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Tuberculosis Knowledge and Stigma towards Students with Tuberculosis among Schoolteachers in Yogyakarta, Indonesia

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Abstract

Aims: This study examined whether schoolteachers' stigma toward students with tuberculosis (TB) in Indonesia, the country with the world's second-largest TB burden, is associated with their overall knowledge or with specific misconceptions.

Instrument & Methods: In this analytical cross-sectional survey, conducted in 2023, 300 teachers were randomly selected from the staff lists of ten purposively chosen public schools in Yogyakarta City, Indonesia. Knowledge was measured with a 16-item index and stigma with an 11-item scale adapted from an instrument validated in Indonesia. The primary analysis treated both scores as continuous; item-level associations with above-median stigma were explored using logistic regression with false discovery rate (FDR) adjustment.

Findings: Knowledge and stigma were weakly and non-significantly correlated (Spearman's ρ=−0.10; 95% confidence interval [CI]: −0.21 to 0.02; adjusted slope=−0.23; 95% CI: −0.55 to 0.09). The belief that everyone in close contact with a person with TB will develop the disease was the strongest exploratory signal (adjusted odds ratio [aOR]=2.52; 95% CI: 1.45–4.38; FDR-adjusted p=0.022). The belief that TB can be cured with herbal medicine (aOR=1.99; 95% CI: 1.21–3.27) did not meet the FDR threshold (adjusted p=0.072). The most prevalent misconception, continued infectiousness after treatment (62.7%), was not associated with stigma (odds ratio=1.02; 95% CI: 0.64–1.63).

Conclusion: Stigma was only weakly related to total knowledge, and the clearest exploratory signal concerned the belief that infection after close contact is inevitable. These cross-sectional associations require replication before they are used to inform school curricula.

Keywords

Tuberculosis [https://www.ncbi.nlm.nih.gov/mesh/68014376];
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Introduction

Tuberculosis (TB) remains the leading cause of death from a single infectious agent, and its burden is concentrated in a small number of countries. Indonesia ranks second worldwide and accounts for roughly one-tenth of incident cases [1]. Children aged 0–14 years made up 8.3% of global notifications in 2024 [1]; in Indonesia, the Ministry of Health reported that about 885,000 TB cases were detected in 2024, of which about 135,000 were in children aged 0–14 years [2]. Even this figure underestimates the problem. A national inventory study covering 31 districts and cities found that 23.5% of 12,293 children diagnosed with or treated for TB in health facilities had not been reported to the national surveillance system, with the highest proportion among children aged 5–9 years [3]. Undetected pediatric cases signal continuing transmission in the settings where children spend their time, and Presidential Regulation No. 67 of 2021 now assigns responsibilities for TB elimination across sectors, including education [4].

The classroom is one of those settings, and it is also where a child treated for TB must eventually return. What happens on that return depends on the adults who run the classroom. Qualitative work with children in Jember described labeling by siblings, neighbors, and schools; separate places to eat; separate seating at school; and children who were often alone [5]. Adolescents and young adults with TB commonly report interrupted schooling, social withdrawal, and worry about falling behind [6]. The consequences extend beyond school: TB stigma delays care-seeking, undermines adherence, and worsens prognosis [7], and three in five Indonesian adults with TB report moderate stigma across seven provinces [8]. Most children who are excluded in this way pose little risk to others. Primary-school-age children typically have paucibacillary, intrathoracic lymph node disease and rarely transmit *Mycobacterium tuberculosis* [6, 9, 10], and World Health Organization guidance identifies adolescents, not younger children, as the pediatric group of transmission concern [11]. Avoidance of a treated child is therefore disproportionate on epidemiological grounds, even before its social costs are considered.

Stigma is better understood as a social process than as a private attitude, and this distinction matters for how teachers should be studied. In Link and Phelan's account [12], stigma unfolds through labeling, stereotyping, separation, status loss, and discrimination, and it requires power to be enacted. The Health Stigma and Discrimination Framework distinguishes drivers, such as fear of infection, from the practices through which stigma is applied and the outcomes it produces [13]. Across the TB literature, fear of infection is the most frequently identified driver [14], and misconceptions about the causes of TB are among its recurrent antecedents [15]. Teachers occupy a distinctive position within this framework. They combine informational authority with practical control, since they answer children's questions about illness and also decide seating, group work, meal arrangements, and, in practice, whether a child is welcome. A teacher who avoids a student with TB is applying stigma, in Link and Phelan's sense, in a setting from which the child has no exit.

Existing evidence suggests that teachers' TB knowledge is often incomplete and that knowledge and attitudes do not always move together. More than half (58.6%) of teacher trainees at a Bhutanese college of education had poor TB knowledge, although their attitudes were largely favorable, particularly among women [16]. Among 391 female health activists in Semarang, a group likely to have more health exposure than most teachers, TB literacy was low, stigma scores were high, and the two were correlated [17]. Qualitative work in coastal Semarang found that TB information reached residents only sporadically, through WhatsApp groups and general health events that rarely addressed TB; that illness was explained in culturally embedded terms; and that some patients who stopped treatment because of side effects turned to herbal remedies (*jamu*) [18]. Teachers are drawn from these same communities, and there is no reason to expect their explanatory models of illness to differ sharply from those of their neighbors.

