.e., medical ward or outpatient, Table 4. At multivariable analysis, being non-clinical (aOR 0.61; 95 % CI 0.38–0.97) and having not attended TBIC training (aOR 0.64; 95 % CI 0.42–0.99), were significantly associated with poor TBIC knowledge.

#### Attitudes towards TB infection control measures

##### Self-efficacy

Almost all the respondents (97 %; 524/537) felt there are things they could do as HCWs to protect themselves from TB, Table 6. The majority (87 %, 464/536) reported that they had a moderate capacity to influence the implementation of TBIC in their facilities. More than three quarters (77 %; 410/530) of the respondents were considered to have a high self-efficacy. At bivariate analysis, being non-clinical cadre (OR 0.56; 95 % CI 0.34–0.91) and having not attended training in TBIC (OR 0.44; 95 % CI 0.28–0.69) were more likely to have a low self-efficacy, Table 5. At multivariable analysis, after controlling for cadre category and knowledge in TBIC, having not attended a TBIC training was significantly associated with a low self-efficacy (aOR 0.52; 95 % CI 0.33–0.81).

#### Perceived threat of acquiring LTBI at work

Twenty one percent (112/537) of the HCWs mentioned that their risk of contracting TB was the same whether the consultation window was open or closed, Table 6. Almost two thirds (63 %; 329/522) of the respondents were considered to have a high perceived threat of acquiring LTBI at work. At bivariate level, a low perceived threat was significantly associated with being female (OR 0.62; 95 % CI 0.41–0.94); having not attended training in TBIC (OR 0.47; 95 % CI 0.33–0.69), and being non-clinician (OR 0.54; 95 % CI 0.35–0.84), Table 7. At multivariable analysis, not having attended TBIC training was significantly associated with having a low perceived threat of acquiring LTBI at work, (aOR 0.54; 95 % CI 0.36–0.81).

#### Discussion

The study assessed HCWs knowledge and attitudes towards TBIC. Twenty four percent (123/517) of the participants answered correctly all the questions about basic TB knowledge. More than half (62 %) of the HCWs were judged to have adequate basic TB knowledge. Being non-clinical cadre was associated with having poor basic TB knowledge. Additionally, more than two thirds of the HCWs were judged to have adequate TBIC knowledge. Indeed, only 7 % of the respondents answered all the questions on knowledge about TBIC correctly. Knowledge about protection offered by the mask was the lowest with only 34 % of the respondents being aware that surgical masks do not protect the wearer against getting TB. Being a non-clinical cadre and not having attended TBIC training, were associated with having poor TBIC knowledge. Over half of the

**Table 6** Attitudes towards TB infection control measures among health care workers in Mukono and Wakiso districts

| Variable  |                    | N       | Percent |
|---|--------------------|---------|---------|
| There are things that I can do as a health worker to protect myself from TB   | Yes                | 524/537 | 98      |
|   | No                 | 13/537  | 2       |
| How much impact do you think you have to influence implementation of TB infection control measures in your facility | A lot              | 464/536 | 87      |
|   | Little/none        | 72/536  | 13      |
| It is my responsibility to help identify TB suspects  | Very much          | 474/537 | 88      |
|   | Somehow/Not at all | 63/537  | 12      |
| My risk of contracting TB is NOT the same whether windows are open or closed  | Yes                | 425/537 | 79      |
|   | No                 | 112/537 | 21      |
| There is need to screen health workers for TB   | Yes                | 447/537 | 83      |
|   | No                 | 90/537  | 17      |
| How concerned are you about getting TB at your work   | Concerned          | 504/529 | 95      |
|   | Not concerned      | 25/529  | 5       |

**Table 7** Bivariate and multivariable analysis of perceived threat of acquiring TB infection at work among HCWs in Wakiso and Mukono districts in Uganda

