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ORIGINAL RESEARCH

Knowledge of Tuberculosis Prevention Across Eight Districts in Central Uganda: An Analysis of Lot Quality Assurance Sampling Survey Data

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Purpose: This study assessed tuberculosis (TB)-related knowledge among people of different demographic groups that is essential for effective TB program planning and implementation.

Materials and Methods: We conducted a cross-sectional study using the lot quality assurance sampling (LQAS) methodology in 8 districts, stratifying each district into five supervision areas (SAs). We randomly sampled 19 villages from each SA using probability proportional to size (PPS). We interviewed 2280 respondents, including 760 each of youth 15–24 years, women 15–49 years and men 15+ years. The data were analyzed in proportions and SA-level classifications using the LQAS-based decision rules.

Results: The findings underscore variations in TB knowledge across demographic groups. Among youths, knowledge of at least two TB symptoms stood at 48.6%, while among women and men, it was 55.3% and 57.0%, respectively. Awareness of TB curability was 75.6% among youths, 80.2% among women, and 84.6% among men. A notable proportion of youths (83.4%), women (89.5%), and men (91.4%) were aware of the potential coexistence of HIV and TB. Concerning actions to take if a family member is suspected of having TB, 89.4% of youth, 92.4% of women, and 57.5% of men were knowledgeable. Knowledge of the risks of incomplete TB treatment was noted among 30.9% of youth, 33.0% of women, and 35.0% of men.

Conclusion: There is variation in the level of knowledge across different TB thematic areas between demographic groups, districts and sub-districts (SAs). Planners and implementers of TB programs should be cognizant of such variations and make deliberate efforts to develop tailored interventions in order to address the information and/or education needs of specific contexts in order to improve TB outcomes. The findings highlight the need to particularly target the youth with education programs on TB.

Plain Language summary: This study assessed how much different groups of people know about tuberculosis (TB).

Why was the study done?: The goal was to find out how well people from different age groups and genders understand TB. Understanding this is important for planning and improving TB health programs.

What methods did we employ?: We selected 2280 people across eight districts. We divided each district into five sub-divisions and selected 19 villages from each sub-division. From each village, we interviewed one each of youth aged 15–24, women aged 15–49, and men aged 15 years or older.

What did we find?:

- Young people who knew about at least two TB symptoms were 48.6%, compared to 55.3% of women and 57.0% of men.
- Awareness that TB can be cured was 75.6% among youths, 80.2% among women, and 84.6% among men.
- Most people knew that TB and HIV can occur together: 83.4% of youths, 89.5% of women, and 91.4% of men.
- About actions to take if someone in their family might have TB, 89.4% of youths, 92.4% of women, and 57.5% of men were aware.
- Knowledge about the dangers of not finishing TB treatment was lower, with only 30.9% of youths, 33.0% of women, and 35.0% of men aware.
- Districts have differences in the amount of people who know about the different areas concerning TB.

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What do these results mean?: People's knowledge about TB varies by age, gender, and location. TB programs need to consider these differences and create targeted education to improve understanding and control of TB. Planners and implementers of TB programs need to particularly target the youth with education programs on TB.

Keywords: tuberculosis knowledge, central Uganda, youth 15–24 years, women 15–49 years, men 15+ years

Introduction

Tuberculosis (TB) is the world's leading infectious disease killer and claimed over 1.2 million lives in 2019 alone.[1] TB is the leading primary cause of death among HIV/AIDS patients, making it a significant global public health concern.[2] According to the 2022 TB report, 30 nations account for 86–90% of the worldwide TB burden, and Uganda ranks 20th among them.[3,4] The World Health Organization (WHO) ranks Uganda eighth in terms of TB burden in Africa, after Nigeria, South Africa, Ethiopia, Kenya, Tanzania, Democratic Republic of Congo, and Mozambique.[4] In 2020 90,000 cases of all types of TB were detected in Uganda, including 12,000 children.[5] While considerable efforts have been made to assess general TB prevalence and co-infection rates, little is known about awareness of TB symptoms, prevention, and treatment, thus hindering efforts to enhance TB cognizance.[6] Educating people about TB's transmission, treatment, and prevention is crucial to halt its spread,[7,8] especially in rural areas where knowledge about TB is reportedly low.[9–11] Enhancing household-level TB education is crucial as most transmissions occur there. Improved TB knowledge improves health-seeking behavior, reinforcing its significance in end-TB strategies for effective control and management.[3]

A significant impediment in tackling TB is attributed to inadequate national research on TB prevention knowledge.[8] Awareness of TB-HIV co-infection aids diagnosis and treatment. Early detection measures for TB in families reduce transmission. Belief in curability enhances treatment adherence while understanding the risks of incomplete treatment promotes its completion, curbing drug resistance. Previous related studies have focused on urban populations, overlooking the crucial need to investigate TB awareness in rural areas where incidence may be high but awareness low.[8,12] Moreover, existing research has concentrated on TB patients' knowledge of how to manage their condition, neglecting the knowledge levels of how to coexist with and support TB patients by non-TB individuals as well as how to safeguard oneself against the disease.[13] This knowledge and practice gap potentially perpetuates transmission. To address this gap, our study assessed TB knowledge among a rural population in central Uganda. Understanding the current state of TB knowledge is vital for developing effective community awareness and patient involvement programs, ultimately leading to improved TB control initiatives.[4]

Materials and Methods

Design and Sampling

We conducted an analysis of a lot quality assurance sampling (LQAS) household survey data focusing on the TB knowledge component. LQAS uses small sample sizes to reliably classify supervision areas (SAs), thus providing for an efficient and cost-effective data collection.[14,15] LQAS, therefore, provides for rapid data collection and is reportedly cheaper than other sampling methodologies.[15,16] Our choice of the LQAS methodology was because of its ability to provide SA-level data, with the premise that the districts and lower local governments such as town councils and sub-counties can use the results for program improvement. The survey was undertaken in February and March 2022 in Uganda's Central districts of Mubende, Kasanda, Kiboga, Kyankwanzi, Mityana, Nakaseke, Luwero, and Nakasongola. The objective of this analysis was to evaluate the extent of knowledge on TB prevention in communities of the eight districts. This study was a component of the Governance Graduation Community Model (GGM), a program facilitated by Mildmay Uganda aimed at empowering districts to assume responsibility for the prevention of HIV/AIDS and TB-HIV transmission. The study indicators were selected in collaboration with district managers and the national TB and leprosy control program and were those not routinely collected in the Health Management Information System (HMIS) but crucial for TB prevention, control and health promotion. We selected and analyzed data of questionnaires for youths 15–24 years, women 15–49 years and men 15 years and above (15+ years). These particular questionnaires were selected because they had questions related to knowledge of TB prevention.