The standard policy response to incomplete knowledge is education, and there is some evidence that it works. A school program in Kelantan, Malaysia, improved knowledge and reduced stigma among adolescents [19], and reviews of TB stigma interventions have found educational components in most of them, although rigorous evaluation of their effect on stigma remains limited [20, 21]. Indonesia has adopted this approach through the *Sekolah Peduli Tuberkulosis* (TB-Caring Schools) guidance, which positions schools, through their health units, as sites for TB education and prevention and assumes that teachers are equipped for that role [22]. That assumption has not been tested.

Education as a policy response also rests on a premise that is rarely stated, namely that stigma varies with how much a person knows. The population evidence for this premise is weaker than its policy prominence suggests, and large surveys in Ethiopia and Uganda point in different directions. In Ethiopia, higher TB knowledge was associated with lower stigma, alongside education and wealth [23], whereas among more than 33,000 Ugandans, correct knowledge of transmission and of TB–HIV co-infection was associated with higher stigma [24]. In southern Thailand, using the community version of the stigma scale adapted in the present study,

general TB knowledge showed no association with community stigma, whereas a single belief, that TB is transmitted by eating and drinking with a person who has it, did [25]. In Cambodia, knowing how TB is transmitted was associated with higher rather than lower stigma among people with TB [26], and in urban Zambia, most people with TB combined biomedical explanations of the disease with alternative ones, such as catching it by sharing cups [27].

An alternative possibility is that stigma turns on a few specific beliefs and that most of what a knowledge questionnaire measures is irrelevant to attitudes. Research on belief correction points in the same direction: corrections are more effective when they name the specific misconception and supply an alternative explanation than when they simply present accurate information [28, 29]. The two possibilities imply very different curricula, and they can be distinguished empirically. Research on TB stigma in Indonesia has so far concentrated on patients, households, and community members [8, 30, 31], and studies of teachers have generally stopped at knowledge without linking it to attitudes towards an identified child. This study, therefore, described TB knowledge and stigma towards students with TB among public schoolteachers in Yogyakarta City. The primary aim was to examine whether stigma is associated with aggregate knowledge, analyzed as a continuous score; a secondary, exploratory aim was to identify particular misconceptions associated with stigma, as hypotheses for future testing.

Materials and Methods

Design and setting

This analytical cross-sectional study was conducted from May to June 2023 in Yogyakarta City, Special Region of Yogyakarta, Indonesia, and is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies [32]. The city recorded 6,022 presumptive TB cases in 2021, together with 142 childhood cases and a pediatric case detection rate of 49.9% [33].

A preliminary survey by the research team identified 59 childhood TB cases across the city's primary health centers between January and July 2022, 17% of them in school-age children. Four of the city's fourteen sub-districts (Jetis, Mantrijeron, Umbulharjo, and Mergangsan) accounted for the majority of these cases and were purposively selected as study sites.

Participants and sampling

The sampling frame comprised teachers in state schools under the Ministry of Education and Culture in the four selected sub-districts, enumerated from the national education database (*Data Pokok Pendidikan*, odd semester 2021). It listed 489 primary (SD), 158 junior secondary (SMP), 151 senior secondary (SMA), and 394 vocational secondary (SMK) teachers, giving a frame of 1,192.

The sample size was calculated to estimate a population proportion with a 5% margin of error at 95% confidence. Because no prior estimate of the prevalence of inadequate knowledge or high stigma among Indonesian teachers was available, the conservative assumption of 50% was used, giving 385 for an infinite population; the finite population correction for a frame of 1,192 reduced this to 291, which was rounded up to 300 to allow for non-response. The sample was allocated proportionally across the four strata (SD: 123, SMP: 40, SMA: 38, and SMK: 99). Sampling then proceeded in two stages. In the first stage, schools were not drawn at random; within each stratum, they were selected on the basis of a teaching staff large enough to meet the stratum quota, giving ten schools (six primary, two junior secondary, one senior secondary, and one vocational). In the second stage, eligible teachers in each selected school were chosen at random from the school's staff list. Teachers were eligible if they taught school-age children in one of the four sub-districts and consented to participate. Teachers at health-focused vocational schools were excluded, since their professional training in communicable disease is unrepresentative of the teaching workforce.

All 300 sampled teachers completed the questionnaire: 124 of the 489 primary teachers in the sampling frame (six schools), 40 of the 158 junior secondary teachers (two schools), 37 of the 151 senior secondary teachers (one school), and 99 of the 394 vocational teachers (one school). The achieved numbers differed from the allocation by one teacher in the primary and senior secondary strata. The school attended by each respondent was not recorded in the analytic dataset, so participation cannot be broken down by individual school, and clustering of teachers within schools could not be modeled (see Statistical analysis).