| Variable               | HCWs perceived threat |              | Univariate analysis<br>Crude OR 95 % CI | Multivariate analysis<br>Adjusted OR 95%CI | P     |
|------------------------|-----------------------|--------------|---|--|-------|
|                        | High, (n%)            | Low (n,%)    |   |  |       |
| District               |                       |              |   |  |       |
| Mukono                 | 171/261 (66)          | 90/261 (34)  | 1                                       | -  |       |
| Wakiso                 | 158/261 (61)          | 103/261 (39) | 0.81 (0.57–1.15)                        |  |       |
| Sex                    |                       |              |   |  |       |
| Male                   | 100/141 (71)          | 41/141 (29)  | 1                                       | 1  |       |
| Female                 | 226/376 (60)          | 150/376 (40) | 0.62 (0.41–0.94)                        | 0.68 (0.44–1.07)                           | 0.09  |
| Age                    |                       |              |   |  |       |
| 15–24                  | 42/68 (62)            | 26/68 (38)   | 1                                       |  |       |
| 25–34                  | 121/186 (65)          | 65/186 (35)  | 1.15 (0.65–2.05)                        | -  |       |
| 35–44                  | 77/122 (63)           | 45/122 (37)  | 1.06 (0.57–1.95)                        |  |       |
| 44 and above           | 89/146 (61)           | 57/146 (39)  | 0.96 (0.54–1.75)                        |  |       |
| Facility level         |                       |              |   |  |       |
| HCIII                  | 108/168 (64)          | 60/168 (36)  | 1                                       |  |       |
| HCIV                   | 71/116 (61)           | 45/116 (39)  | 0.87 (0.54–1.43)                        | -  |       |
| Hospital               | 150/238 (63)          | 88/238 (37)  | 0.95 (0.63–1.43)                        |  |       |
| Facility ownership     |                       |              |   |  |       |
| Government             | 209/344 (61)          | 135/344 (39) | 1                                       | 1  |       |
| PNFP                   | 120/178 (67)          | 58/178 (33)  | 1.34 (0.91–1.96)                        | 1.28 (0.84–1.94)                           | 0.25  |
| Cadre                  |                       |              |   |  |       |
| Clinical               | 277/421 (66)          | 144/421 (34) | 1                                       | 1  |       |
| Non-clinical           | 50/98 (51)            | 48/98 (49)   | 0.54 (0.35–0.84)                        | 0.63 (0.39–1.02)                           | 0.06  |
| Workplace              |                       |              |   |  |       |
| In-patient             | 50/75 (67)            | 25/75 (33)   | 1                                       | -  |       |
| Out-patient            | 273/440 (62)          | 167/440 (38) | 0.82 (0.49–1.37)                        |  |       |
| Attended TBIC training |                       |              |   |  |       |
| Yes                    | 168/230 (73)          | 62/230 (27)  | 1                                       | 1  |       |
| No                     | 161/286 (56)          | 125/286 (44) | 0.47 (0.33–0.69)                        | 0.54 (0.36–0.81)                           | <0.01 |
| Basic TB knowledge     |                       |              |   |  |       |
| Poor                   | 106/187 (57)          | 81/187 (43)  | 1                                       | 1  |       |
| Good                   | 208/311 (67)          | 103/311 (33) | 1.54 (1.06–2.24)                        | 1.24 (0.84–1.86)                           | 0.27  |

respondents had positive attitudes towards TBIC. Having not attended TBIC training was associated with a low self-efficacy and perceived threat to acquiring TB at work.

The findings that non-clinical staff and not attending TBIC training tend to have poor basic TB knowledge, TBIC knowledge and poor attitudes towards TBIC (low HCWs' self-efficacy and perceived threat of acquiring LTBI at work), is similar to what was found in the Russian study where physicians and nurses were more knowledgeable than the support staff i.e., non-clinical [20]. This may be attributable to their different educational background and lack of priority for in-service IC

trainings. Thus calls for the need to train non-clinical HCWs in TBIC in order to improve their knowledge and attitudes. This is because literature shows a heightened risk of getting TB disease among housekeeping staff [21]. The lower level of knowledge on use of masks is worrying. This is similar to what was found in a study done Ethiopia [22]. Knowledge of TBIC is similar to or higher than what was reported in the Ethiopian study, where 74.4 % of the respondents were found to have good TBIC knowledge [22], while in our study it is 69 %. This difference can be explained by a higher cut off of 70 % for our study, compared to the 60 % in the Ethiopian study.



Not having attended TBIC training was associated with poor TBIC knowledge and attitudes towards TBIC (HCWs' self-efficacy and perceived threat of acquiring LTBI at work). This is consistent with findings from elsewhere that lack of trained staff is a big obstacle to TB control [22, 23]. This raises the importance of training all HCWs in TB and TBIC, i.e., institutionally based and in-service training/continuing education. Well educated HCWs with education needs tailored to job categories is critical for implementation of TBIC measures [3, 20]. A baseline assessment prior to the training can help identify both the strengths and weaknesses of the HCWs and thus enhance targeted training. Trainings for nursing aids and other lower cadres like cleaners and security guards can be specially arranged at the health facility to focus on their needs and gaps with regard to TBIC.

This study has limitations. We didn't measure the practice of TBIC. Looking at TBIC practice would have given a complete picture. However, this was reported in one of the publications [24], where implementation of TBIC was found to be poor. The strengths of our study was to include all cadres of HCWs both clinical and non-clinical.

## Conclusions

More than half of the respondents were found to have good basic TB knowledge, TBIC knowledge and positive attitudes towards TBIC. Being a non-clinical cadre was associated with poor basic TB knowledge and TBIC knowledge. In addition, not having received training in TBIC was associated with poor TBIC knowledge and attitudes towards TBIC. These gaps in knowledge and attitudes recorded in this study can increase the risk of nosocomial transmission of TB. For effective implementation of TBIC, training in TBIC is critical with support staff (nursing aids, cleaners and security) being prioritized.

## Abbreviations

HCWs, health care workers; MDR-TB, multi drug resistant tuberculosis; SD, standard deviation; TBCAP, Tuberculosis Assistance Programme; TBIC, tuberculosis infection control

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## Availability of data and materials

Data supporting the findings can be found in the Tables. Additional data that was analysed may be shared upon request.

## Authors' contributions

EB and EMH were involved in the development of the proposal. EB carried out field work. EB, EMH and SK undertook data analysis. EB, EMH and SK drafted the manuscript and approved the final draft for publication.

## Competing interests

The authors declare that they have no competing interests.

## Consent for publication

Not applicable.

## Ethical approval and consent to participants

The research protocol was approved by the institutional review board of the Makerere University School of Public Health and the Uganda National Council for Science and Technology (Ref.nr. HS 880). Permission from the in-charges of the health facilities was obtained. Informed written consent was obtained from the participants at the time of data collection. Respondents were assured of confidentiality.

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