Table 1 Study Districts and Supervision Area Stratification

S/N	District	Sub-county (SC)/Town Council (TC)/division	Supervision Area (SA)
1	Kiboga	Kiboga TC	A
		Kibiga SC, and Kapeke SC	B
		Bukomeero TC, Bukomero SC, and Kyomya SC	C
		Dwaniro SC, and Muwanga SC	D
		Kyekumbya SC, Lwamata TC, and Lwamata SC	E
2	Kyankwanzi	Butemba TC, Byerima SC, and Butemba SC	F
		Kyankwanzi TC, Kyankwanzi SC, and Bbanda SC	G
		Sirimula SC, Nkandwa SC, Ntwetwe TC, Ntwetwe SC, and Gayaza SC	H
		Wattuba SC, Wattuba TC, Mulagi SC, and Masodde- Kalagi TC	I
		Bananywa, Ntunda TC, Nsambya SC, Kiryannongo SC, and Kigando SC	J
3	Mubende	Mubende MC (Central & East), and Bagezza SC	K
		Kasambya TC, Kasambya SC, and Kigando SC	L
		Kiyuni SC, Butoloogo SC, and Madudu SC	M
		Nabingoola SC, Nabingoola SC, Kibalinga SC	N
		Kitenga SC, Kalonga SC, and Kyenda TC	O
4	Kassanda	Bukuya SC, and Makokoto SC	P
		Kitumbi SC, Mbirizi SC, and Kijuna SC	Q
		Nalutuntu SC, and Myanzi SC	R
		Kassanda TC, Kassanda SC, Kilwana SC	S
		Manyogaseka SC, and Kiganda SC	T
5	Mityana	Kikandwa, Ssekanyonyi, and Busunju TC Namungo	U
		Bulera SC, and Kalangaalo SC	V
		Kakindu SC, and Malangala SC	W
		Busimbi Division, Ttamu Division, and Mityana Central Division	X
		Maanyi SC, Banda SC, and Butayunja SC	Y
6	Luwero	Wobulenzi TC, and Katikamu SC	Z
		Bamunanika SC, Kikyusa SC, and Kamira SC	AB
		Makulubita, Nyimbwa, and Bombo TC	AC
		Luwero TC, and Butuntumula SC	AD
		Kalagala SC, and Zirobwe SC	AE
7	Nakaseke	Kapeeka SC, Semuto SC, and Semuto TC	AF
		Nakaseke SC, Nakaseke TC, and Kasangombe SC	AG
		Wakyato SC, and Butalangu TC	AH
		Ngoma SC, Ngoma TC, Kinyogoga SC, and Kinoni SC	AI
		Kiwoko TC, and Kito SC	AJ
8	Nakasongola	Kakooge SC, and Kakooge TC	AK
		Wabinyonyi SC, and Nakasongola TC	AL
		Kalongo SC, and Kalungi SC	AM
		Lwampanga SC, and Lwabiyata SC	AN
		Nakitoma SC, Nabiswera SC, and Migeera TC	AO
Total SAs			**40**

During the survey, the 2014 Uganda National Housing and Population Census list of villages with the corresponding number of households was used as a sampling frame.[17] Mildmay, in collaboration with the district managers, divided each district into five SAs. The SAs were non-overlapping and had a programmatic link to district supervisory roles. A random sample of 19 villages or interview locations was selected from each SA using probability proportional to size (PPS). Table 1 displays the SAs labelled from A to AO.

Household and Respondent Selection

The selection of the households followed the LQAS principles.[18] A starting household for the interview was chosen at random using the most recent local council-1 (LC1) household registers available. Where such a list was lacking, community maps were used to divide the village into small sections with almost evenly distributed household sizes. One section was then randomly selected and all households in the selected section listed. From this list, we randomly selected a reference household. Search for eligible respondents commenced from the household next nearest to the front door of the reference household using the parallel sampling approach. From there on, we followed the sequence of "next nearest household" from front door of the current one until one questionnaire set designated for the interview location is completed. At the household, all the eligible respondents for each questionnaire were listed, and one was chosen at random. If a respondent met the criteria for more than one questionnaire, he or she was assigned at random to one of the target groups for an interview. Only one interview was conducted in each household.

Data Collection

The data collection exercise was carried out by data collectors who were health department staff from the respective districts. Earlier studies conducted in Uganda show that the use of local staff to collect research data in the districts where they work does not bias data collection.[19,20] The enumerators received one-week training on LQAS methods, ethics and data collection tools prior to data collection, including both theoretical and practical sessions. Each SA had one data collector. Data collection was overseen by one supervisor in each district. Data collectors were assisted in household selection by community leaders and/or village health team members (VHTs). Data were collected from 19 respondents in each supervision area for each target population. For the entire district, 95 respondents from each target group were interviewed, yielding 285 and 2280 interviews/respondents for each district and the entire study, respectively. All the questionnaires were administered by data collectors.