Measures

Knowledge of childhood TB was assessed with a 16-item instrument adapted from the questionnaire of Tolossa et al. [34], covering signs and symptoms (one item), transmission (five items), prevention of transmission (five items), and treatment and prophylaxis (five items). Items were scored dichotomously, with reverse scoring for negatively worded items, giving a range of 0–16. The total was used as a knowledge index, that is, a count of correct answers to distinct factual questions, rather than as a scale measuring a single latent trait (see Validity and reliability).

Stigma towards students with TB was measured with the 11-item community stigma scale developed by Van Rie et al. [35], translated into Indonesian for community members [30], formally adapted and validated among community members and people with TB [31], and, more recently, validated among

Indonesian healthcare workers [36]. Items load onto two domains, isolation (seven items) and distancing (four items), each rated from strongly disagree (1) to strongly agree (4), giving a range of 11–44, with higher scores indicating greater stigma. For this study, the item stems were modified so that the referent was a student with TB in the respondent's own school rather than a community member, and the items were worded in the first person so that they recorded the teacher's own attitudes rather than perceptions of how others behave; for example, the community item about not wanting to eat or drink with a person with TB became "I do not want to eat or drink with a student with TB at school". The wording of each item is shown in Table 3.

Covariates comprised age, sex, highest completed qualification, school level, principal source of TB information (formal, comprising health workers, health facilities, or organized training; or non-formal, comprising television, the internet, or social media), personal or family history of TB, and prior receipt of TB information at school. Sex was self-reported as male or female; gender identity was not measured, and no gender-based analysis beyond sex was possible.

Validity and reliability

Content validity of both adapted instruments was established through review by three subject experts per instrument, namely a consultant pediatric TB physician, a primary health center TB program officer, and a pediatric nursing lecturer for the knowledge instrument; and a mental health nurse specialist and two academics with published stigma research for the stigma scale. Construct validity was examined in a pilot of 30 teachers drawn from the same strata and not included in the main study, in which all items exceeded the critical Pearson correlation ($r=0.361$, $df=28$), with item-total correlations of 0.380–0.727 for knowledge and 0.531–0.781 for stigma. Internal consistency in the pilot was 0.759 for knowledge (Cronbach's alpha, equivalent to Kuder–Richardson formula 20 for dichotomous items) and 0.864 for stigma. In the main sample, internal consistency was 0.84 for the stigma scale but only 0.23 for the knowledge index. Alpha is not a fixed property of an instrument and falls when items have little variance [37], and eight of the sixteen knowledge items were answered correctly by more than 90% of the main sample.

Low alpha is also less informative for the knowledge instrument than for the stigma scale, because alpha assumes a reflective scale whose items are interchangeable indicators of one latent trait. A knowledge test of this kind is better regarded as a formative index, in which each item records a separate fact and a teacher who knows one fact need not know another; internal consistency is not an appropriate criterion for such an index [38]. Therefore, the total was used only as a count of correct answers, to test the assumption built into school programs that teachers who know more will stigmatize less, and no conclusion was drawn about a latent knowledge construct. The pilot item-total correlations and alpha reported above are criteria for a reflective scale and carry limited weight for an index. The fall in alpha from 0.759 in the 30-teacher pilot to 0.23 in the main sample cannot be explained from the data, although alpha estimated in a small sample is imprecise, and it reinforces the decision not to treat the total as a measure of a single construct. If the instrument is nonetheless treated as a reflective scale, its low reliability would bias associations between the total and stigma towards the null [39], and the aggregate results were interpreted with that in mind.

Data collection

After the study was explained and written informed consent was obtained, participants completed a self-administered questionnaire delivered through Google Forms by link or QR code. Three trained research assistants supervised administration, verified that all items were answered before submission, maintained a register to prevent duplicate entries, and coordinated follow-up with school leadership. Data collection extended beyond the planned six days because roughly 70% of eligible teachers had limited availability during the examination period at the end of the academic year.

Statistical analysis

Analyses were performed in IBM SPSS Statistics version 26.0, with verification in Python 3.11 (pandas, SciPy, statsmodels). Categorical variables are presented as frequencies and percentages, with Wilson score 95% CIs for the main prevalence estimates, and continuous variables as mean ± standard deviation (SD) and median with interquartile range (IQR). Differences between proportions are presented with Wald 95% CIs. No CIs are given for the proportions above and below the sample medians, because those cut-offs are defined by the sample itself.

The primary analysis treated knowledge and stigma as continuous scores, because dichotomization discards information, reduces power, and can make results depend on the cut point [40]. Both scores departed from normality (Kolmogorov–Smirnov $p<0.05$), so their association was summarized with Spearman's rank correlation, with a 95% CI obtained by Fisher's z transformation, and modeled by linear regression of the stigma score on the knowledge score, adjusted for age, sex, and principal information source. Spearman correlations between each of the four knowledge domains and the stigma score were examined in the same way. This continuous analysis was pre-specified as a sensitivity analysis and was designated as the primary analysis during peer review.

As a secondary analysis, retained for comparison with studies that report cut points, both scores were dichotomized at the sample median (adequate

knowledge: 13 or above; high stigma: above 24). Bivariable associations were tested with Pearson's chi-square test with continuity correction for 2×2 tables, and Fisher's exact test where any expected cell count fell below five.

A logistic model of high stigma on knowledge category and information source, the only covariate associated with stigma at $p<0.25$ in bivariable screening, is reported for transparency and was not used for inference.

The item-level analysis was exploratory and was not specified before data collection, so its results are reported as hypothesis-generating. Each of the 16 knowledge items (incorrect versus correct answer; because each item is binary, only the outcome is dichotomized in these models) was tested against high stigma by univariable logistic regression, with Wald p-values adjusted across the 15 estimable tests using the Benjamini–Hochberg FDR [41]; one item with fewer than ten incorrect responses was not estimable. An FDR-adjusted p below 0.05 was taken as the threshold for a signal robust to multiple testing. Items with an unadjusted p below 0.05 were then entered into a multivariable logistic model together with all seven covariates listed under Measures.

All seven measured covariates were entered simultaneously rather than selected statistically, because data-driven selection, such as backward elimination, yields biased coefficients and CIs that are too narrow [42]. This full model is the main item-level model.

The covariate set was justified using the Health Stigma and Discrimination Framework [13], in which age, sex, and highest qualification were treated as individual characteristics that may shape both knowledge and attitudes; principal information source and prior TB information at school as features of the information environment; personal or family history of TB as prior exposure; and school level as the sampling stratum and a proxy for school context. The model contained 12 parameters and 143 high-stigma events, about 12 events per parameter.

The reduced model obtained by backward elimination is reported only as a sensitivity analysis. Explained variance was summarized with Nagelkerke's R^2 [43], and calibration of the secondary and sensitivity models was assessed with the Hosmer–Lemeshow test. Odds ratios (ORs) are reported with 95% CIs to two decimal places and exact p-values to three decimal places, and a two-sided p below 0.05 was considered statistically significant.

Teachers were sampled within schools, but the school attended by each respondent was not recorded in the analytic dataset, so a multilevel model or cluster-robust standard errors could not be fitted. Ignoring clustering tends to make CIs too narrow when respondents in the same cluster resemble one another [44], so the intervals reported here may understate uncertainty. School level was included in the adjusted model, and in the senior secondary and vocational strata, the stratum corresponds to a single school.

Findings

Participant characteristics

All 300 sampled teachers completed the questionnaire with no missing items. Women made up 184 respondents (61.3%). The mean age was 41.6±11.3 years (range: 23–60), with 159 teachers (53.0%) older than 40; almost the entire sample held a bachelor's degree or higher (293, 97.7%), including 30 (10.0%) with a postgraduate qualification. Two-thirds of the teachers (203, 67.7%) named non-formal media as their principal source of TB information. Thirty-eight (12.7%) reported personal or family experience of TB, and 143 (47.7%) had never received TB information at school (Table 1).

Knowledge of childhood tuberculosis

Knowledge scores ranged from 7 to 16 (of a possible 16), with a median of 13 (IQR: 12–14) and a mean of 12.86±1.62. Applying the median cut-off, 183 teachers (61.0%) were classified as having adequate knowledge.

The aggregate figure conceals a very uneven profile across the sixteen items (Table 2). Teachers were near-unanimous on airborne spread, with 289 (96.3%) knowing that poor ventilation and limited sunlight favor transmission, 288 (96.0%) that covering the mouth prevents it, and 275 (91.7%) that sharing a drinking glass does not transmit TB. Four items broke this pattern. Only 112 teachers (37.3%) knew that TB is no longer transmissible after six months of standard treatment, and only 162 (54.0%) rejected the claim that TB can be cured with herbal medicine. Only 176 (58.7%) identified a cough lasting more than two weeks as a cardinal symptom, and 83 (27.7%) believed that everyone in close contact with a person with TB will develop the disease.

Of the seven characteristics examined, two were associated with knowledge category (Table 1). Female teachers were more likely than male teachers to be classified as having adequate knowledge (69.0% versus 48.3%; difference: 20.7 percentage points; 95% CI: 9.4–32.0; p=0.001), and teachers over 40 were more likely to be so classified than younger colleagues (67.3% versus 53.9%; difference: 13.4 percentage points; 95% CI: 2.4–24.4; p=0.024). School level, qualification, information source, TB history, and prior TB information at school were not associated with knowledge.

Table 1. Characteristics of the participating teachers, their distribution by knowledge and stigma categories, and adjusted odds ratios for high stigma (n=300; numbers in parentheses are percentages)