Data Analysis

Data was collected electronically, uploaded daily, and double-checked for duplicate uploads and field entry errors, which were corrected on a daily basis. For all of the agreed-upon survey indicators, two levels of analysis were used.[18] The first level combines the coverage proportion results from all SAs in each district (catchment area) and the entire project, as well as the 95% confidence intervals. The second level of analysis involved SA classification to identify priority SAs (those in greatest need of assistance) by using an LQAS decision rule (DR) to identify those falling below the project's average coverage for each indicator. The DRs were set using the average coverage estimated in the first level of analysis. Given that the LQAS table of DRs uses coverage in multiples of five, our survey coverage for each indicator was rounded up to the nearest multiple of five.[12] Thus, this rounded average coverage was used as the basis for setting the DR. We considered coverage of 80% or more to be high in the analysis of the results, as applied in earlier LQAS surveys elsewhere. We analyzed data on the following study indicators; 1) percentage of youth 15–24 years who know that a person can have both HIV and TB, 2) percentage of women 15–49 years who know that a person can have both HIV and TB, 3) percentage of men 15+ years who know that a person can have both HIV and TB, 4) percentage of youth 15–24 years who know what action to take when a family member is suspected to have TB, 5) percentage of women 15–49 years who know what action to take when a family member is suspected to have TB, 6) percentage of men 15+ years who know what action to take when a family member is suspected to have TB, 7) percentage of youth 15–24 years who know that TB can be cured, 8) percentage of women 15–49 years who know that TB can be cured, 9) percentage of men 15+ years who know that TB can be cured, 10) percentage of youth 15–24 years who know at least two signs or symptoms TB, 11) percentage of women 15–49 years who know at least two signs or symptoms TB, 12) percentage of men 15+ years who know at least two signs or symptoms TB, 13) percentage of youth 15–24 years who know the risk of not completing TB treatment, 14) percentage of women 15–49 years who know the risk of not completing TB treatment, and 15) percentage of men 15+ years who know the risk of not completing TB treatment.

Results

The results are presented at two levels. First, the coverage proportion and 95% confidence intervals that are based on the aggregated results of all SAs in each district and the entire study. The second level of results involves classification of SA coverage against the average coverage of each indicator. Table 2 summarizes the findings of the district-level and overall coverage.

Knowledge of TB-HIV/AIDS Co-Infection

The knowledge that a person can have both TB and HIV is generally high across different demographic groups and districts, with men having the highest coverage of 91.4% (95% CI: 89.4–93.4), followed by women at 89.5% (95% CI: 87.3–91.7). At 83.4% (95% CI: 80.8–86.1), the youth had the lowest proportion who know that a person can have both TB and HIV. Variation exists in coverage within respondent groups across districts and SAs. The proportion of youth 15–24 years who know that a person can have both TB and HIV ranged from 59.3% (95% CI: 49.3–69.4) in Kyankwanzi district to 93.6% (95% CI: 88.6–98.6) in Kiboga district. At 77.9% (95% CI: 69.4–86.4) and 79.4% (95% CI: 71.1–87.7), Mubende and Nakasongola districts, respectively, also had a lower proportion of youth 15–24 years who know that a person can have both TB and HIV compared with average coverage. In contrast, women 15–49 and men 15+ years in all districts demonstrate high knowledge levels, but disparities persist across SAs within districts (Table 3).

SA-Level Classification of Coverage of Knowledge That a Person Can Have Both HIV and TB

SAs F, G, and H in Kyankwanzi, Z in Luwero, and AM and AO in Nakasongola fell short of the 83.4% (rounded up to 85%) coverage of youth aged 15–24 years who are aware that someone can have both HIV and TB. For women aged 15–49 years, SAs D in Kiboga, F and H in Kyankwanzi, N and O in Mubende, and AM in Nakasongola did not achieve the DR of 15 (ie, failed to reach 89.5%) of women who know that one can have both HIV and TB. SAs F, H, and I in Kyankwanzi, K in Mubende, AI in Nakaseke, and AK in Nakasongola fell short of the 91.4% coverage of men 15+ years who know that one can be infected with both HIV and TB, not meeting the DR of 16 (Table 3).

Knowledge of Actions to Take When a Family Member is Suspected to Have TB

From Table 2, knowledge of the action to take if a family member is suspected to have TB is generally high across all demographic groups except among men 15+ years, with only 57.5% (95% CI: 53.9–61.0) of them knowing the action to take. Women 15–49 years had the highest proportion who know the action to take if a family member is suspected to have TB at 92.4% (95% CI: 90.5–94.3), followed by youth 15–24 years at 89.4% (95% CI: 87.2–91.6). Variation exists within respondent groups in proportion who know the correct action to take if a family member is suspected of having TB across districts. Men 15+ years who know the action to take if a family member is suspected to have TB ranged from 30.9% (95% CI: 21.5–40.4) in Mubende to 88.6% (95% CI: 82.1–95.1) in Nakaseke. In addition, falling short of the overall average coverage among men 15+ years was Kasanda district at 46.6% (95% CI: 36.3–56.8) and Kyankwanzi at 37.9% (95% CI: 28.0–47.9). All districts had a high coverage of women 15–49 and youth 15–24 years who know the action to take if a family member is suspected to have TB. There are disparities in coverage among SAs within and between districts as in Table 4 and discussed below.

SA-Level Classification of Coverage of Respondents with Knowledge of Actions to Take if a Family Member is Suspected to Have TB

From Table 4, regarding youth 15–24 years who know the actions to take if a family member is suspected to have TB, only one SA in each of Kyankwanzi and Nakasongola and two SAs in Mubende district fell short of the DR of 15, implying they did not attain 89.4% (rounded upwards to 90%). Among women 15–49 years, one SA in each of Nakaseke and Nakasongola districts failed to attain the DR of 16 regarding knowledge of the actions to take if a family member is suspected to have TB, meaning they did not attain the average coverage of 92.4% (rounded upwards to 95%). Among men 15+ years who know the actions to take if a family member is suspected to have TB, one SA in Kiboga, two SAs in

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Table 2 District-Level and Overall Coverage in Tuberculosis (TB) Knowledge Indicators

Indicator	Overall	Kasanda	Kiboga	Kyankwanzi	Luwero	Mityana	Mubende	Nakaseke	Nakasongola
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
% of youth 15–24 years who know that a person can have both HIV and TB	83.4% (80.8–86.1)	91.2% (85.4–97.0)	93.6% (88.6–98.6)	59.3% (49.3–69.4)	83.4% (75.8–91.0)	92.5% (87.1–97.9)	77.9% (69.4–86.4)	88.0% (81.3–94.6)	79.4% (71.1–87.7)
% of women 15–49 years who know that a person can have both HIV and TB	89.5% (87.3–91.7)	96.9% (93.4–100.5)	92.5% (87.0–97.9)	83.9% (76.4–91.5)	87.8% (81.0–94.6)	95.6% (91.4–99.8)	84.4% (76.9–91.8)	87.5% (80.8–94.3)	86.8% (79.8–93.8)
% of men 15+ years who know that a person can have both HIV and TB	91.4% (89.4–93.4)	92.5% (87.1–97.9)	94.8% (90.2–99.3)	80.5% (72.4–88.6)	92.3% (86.8–97.7)	97.7% (94.6–100.8)	91.0% (85.1–96.8)	92.0% (86.5–97.6)	84.0% (76.5–91.5)
% of youth 15–24 years who know what action to take when a family member is suspected to have TB	89.4% (87.2–91.6)	95.7% (91.5–99.8)	98.0% (95.1–100.9)	86.0% (78.9–93.1)	90.7% (84.8–96.7)	92.9% (87.6–98.2)	79.7% (71.4–87.9)	88.2% (81.6–94.8)	88.5% (82.0–95.1)
% of women 15–49 years who know what action to take when a family member is suspected to have TB	92.4% (90.5–94.3)	95.4% (91.1–99.7)	96.0% (92.0–100.0)	96.1% 92.1–100.1)	94.9% (90.3–99.4)	92.4% (87.0–97.8)	86.7% (79.7–93.6)	90.0% (83.9–96.2)	91.5% (85.8–97.3)
% of men 15+ years who know what action to take when a family member is suspected to have TB	57.5% (53.9–61.0)	46.6% (36.3–56.8)	64.7% (54.9–74.5)	37.9% (28.0–47.9)	74.9% (66.0–83.8)	62.2% (52.3–72.2)	30.9% (21.5–40.4)	88.6% (82.1–95.1)	62.2% (52.2–72.1)
% of youth 15–24 years who know that TB can be cured	75.6% (72.5–78.6)	77.9% (69.4–86.4)	86.0% (78.9–93.1)	44.4% (34.2–54.6)	79.4% (71.1–87.7)	95.4% (91.2–99.7)	70.4% (61.1–79.8)	68.0% (58.4–77.5)	67.7% (58.1–77.3)
% of women 15–49 years who know that TB can be cured	80.2% (77.3–83.0)	86.2% (79.2–93.3)	91.9% (86.3–97.5)	70.9% (61.6–80.2)	86.7% (79.7–93.7)	94.4% (89.6–99.1)	63.5% (53.7–73.4)	79.2% (70.9–87.5)	62.8% (52.9–72.8)
% of men 15+ years who know that TB can be cured	84.6% (82.0–87.2)	89.3% (83.0–95.6)	95.3% (91.0–99.6)	72.9% (63.8–82.0)	84.9% (77.6–92.3)	96.9% (93.3–100.4)	76.4% (67.7–85.1)	84.6% (77.2–92.0)	74.1% (65.1–83.0)
% of youth 15–24 years who know at least two signs or symptoms TB	48.6% (45.1–52.2)	52.2% (42.0–62.4)	55.7% (45.5–65.8)	54.9% (44.7–65.1)	26.5% (17.5–35.6)	69.8% (60.4–79.2)	58.3% (48.2–68.4)	19.6% (11.4–27.7)	56.8% (46.6–66.9)
% of women 15–49 years who know at least two signs or symptoms TB	55.3% (51.7–58.8)	77.8% (69.3–86.3)	67.6% (58.0–77.2)	69.8% (60.4–79.2)	28.1% (18.8–37.4)	69.5% (60.1–78.9)	55.7% (45.5–65.9)	26.9% (17.8–35.9)	67.1% (57.5–76.8)

% of men 15+ years who know at least two signs or symptoms TB	57.0% (53.5–60.5)	79.5% (71.3–87.8)	62.8% (52.9–72.7)	59.7% (49.7–69.7)	34.6% (24.8–44.3)	74.1% (65.1–83.1)	57.7% (47.6–67.9)	34.5% (24.8–44.2)	63.1% (53.2–73.0)
% of youth 15–24 years who know the risk of not completing TB treatment	30.9% (27.6–34.2)	40.1% (30.0–50.1)	38.8% (28.8–48.8)	32.4% (22.8–42.0)	24.4% (15.6–33.2)	43.1% (33.0–53.3)	26.4% (17.4–35.5)	22.5% (14.0–31.1)	19.6% (11.5–27.7)
% of women 15–49 years who know the risk of not completing TB treatment	33.0% (29.7–36.4)	44.8% (34.6–55.0)	48.2% (37.9–58.4)	42.5% (32.4–52.6)	21.1% (12.7–29.6)	39.2% (29.2–49.2)	31.4% (21.9–40.9)	25.3% (16.4–34.2)	20.1% (11.8–28.4)
% of men 15+ years who know the risk of not completing TB treatment	35.0% (31.6–38.4)	52.7% (42.4–62.9)	38.7% (28.7–48.7)	37.6% (27.7–47.5)	21.2% (12.9–29.6)	39.7% (29.7–49.7)	40.6% (30.5–50.7)	23.3% (14.7–32.0)	28.8% (19.5–38.1)

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Table 3 SA-Level Coverage of Respondents Who Know That a Person Can Have Both HIV and TB

		Youth 15–24 Years	Women 15–49 Years	Men 15+ Years
District	**Average (%)**	**83.4%**	**89.5%**	**91.4%**
	SA	**DR=14**	**DR=15**	**DR=16**
Kasanda	P	16	19	18
	Q	17	17	17
	R	18	19	16
	S	17	19	18
	T	19	18	19
Kiboga	A	18	18	18
	B	18	19	18
	C	17	17	18
	D	19	14*	17
	E	17	19	19
Kyankwanzi	F	9*	14*	15*
	G	6*	16	16
	H	7*	14*	12*
	I	16	18	15*
	J	15	18	19
Luwero	AB	17	18	18
	AC	19	16	16
	AD	17	16	19
	AE	16	17	17
	Z	10*	17	18
Mityana	U	17	17	18
	V	18	18	18
	W	18	19	19
	X	19	19	19
	Y	15	18	19
Mubende	K	14	18	15*
	L	14	19	19
	M	15	15	18
	N	16	14*	17
	O	15	14*	17

(*Continued*)

Table 3 (Continued).