Characteristic	Category	n (%)	Adequate knowledge		High stigma		Multivariable model	
			n (%)	p	n (%)	p	aOR (95% CI)	p
All teachers		300 (100)	183 (61.0)		143 (47.7)			
Age (years)	18–40	141 (47.0)	76 (53.9)	0.024	71 (50.4)	0.446	1.00 (reference)	
	Over 40	159 (53.0)	107 (67.3)		72 (45.3)		0.84 (0.52–1.37)	0.490
Sex	Male	116 (38.7)	56 (48.3)	0.001	53 (45.7)	0.670	1.00 (reference)	
	Female	184 (61.3)	127 (69.0)		90 (48.9)		1.36 (0.81–2.29)	0.246
School level	Primary (SD)	124 (41.3)	69 (55.6)	0.103	58 (46.8)	0.775	1.00 (reference)	
	Junior secondary (SMP)	40 (13.3)	24 (60.0)		22 (55.0)		1.39 (0.65–2.97)	0.391
	Senior secondary (SMA)	37 (12.3)	20 (54.1)		18 (48.6)		1.05 (0.48–2.29)	0.910
	Vocational (SMK)	99 (33.0)	70 (70.7)		45 (45.5)		0.99 (0.55–1.77)	0.976
Highest qualification	Diploma	7 (2.3)	4 (57.1)	1.000[a]	2 (28.6)	0.451[a]	0.41 (0.08–2.24)	0.305
	Bachelor's degree	263 (87.7)	179 (61.1)[b]		141 (48.1)[b]		1.00 (reference)	
	Postgraduate degree	30 (10.0)					1.13 (0.51–2.50)	0.771
Principal source of TB information	Formal	97 (32.3)	58 (59.8)	0.865	38 (39.2)	0.056	1.00 (reference)	
	Non-formal	203 (67.7)	125 (61.6)		105 (51.7)		1.65 (0.93–2.90)	0.085
Personal or family history of TB	Yes	38 (12.7)	26 (68.4)	0.409	16 (42.1)	0.575	0.98 (0.46–2.06)	0.954
	No	262 (87.3)	157 (59.9)		127 (48.5)		1.00 (reference)	
Ever received TB information at school	Yes	157 (52.3)	94 (59.9)	0.763	72 (45.9)	0.589	1.00 (0.60–1.67)	0.989
	No	143 (47.7)	89 (62.2)		71 (49.7)		1.00 (reference)	

TB, tuberculosis; aOR, adjusted odds ratio; CI, confidence interval. SD, SMP, SMA, and SMK denote Indonesian primary, junior secondary, senior secondary, and vocational secondary schools. Percentages for knowledge and stigma are row percentages. Adequate knowledge is a score of 13 or above out of 16; high stigma is a score above 24 out of 44. p-values are from Pearson's chi-square test with continuity correction where applicable; [a] Fisher's exact test; [b] bachelor's and postgraduate degrees combined for the bivariable comparison. Adjusted ORs are from the exploratory multivariable logistic model of high stigma (143 events; 12 parameters), in which all seven characteristics and the two candidate misconceptions shown in Table 2 were entered simultaneously; Nagelkerke R^2=0.111.

Table 2. Item-level responses on knowledge of childhood tuberculosis and unadjusted and adjusted associations between each incorrect response and high stigma (n=300; numbers in parentheses are percentages)

Domain and item	Correct	Incorrect [95% CI]	High stigma		Association with high stigma			
			If incorrect	If correct	OR (95% CI)	p	FDR p	aOR (95% CI)
Signs and symptoms								
A cough lasting more than two weeks is a sign of TB	176 (58.7)	124 (41.3) [35.9–47.0]	58 (46.8)	85 (48.3)	0.94 (0.59–1.49)	0.795	0.852	–
Transmission								
TB is transmitted by shaking hands [a]	206 (68.7)	94 (31.3) [26.3–36.8]	49 (52.1)	94 (45.6)	1.30 (0.80–2.12)	0.297	0.635	–
Covering the mouth when coughing or sneezing prevents TB transmission	288 (96.0)	12 (4.0) [2.3–6.9]	7 (58.3)	136 (47.2)	1.56 (0.49–5.05)	0.454	0.816	–
TB can be transmitted by drinking from the same glass [a]	275 (91.7)	25 (8.3) [5.7–12.0]	8 (32.0)	135 (49.1)	0.49 (0.20–1.17)	0.107	0.389	–
TB is still transmissible after six months of regular treatment [a]	112 (37.3)	188 (62.7) [57.1–67.9]	90 (47.9)	53 (47.3)	1.02 (0.64–1.63)	0.926	0.926	–
TB is transmitted more readily where ventilation and sunlight are poor	289 (96.3)	11 (3.7) [2.1–6.4]	6 (54.5)	137 (47.4)	1.33 (0.40–4.46)	0.643	0.816	–
Prevention of transmission								
Everyone in close contact with a person with TB will develop TB [a]	217 (72.3)	83 (27.7) [22.9–33.0]	52 (62.7)	91 (41.9)	2.32 (1.38–3.91)	0.002	0.022	2.52 (1.45–4.38)
Wearing a mask when coughing does not prevent TB transmission [a]	224 (74.7)	76 (25.3) [20.7–30.5]	34 (44.7)	109 (48.7)	0.85 (0.51–1.44)	0.554	0.816	–
Treating a student with TB as soon as the illness is identified prevents transmission	293 (97.7)	7 (2.3) [1.1–4.7]	5 (71.4)	138 (47.1)	–[b]	–	–	–
A nutritious diet helps prevent TB	285 (95.0)	15 (5.0) [3.1–8.1]	8 (53.3)	135 (47.4)	1.27 (0.45–3.60)	0.653	0.816	–
A student with TB does not need support from the school [a]	274 (91.3)	26 (8.7) [6.0–12.4]	17 (65.4)	126 (46.0)	2.22 (0.96–5.15)	0.064	0.318	–
Treatment and prophylaxis								
TB can be cured with herbal medicine [a]	162 (54.0)	138 (46.0) [40.4–51.7]	77 (55.8)	66 (40.7)	1.84 (1.16–2.91)	0.010	0.072	1.99 (1.21–3.27)
A student diagnosed with TB can be cured with six months of medication	271 (90.3)	29 (9.7) [6.8–13.5]	10 (34.5)	133 (49.1)	0.55 (0.24–1.22)	0.139	0.389	–
TB can be prevented by BCG vaccination	267 (89.0)	33 (11.0) [7.9–15.0]	14 (42.4)	129 (48.3)	0.79 (0.38–1.64)	0.523	0.816	–
Students with a history of close contact should be examined for TB	272 (90.7)	28 (9.3) [6.5–13.2]	14 (50.0)	129 (47.4)	1.11 (0.51–2.41)	0.795	0.852	–
TB can be prevented with preventive therapy for close contacts	246 (82.0)	54 (18.0) [14.1–22.7]	21 (38.9)	122 (49.6)	0.65 (0.35–1.18)	0.156	0.389	–