		Youth 15–24 Years	Women 15–49 Years	Men 15+ Years
District	**Average (%)**	**83.4%**	**89.5%**	**91.4%**
	SA	**DR=14**	**DR=15**	**DR=16**
Nakaseke	AF	18	16	17
	AG	14	16	19
	AH	18	16	19
	AI	19	18	15*
	AJ	16	19	17
Nakasongola	AK	14	19	15*
	AL	17	15	16
	AM	12*	14*	16
	AN	18	17	17
	AO	13*	16	16

Notes: *Number of respondents in the SA who know that a person can have both HIV and TB is less than the DR. SA coverage is below average coverage.

Table 4 SA-Level Coverage of Respondents Who Know the Actions to Take When a Family Member is Suspected to Have TB

		Youth 15–24 Years	Women 15–49 Years	Men 15+ Years
District	**Average (%)**	89.4%	92.4%	57.5%
	SA	DR=15	DR=16	DR=9
Kasanda	P	18	19	8*
	Q	18	18	10
	R	19	17	7*
	S	18	18	9
	T	18	19	10
Kiboga	A	19	19	18
	B	19	19	0*
	C	18	17	17
	D	19	17	18
	E	18	19	17
Kyankwanzi	F	15	17	3*
	G	10*	18	9
	H	16	19	6*
	I	19	19	12
	J	17	18	8*

(*Continued*)

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Table 4 (Continued).

		Youth 15–24 Years	Women 15–49 Years	Men 15+ Years
Luwero	AB	17	17	14
	AC	17	17	14
	AD	18	19	13
	AE	18	18	15
	Z	16	18	15
Mityana	U	18	19	14
	V	17	16	9
	W	16	19	11
	X	19	17	10
	Y	17	17	16
Mubende	K	15	16	4*
	L	16	16	10
	M	14*	16	7*
	N	17	17	4*
	O	14*	18	3*
Nakaseke	AF	16	18	18
	AG	16	15*	18
	AH	19	18	18
	AI	19	17	11
	AJ	17	19	16
Nakasongola	AK	19	18	11
	AL	18	17	15
	AM	16	15*	14
	AN	16	18	9
	AO	14*	18	11

Notes: *Number of respondents in the SA who know the actions to take when a family member is suspected to have TB is less than the DR. The SA coverage is below average coverage.

Kasanda, and three SAs in Kyankwanzi, as well as four SAs in Mubende did not achieve the DR of 9, falling short of the average coverage of 57.5% (rounded upwards to 60%).

Knowledge That TB Can Be Cured

The knowledge that TB can be cured varies across different demographic groups and districts, with average coverage ranging from 75.6% (95% CI: 72.5–78.6) among youth 15–24 years through 80.2% (95% CI: 77.3–83.0) among women 15–49 years to 84.6% (95% CI: 82.0–87.2) among men 15+ years. There were notable variations in coverage within demographic groups by district and SA. The proportion of youth 15–24 years who know that TB can be cured ranged from 44.4% (95% CI: 34.2–54.6) in Kyankwanzi to 95.4% (95% CI: 91.2–99.7) in Mityana. Nakaseke, 68.0% (95% CI: 58.4–77.5), Mubende, 70.4% (95% CI: 61.1–79.8) and Nakasongola, 67.7% (95% CI: 58.1–77.3) were the other districts

with coverage lower than the 75.6% (95% CI: 72.5–78.6) average regarding youth 15–24 years who know that TB can be cured. Among women 15–49 years, Kiboga had the highest coverage at 91.9% (95% CI: 86.3–97.5), while Mubende and Nakasongola fell below the average at 63.5% (95% CI: 53.7–73.4) and 62.8% (95% CI: 52.9–72.8), respectively. Among men 15+ years, Mityana had the highest coverage at 96.9% (95% CI: 93.3–100.4), while Kyankwanzi fell below the average at 72.9% (95% CI: 63.8–82.0). Table 5 shows the SA-level classification of coverage of those who know that TB can be cured, with the analysis presented in the section below.

Coverage at the SA Level of Knowledge That Tuberculosis Can Be Cured

Table 5 shows the SA-classification of coverage regarding knowledge that TB is curable.

Among youth 15–24 years, one SA in each of Kiboga and Nakaseke districts, two SAs in Mubende, three SAs in Nakasongola, and four SAs in Kyankwanzi did not attain the DR of 13, implying that less than 75.6% (rounded upwards to 80%) of youth 15–24 years in these SAs know that TB can be cured. Among women 15–49 years, one SA in Kasanda, two SAs in Nakaseke, three SAs in each of Kyankwanzi and Nakasongola districts, as well as four SAs in Mubende fell short of the DR of 14, implying that they did not reach 80.2% (rounded upwards to 85%) coverage regarding women 15–49 years who know that TB can be cured. Among men 15+ years, in each of Kyankwanzi, Mubende, and Nakasongola districts, two SAs fell short of the DR of 14, meaning less than 84.6% (rounded upwards to 85%) of men 15+ years in these SAs know that TB can be cured.

Table 5 SA-Level Coverage of Respondents Who Know That TB Can Be Cured

		Youth 15–24 Years	Women 15–49 Years	Men 15+ Years
District	**Average (%)**	**75.6%**	**80.2%**	**84.6%**
	SA	**DR=13**	**DR=14**	**DR=14**
Kasanda	P	15	16	16
	Q	14	13*	17
	R	15	16	16
	S	14	19	17
	T	17	17	19
Kiboga	A	16	19	18
	B	18	19	19
	C	12*	14	17
	D	18	17	17
	E	17	18	19
Kyankwanzi	F	6*	12*	12*
	G	6*	16	16
	H	7*	13*	13*
	I	13	13*	15
	J	9*	15	15

(*Continued*)

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Table 5 (Continued).

		Youth 15–24 Years	Women 15–49 Years	Men 15+ Years
District	**Average (%)**	**75.6%**	**80.2%**	**84.6%**
	SA	**DR=13**	**DR=14**	**DR=14**
Luwero	AB	18	18	18
	AC	14	15	17
	AD	15	17	16
	AE	16	17	16
	Z	13	16	14
Mityana	U	18	18	19
	V	18	19	16
	W	19	18	19
	X	18	17	19
	Y	18	18	19
Mubende	K	12*	15	18
	L	14	12*	15
	M	14	12*	16
	N	15	10*	10*
	O	11*	11*	12*
Nakaseke	AF	9*	16	15
	AG	15	15	17
	AH	17	13*	15
	AI	13	11*	15
	AJ	17	18	19
Nakasongola	AK	12*	6*	10*
	AL	14	16	14
	AM	10*	13*	13*
	AN	16	16	17
	AO	11*	10*	17

Notes: *Number of respondents in the SA who know that TB can be cured is less than the DR. The SA coverage is below average coverage.

Knowledge of Signs and Symptoms of TB

Knowledge of at least two TB signs or symptoms is low across all the demographic groups (Table 2). Proportion of respondents who know at least 2 signs or symptoms of TB ranged from 48.6% (95% CI: 45.1–52.2) among youth 15–24 years to 57.0% (95% CI: 53.5–60.5) among men 15+ years, with 55.3% (95% CI: 51.7–58.8) coverage among women 15–49 years. There were notable variations in coverage within respondent groups across districts and SAs. Among youth 15–24 years, at 69.8% (95% CI: 60.4–79.2), Mityana had a higher proportion knowledgeable about at least 2 signs or

symptoms of TB than the average, while Luwero and Nakaseke at 26.5% (95% CI: 17.5–35.6) and 19.6% (95% CI: 11.4–27.7), respectively, had their estimates below average. Among women 15–49 years, Kasanda at 77.8% (95% CI: 69.3–86.3) exceeded the average coverage of those who know at least 2 signs or symptoms of TB, while Nakaseke and Luwero fell below the average coverage at 26.9% (95% CI: 17.8–35.9) and 28.1% (95% CI: 18.8–37.4), respectively. Kasanda had the highest proportion of men 15+ years who know at least 2 signs or symptoms of TB at 79.5% (95% CI: 71.3–87.8), while Nakaseke and Luwero each had their estimates below average coverage at 34.5% (95% CI: 24.8–44.2) and 34.6% (95% CI: 24.8–44.3), respectively.

SA-Level Coverage of Respondents Who are Aware of at Least Two TB Signs or Symptoms

Table 6 shows the SA-level classification of coverage of respondents who know at least two TB signs or symptoms.

Regarding youth 15–24 years, one SA in each of Kasanda and Nakasongola districts, two SAs in each of Nakaseke and Kiboga districts as well as four SAs in Luwero did not attain the DR of 7, implying the SAs each had less than 48.6% (rounded upwards to 50%) of youth 15–24 years know least two signs or symptoms of TB. Among women 15–49 years, one SA in each of Kasanda, Kiboga, Luwero and Mubende districts, three SAs in Nakaseke and all the five SAs in Luwero did not attain the DR of 9. Thus, less than 55.3% (rounded upwards to 60%) of women 15–49 years in these SAs know at least 2 signs or symptoms of TB. Among men 15+ years, one SAs in Nakasongola, two SAs in each of Nakaseke and Kiboga districts and four SAs in Luwero did not attain the DR of 9. Thus, less than 57.0% (rounded upwards to 60%) of men 15+ years in these SAs know at least two signs or symptoms of TB.

Table 6 SA-Level Classification of Coverage of Respondents Who Know at Least 2 Signs or Symptoms of TB

		Youth 15–24 Years	Women 15–49 Years	Men 15+ Years
District	**Average (%)**	**48.6%**	**55.3%**	**57.0%**
	SA	**DR=7**	**DR=9**	**DR=9**
Kasanda	P	10	8*	13
	Q	7	16	13
	R	12	17	18
	S	6*	14	14
	T	19	19	19
Kiboga	A	6*	16	11
	B	18	19	19
	C	12	15	13
	D	3*	2*	4*
	E	8	9	8*
Kyankwanzi	F	11	16	13
	G	7	11	13
	H	7	11	13
	I	12	13	10
	J	13	14	9

(*Continued*)

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Table 6 (Continued).

		Youth 15–24 Years	Women 15–49 Years	Men 15+ Years
District	**Average (%)**	**48.6%**	**55.3%**	**57.0%**
	SA	**DR=7**	**DR=9**	**DR=9**
Luwero	AB	9	8*	7*
	AC	5*	5*	6*
	AD	6*	5*	10
	AE	5*	4*	6*
	Z	1*	6*	4*
Mityana	U	12	13	14
	V	14	15	16
	W	11	15	13
	X	14	13	15
	Y	15	10	11
Mubende	K	11	9	9
	L	11	6*	10
	M	8	11	10
	N	13	13	11
	O	15	15	17
Nakaseke	AF	0*	0*	5*
	AG	2*	8*	4*
	AH	12	9	12
	AI	8	7*	11
	AJ	9	9	9
Nakasongola	AK	10	12	12
	AL	14	17	13
	AM	4*	9	8*
	AN	14	15	15
	AO	9	9	10

Notes: *Number of respondents in the SA who know at least 2 signs or symptoms of TB is less than the DR. The SA coverage is below average coverage.

Knowledge of the Risks Associated with Not Completing TB Treatment

The knowledge of at least two risks associated with a TB patient failing to complete treatment varies across different demographic groups and districts. On average, 35.0% (95% CI: 31.6–38.4) of men 15+ years, 33.0% (95% CI: 29.7–36.4) of women 15–49 years, and 30.9% (95% CI: 27.6–34.2) of youth 15–24 years were knowledgeable about at least two risks associated with a TB patient not completing treatment. There were notable variations within each demographic group across districts and SAs. Among youth 15–24 years, Mityana had a coverage of 43.1% (95% CI:

33.0–53.3), higher than the average estimate, while Nakasongola, 19.6% (95% CI: 11.5–27.7), Luwero, 24.4% (95% CI: 15.6–33.2), Mubende, 26.4% (95% CI: 17.4–35.5), and Nakaseke had their coverage estimates below the average. Among women 15–49 years, Kiboga exceeded the average coverage at 48.2% (95% CI: 37.9–58.4), while Nakasongola, 20.1% (95% CI: 11.8–28.4), Luwero, 21.1% (95% CI: 12.7–29.6), Mubende, 31.4% (95% CI: 21.9–40.9), and Nakaseke, 25.3% (95% CI: 16.4–34.2) fell short. Among men 15+ years, Kasanda had the highest and above-average-coverage at 52.7% (95% CI: 42.4–62.9), while Luwero, 21.2% (95% CI: 12.9–29.6), Nakaseke, 23.3% (95% CI: 14.7–32.0), and Nakasongola, 28.8% (95% CI: 19.5–38.1) fell short of the average coverage.