TB, tuberculosis; BCG, Bacillus Calmette–Guérin; CI, confidence interval; OR, odds ratio; aOR, adjusted odds ratio; FDR, Benjamini–Hochberg false discovery rate across the 15 estimable tests. [a] Negatively worded item; a correct response is disagreement. The 95% CI (Wilson score) refers to the percentage answering the item incorrectly. High stigma (score above 24 out of 44; n=143) is shown as n (%) among teachers answering the item incorrectly and correctly. ORs and Wald p-values are from univariable logistic regression of high stigma on each incorrect response (reference: correct response); aORs are from the multivariable model described in Table 1. [b] Not tested (fewer than ten incorrect responses).

Table 3. Item-level responses on stigma towards students with tuberculosis (n=300; numbers in parentheses are percentages)

Domain and item	Agree	95% CI for agree, %	Disagree
Isolation			
I am worried about myself and other students eating and drinking with a student with TB	197 (65.7)	60.1–70.8	103 (34.3)
I feel uncomfortable being close to a student with TB	142 (47.3)	41.8–53.0	158 (52.7)
If a student has TB, I will keep my distance while they attend school	130 (43.3)	37.8–49.0	170 (56.7)
I would tell other parents that their children should not play with a child with TB	69 (23.0)	18.6–28.1	231 (77.0)
A student with TB should not attend school until declared cured	103 (34.3)	29.2–39.9	197 (65.7)
I am anxious that the school's reputation would suffer if a child with TB continued to attend	24 (8.0)	5.4–11.6	276 (92.0)
I avoid touching a student with TB	71 (23.7)	19.2–28.8	229 (76.3)
Distancing			
I do not want to eat or drink with a student with TB at school	140 (46.7)	41.1–52.3	160 (53.3)
I am worried other parents would object if a student with TB were allowed to attend	125 (41.7)	36.2–47.3	175 (58.3)
I think a student with TB is disgusting	16 (5.3)	3.3–8.5	284 (94.7)
I do not want to speak directly with a student with TB	47 (15.7)	12.0–20.2	253 (84.3)

TB, tuberculosis; CI, confidence interval. "Agree" combines "agree" and "strongly agree"; "disagree" combines "disagree" and "strongly disagree". The 95% CI (Wilson score) refers to the percentage agreeing.

Stigma towards students with tuberculosis

Stigma scores ranged from 11 to 41 (of a possible 44), with a median of 24 (IQR: 22–28) and a mean of 24.76±4.44. Applying the median cut-off, 157 teachers (52.3%) were classified as having low stigma and 143 (47.7%) as having high stigma. Overtly hostile attitudes were rare: only 16 teachers (5.3%) agreed that a student with TB is disgusting, 24 (8.0%) worried about the school's reputation, and 47 (15.7%) would avoid speaking to such a student. Attitudes concerning proximity and shared food were far more common (Table 3). Nearly two-thirds of the teachers (197, 65.7%; 95% CI: 60.1–70.8) were worried about themselves and other students eating and drinking alongside a student with TB, and 140 (46.7%) said they personally would not do so. Almost half (142, 47.3%) felt uncomfortable in close proximity, and 130 (43.3%) would keep their distance for as long as the student attended. One-third (103, 34.3%) held that the student should not attend school until declared cured, and 125 (41.7%) anticipated objections from other parents.

No demographic characteristic was statistically significantly associated with stigma (Table 1). Teachers relying on non-formal information sources were more often classified as having high stigma (105 of 203, 51.7% versus 38 of 97, 39.2%; difference: 12.5 percentage points; 95% CI: 0.6–24.4), although the continuity-corrected chi-square test fell just short of the conventional threshold (p=0.056).