SA-Level Coverage Classification of Respondents Who are Aware of at Least Two Risks Associated with a Patient Failing to Complete TB Treatment

Table 7 depicts the SA-level classification of coverage of respondents who are aware of at least two risks associated with a patient failing to complete TB treatment.

Table 7 SA-Level Classification of Coverage of Respondents Who Know at Least 2 Risks Associated with a Patient Not Completing TB Treatment

		Youth 15–24 Years	Women 15–49 Years	Men 15+ Years
District	**Average (%)**	30.9%	33.0%	35.0%
	SA	DR=4	DR=4	DR=4
Kasanda	P	10	7	9
	Q	9	8	12
	R	7	10	11
	S	6	8	9
	T	7	10	9
Kiboga	A	4	12	3*
	B	18	19	19
	C	0*	2*	1*
	D	0*	1*	0*
	E	8	7	6
Kyankwanzi	F	6	8	9
	G	7	12	5
	H	4	8	8
	I	8	6	6
	J	7	9	6
Luwero	AB	6	1*	3*
	AC	5	4	7
	AD	5	9	5
	AE	2*	3*	2*
	Z	6	3*	3*

(*Continued*)

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Table 7 (Continued).

		Youth 15–24 Years	Women 15–49 Years	Men 15+ Years
Mityana	U	5	3*	5
	V	9	12	11
	W	8	6	8
	X	9	8	4
	Y	11	9	13
Mubende	K	5	7	6
	L	3*	4	6
	M	4	3*	5
	N	8	7	10
	O	6	12	15
Nakaseke	AF	3*	1*	2*
	AG	4	9	5
	AH	5	6	8
	AI	12	8	11
	AJ	0*	2*	1*
Nakasongola	AK	4	5	4
	AL	4	5	7
	AM	5	8	9
	AN	3*	0*	4
	AO	3*	3*	5

Notes: *Number of respondents in the SA who know at least 2 risks associated with a patient not completing TB treatment is less than the DR. The SA coverage is below average coverage.

Among youth 15–24 years, the DR of 4 was not reached in one SA in each of Luwero and Mubende districts, and two SAs in each of Kiboga, Nakaseke and Nakasongola districts. In these SAs, less than 30.9% (rounded upwards to 35%) of youth 15–24 years know at least two risks associated with a patient not completing their TB treatment. Among women 15–49 years, the DR of 4 was not reached in one SA in each of Mityana and Mubende districts, two SAs in each of Kiboga, Nakaseke and Nakasongola districts, and three SAs in Luwero district. In these SAs, less than 33.0% (rounded upwards to 35%) of women 15–49 years know at least two risks associated with a patient not completing their TB treatment. Regarding men 15+ years who know at least two risks linked to incomplete TB treatment, two SAs in Nakaseke, and three SAs in each of Kiboga and Luwero districts did not attain the DR of 4, thus fell short of the 35.0% average coverage.

Discussion

It is important that the population knows about the likelihood of TB/HIV co-infection given that people living with HIV are 12–16 times more likely to develop active TB,[21] while over 33% of persons living with HIV have active TB.[22,23] We found that the knowledge that a person can have both TB and HIV is generally high across all respondent groups, with men having the most knowledge, followed by women, and youth 15–24 years having the least. The high level of

awareness of TB-HIV coexistence in the study area suggests effective dissemination of information through public health campaigns and educational initiatives as well as the success in implementing Uganda's TB/HIV collaborative policy, particularly regarding TB/HIV link awareness. Leveraging this success, health authorities can put in place measures to sustain the further education of the population on TB-HIV co-infection prevention, early detection, and management. The findings also imply that it is crucial to target interventions, focusing on vulnerable groups such as the youth aged 15–24 who demonstrated the lowest awareness, with emphasis on TB-HIV co-infection risks, prevention, and early symptoms in tailored educational programs conducted through schools, colleges, social media, and youth organizations. Besides, strengthening awareness campaigns and expanding efforts to underperforming districts and SAs is essential, mainly among the youth. To address the reasons behind low awareness, local context considerations may be necessary.

Our findings reveal a concerning gap in knowledge among men 15+ years regarding what to do if a family member is suspected of having TB, with only 57.5% demonstrating awareness. This proportion is lower than the findings from an earlier study in Ethiopia, whose results were not disaggregated by demographic group, which found that 69.1% of respondents believed one should go to a health facility if they develop symptoms of TB.[24] However, the youth and women of reproductive age in our study demonstrated a higher knowledge regarding the appropriate actions to take if someone shows symptoms suggestive of TB than reported in the Ethiopian study. The low knowledge among men is particularly concerning given men's role as decision-makers for their families' healthcare. The lack of knowledge among men may hinder appropriate care-seeking for their family members, exacerbating the already high prevalence of tuberculosis among males in Uganda.[7] While TB campaigns have successfully increased awareness about symptoms and cures, they may have inadvertently overlooked men's understanding of what actions to take when experiencing symptoms. This highlights the need to enhance men's knowledge in this area, going beyond mere awareness to improve health literacy and promote timely care-seeking. Targeted interventions addressing this knowledge gap are crucial to ensure effective TB management and control.

The results reveal significant insights into awareness of tuberculosis curability, with 84.6% of men 15+ years, 80.2% of women 15–49 years, and 75.6% of youth 15–24 years acknowledging the potential cure for TB if one is on treatment. Previous studies in Uganda[7,8] and Ethiopia[24] revealed similar results regarding knowledge that TB is curable, with the proportion knowledgeable in Ethiopia (78.3%) close to those of youth and women in this study. Men play an important role in determining healthcare decisions for their families, so it is encouraging that 84.6% are aware that TB is curable. The awareness of TB curability among 80.2% of women is encouraging, particularly considering their crucial role in family healthcare, especially concerning children.