Aggregate knowledge and stigma

In the primary analysis, with both scores treated as continuous, knowledge and stigma were weakly and non-significantly correlated (Spearman's ρ=−0.096; 95% CI: −0.207 to 0.017; p=0.095). In linear regression adjusted for age, sex, and information source, each additional knowledge point was associated with a 0.23-point lower stigma score, an estimate compatible with no association (95% CI: −0.55 to 0.09; p=0.151). Of the four knowledge domains, only prevention of transmission was correlated with the stigma score (ρ=−0.140; 95% CI: −0.249 to −0.027; p=0.015); the symptom, transmission, and treatment domains were not significantly correlated with it (coefficients not shown).

In the secondary, dichotomized analysis, high stigma was reported by 66 of the 117 teachers below the knowledge median (56.4%) and by 77 of the 183 at or above it (42.1%; difference: 14.3 percentage points; 95% CI: 2.8–25.8; p=0.021), a crude OR of 1.78 (95% CI: 1.11–2.85). Stigma scores were also marginally higher below the knowledge median (median: 25; IQR: 22–29 versus median: 24; IQR: 22–27; Mann–Whitney p=0.025). An association between total knowledge and stigma was therefore detectable only when knowledge was split at the median, and the continuous analyses using all information in both scores did not confirm it. In the adjusted dichotomized model, inadequate knowledge (aOR=1.81; 95% CI: 1.13–2.91; p=0.014) and a non-formal information source (aOR=1.70; 95% CI: 1.03–2.80; p=0.037) were associated with high stigma, but the model explained little of the variance in stigma (Nagelkerke R^2=0.045; Hosmer–Lemeshow χ^2=7.18, df=8, p=0.518).

Exploratory item-level analysis

Because the item-level analysis was exploratory, its results are presented as signals for later testing rather than as confirmed associations. When the sixteen items were examined individually, two errors stood out (Table 2). Teachers who believed that everyone in close contact with a person with TB will develop the disease had more than twice the odds of high stigma (unadjusted OR=2.32; 95% CI: 1.38–3.91; p=0.002; FDR-adjusted p=0.022); 52 of these 83 teachers (62.7%) were classified as having high stigma, compared with 91 of the 217 (41.9%) answering correctly. This was the only item to meet the FDR threshold. Teachers who believed that TB

can be cured with herbal medicine had 1.84 times the odds of high stigma (95% CI: 1.16–2.91; p=0.010), but this association did not meet the FDR threshold (adjusted p=0.072); 77 of 138 (55.8%) versus 66 of 162 (40.7%) were classified as having high stigma. A third item, that a student with TB does not need school support, showed a similar effect size but was held by only 26 teachers and was not statistically significant (OR=2.22; 95% CI: 0.96–5.15; p=0.064).

The remaining items showed no association, including the most prevalent misconception in the sample. The belief that a child remains infectious after six months of treatment was held by 188 teachers (62.7%), yet was unrelated to stigma classification (high stigma in 90 of 188 holders, 47.9%, and in 53 of 112 non-holders, 47.3%; OR=1.02; 95% CI: 0.64–1.63; p=0.926). Failure to recognize a prolonged cough, belief in transmission by handshake, and belief in transmission by a shared glass were likewise unrelated.

Both items with an unadjusted p below 0.05 were entered into a multivariable model together with all seven measured covariates (Tables 1 and 2). The close-contact belief remained associated with high stigma (aOR=2.52; 95% CI: 1.45–4.38; p=0.001), as did the herbal-medicine belief (aOR=1.99; 95% CI: 1.21–3.27; p=0.007), although only the former had met the FDR threshold in the univariable screen. No covariate was statistically significant, and the model explained little of the variation in stigma (Nagelkerke R^2=0.111). The reduced model obtained by backward elimination gave similar estimates for the two beliefs (aOR=2.50; 95% CI: 1.47–4.27; p<0.001 and aOR=1.86; 95% CI: 1.16–2.99; p=0.010, respectively), with a non-formal information source retained (aOR=1.66; 95% CI: 1.00–2.77; p=0.051; Nagelkerke R^2=0.094; Hosmer–Lemeshow χ^2=8.63, df=8, p=0.374).

Discussion

Teachers in this sample knew a great deal about how TB spreads, yet their total knowledge score was only weakly related to stigma. In the primary, continuous analysis, the correlation was close to zero and the adjusted slope was compatible with no association; an association appeared only when knowledge was split at the median, which is the form in which such results are usually reported. The exploratory item-level analysis pointed elsewhere. The belief that everyone in close contact with a person with TB will develop the disease was the strongest signal and the only one to survive correction for multiple testing, whereas the belief that TB can be cured with herbal medicine showed a weaker association that did not. The most common error, that a child remains infectious after six months of treatment, was not associated with stigma. These are cross-sectional associations from one city, and the item-level results are hypotheses for further testing rather than established findings.