It is concerning, however, that young people are less aware of TB despite their higher susceptibility. Their low awareness rate of 75.6% leaves them susceptible to delayed treatment compared to older men and women. The overall high awareness surpassing 75% (range 75.6%–84.6%) regarding knowledge of the curability of tuberculosis (TB) reveals the noteworthy success of TB prevention and control efforts in the districts. This also provides hope that a greater proportion of people may accept TB treatment after knowing that they have a chance of being cured. While effective awareness campaigns of TB curability have been observed, more targeted interventions are crucial among youth, especially to address knowledge gaps and ensure timely treatment-seeking behaviors.

Respondents with knowledge of at least two TB signs or symptoms have low coverage across all target groups, with disparities between districts and SAs: 57.0% among men 15+ years, 55.3% among women 15–49 years, and 48.6% among youth 15–24 years. The low knowledge regarding TB signs or symptoms mimic those of an earlier study in Ethiopia.[24] As observed elsewhere, good knowledge of TB signs and symptoms is likely to stimulate timely TB health care seeking, even before one is diagnosed.[2] The low knowledge about TB signs and symptoms by the respondents in this study is likely to jeopardize treatment seeking. The low knowledge about tuberculosis signs and symptoms observed in this study is also a likely indicator that information about tuberculosis signs and symptoms by health education and promotion departments or TB control personnel is not reaching the people. Otherwise, it could indicate that the information is not being properly understood by those who are supposed to receive it. The findings also affirm earlier studies which show that people are more knowledgeable about TB treatment than they are about symptoms.[2] Particular districts and SAs stood out for having a low proportion of respondents who know at least two signs or symptoms of tuberculosis. This finding implies that planners and implementers of TB prevention, care and treatment programs need to

consider contextual variations in reach with interventions and consider prioritizing the low-coverage areas. The low coverage of knowledge of signs and symptoms of TB implies delay in TB care seeking and diagnosis, watering down potential positives accruing from other thematic areas with high knowledge such as knowledge that TB can be cured and knowledge of actions to take if a family member is suspected to have TB (particularly high knowledge among women and youth). This finding underpins the need for cascaded monitoring of interventions and outcomes, including that of awareness so as not to have program outcomes derailed by a single process within a service cascade.

In terms of knowledge of the risks associated with not completing TB treatment, 35.0% of men 15+ years, 33.0% of women 15–49 years, and 30.9% of youth 15–24 years, in that order, knew at least two risks associated with a TB patient not completing TB treatment. These findings suggest that TB treatment completion rates in these districts may be influenced by a lack of knowledge about the risks of not completing TB treatment. This is likely to have an effect on treatment success rates in the areas studied in the long run. Given that almost all of the districts had inadequate coverage, they should all be targeted.

Increase in knowledge about TB is positively correlated with improvements in attitude towards the disease,[24] and practices related to TB.[24,25] Living in the rural and peri-urban locations is particularly associated with a lower TB knowledge compared to urban areas.[25] The majority of our study districts were rural-based, with only a few urban centers, and this could have influenced the low knowledge in some dimensions of TB awareness in this study. This highlights the need for planners and implementers of TB programs in these districts and elsewhere to deliberately target rural areas, like our study districts, with educational programs on TB.

In virtually all the indicators, variation exists in coverage of knowledge between SAs within districts and between the districts themselves, underpinning the need for programs to devise mechanisms for routinely identifying low-performance areas, prioritizing them for intervention and/or improvement in order to improve the overall program coverage.

Strengths

This study offers a detailed evaluation of TB-related knowledge across various demographic groups, highlighting specific gaps and strengths, which is crucial for designing targeted interventions.

The use of the LQAS methodology enables efficient data collection and sub-district-level analysis, allowing for the identification of localized variations in knowledge. Provision of data at such local level provides for prioritizing areas for intervention. This is particularly beneficial in decentralized settings such as Uganda, where decision-making autonomy is devolved to the sub-county level.

The study had an adequate sample size of 760 respondents per demographic group, with participants sampled across eight districts and multiple supervision areas. This provides strong statistical power and precision of estimates, making the findings generalizable.

Limitations

This study solely examined the knowledge of respondents regarding TB prevention and did not investigate the extent to which they translate this knowledge into practice, thereby limiting the understanding of the gap between knowledge and behavior in TB prevention. The study focuses on youth, women, and men but excludes other vulnerable populations, such as elderly persons, children, or people with disabilities, who might face unique barriers to TB knowledge. Future similar studies should be cognizant of such vulnerable groups.

Conclusion

There is variation in the level of knowledge across different TB thematic areas between demographic groups, districts and sub-districts (SAs). Planners and implementers of TB programs should be cognizant of such variations and make deliberate efforts to develop tailored interventions in order to address the information and/or education needs of specific contexts in order to improve TB outcomes. The findings highlight the need to particularly target the youth with education programs on TB. Integrating TB educational programs into existing school health activities provides an opportunity to address this recommendation for school-going youth. Additionally, incorporating these programs into health education sessions at health facilities and community

outreach efforts can help reach out-of-school youth and other adult populations. Out-of-school youth can also be reached through other health-related youth clubs.

Data Sharing Statement

All necessary data have been presented in this study, and data on respondent characteristics are available upon request from the first author.

Ethical Consideration and Consent

The study was approved by the Mildmay Uganda Research and Ethics Committee (# REC REF 0804-2018) and the Uganda National Council of Science and Technology (number SS639ES). We obtained written informed consent from each respondent before conducting an interview. We obtained both (written) parental consent and respondent's assent for minors 15–17 years who were not in the category of mature or emancipated minors. Respondents who did not consent or assent or whose parents did not consent (in the case of minors) were replaced by randomly selected substitutes. This study complies with the Declaration of Helsinki regarding research involving human subjects.

Consent for Publication

All the authors consent to the publication.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no conflicts of interest.

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