The weak aggregate result is consistent with the Ugandan and Thai surveys described in the Introduction, neither of which found that greater knowledge went with less stigma [24, 25], and with a systematic review of 30 knowledge, attitude, and practice surveys in low- and middle-income countries, which reported knowledge gaps and stigmatizing attitudes side by side without examining whether one drives the other [45]. Two features of the present data may also contribute, although neither can be tested directly here. First, when most respondents answer most items correctly, the total is dominated by variation on a few harder items, and whether those happen to be the items that matter for attitudes depends on how the instrument was built. Second, measurement error may play a role: if the knowledge total is regarded as a reflective scale, its low internal consistency would weaken any association with stigma [39], so a weak correlation does not show that knowledge as such is irrelevant to attitudes. The fact that the association reached significance only after dichotomization is a pattern Altman and Royston warn against, since dichotomizing discards information, can make results depend on where the cut point falls, and may increase the risk of a false-positive finding [40].

The stronger signal concerned the belief that everyone in close contact with a person with TB will develop the disease, which was held by just over a quarter of teachers and was associated with about two and a half times the odds of high stigma after adjustment. The evidence on contacts indicates otherwise: in a meta-analysis of 95 contact-investigation studies from low- and middle-income settings, 3.1% of contacts had active TB at screening and about half had latent infection [46]. One interpretation, which these data cannot test, is that a teacher who regards infection after proximity as inevitable sees avoidance as the only available protection. Fear of infection is the most consistently reported driver of TB stigma [14], and the Health Stigma and Discrimination Framework treats it as one of the drivers that set in motion stigma practices such as separation and exclusion [13]. The close-contact item belongs to the prevention domain, the only domain whose score correlated with stigma in the continuous analysis. Because the item contributes to that domain score, the two results are not independent, and the signal still needs confirmation in another sample.

The herbal-medicine belief was held by nearly half of the sample, and its association with high stigma was weaker and less certain because it did not survive correction for multiple testing. If confirmed, it would fit a reading in which a teacher who doubts that biomedical treatment cures TB sees no point at which the child stops being a hazard. The prevalence

of the belief is not surprising in Java, where the use of traditional medicine is common and more likely than in other regions of Indonesia [47], and herbal remedies also appear among the incorrect treatments reported in knowledge, attitude, and practice surveys elsewhere [45]. Stigma, as Weiss et al. argued [48], takes its content from local meaning. Read together, the two beliefs suggest a picture of TB as caught inevitably and cured unreliably; however, that reading rests on one association that met the FDR threshold and one that did not, and it should be treated as a hypothesis.

Nearly two-thirds of teachers believed that a child remains infectious after completing six months of treatment, by a wide margin the commonest error in the sample, yet high stigma was almost equally frequent among teachers who held the belief and those who did not (47.9% and 47.3%). An association had been expected, because the belief seems to license exclusion of a treated child. The finding suggests that how often a misconception is held says little about whether it is associated with attitudes, which is a caution against designing stigma-reduction content from a frequency table alone. Why this belief showed no association cannot be determined from the data, and the explanations that follow are conjectures. The stigma items describe a student who currently has TB rather than one who has completed treatment, so a belief about infectiousness after treatment may simply have had little bearing on the answers; a version of the scale referring to a treated student could test this. Teachers may also hold the belief as an abstract fact rather than as a guide to conduct. A further possibility is that the belief matters less for primary-school pupils, who are rarely infectious even before treatment [6, 9, 10], than for adolescents, who often have adult-type infectious disease [11]; an analysis stratified by school level in a larger sample could examine this. Correcting the belief is justified on grounds of accuracy, but these data give no reason to expect that doing so would change attitudes.

A substantial part of the stigma measured in this study was not explained by any knowledge measure. Unease about eating and drinking alongside a student with TB, the most endorsed item in the instrument, was reported by 65.7% of teachers, while 91.7% of the same teachers correctly stated that TB is not transmitted through a shared glass. A similar gap between biomedical explanations and food-related avoidance has been described among people with TB in urban Zambia [27]. In Link and Phelan's account, separation is a social act performed on a labeled person [12], and it does not need an epidemiological warrant. That 41.7% of teachers anticipated objections from other parents locates a further part of the problem outside the teacher entirely. Education directed only at teachers would leave that anticipatory pressure intact, which is one reason current stigma frameworks recommend intervention at more than one level [13, 21].

Information source was the contextual factor closest to statistical significance, although its association with stigma was imprecise and was not significant in the fully adjusted model (aOR=1.65; 95% CI: 0.93–2.90; p=0.085). Two-thirds of teachers named television, the internet, or social media as their principal source of TB information. Ethiopian qualitative work identified inappropriate media messages as one cause of TB stigma [7], and in coastal Semarang, TB information reached residents only sporadically, through WhatsApp groups and general health events that rarely addressed TB specifically [18]. Nearly half of the sample had never received TB information at school. Together, these observations suggest that informal media may be filling a gap left by formal provision, a gap that the *Sekolah Peduli Tuberkulosis* guidance already gives schools a mandate to address [22].

The implications for nursing practice, education, and policy are tentative, because the design is cross-sectional and the item-level findings are exploratory. With that caveat, a program that only raises overall TB knowledge among teachers like these would largely cover what they already know, and in these data, the total knowledge score was a weak correlate of attitudes. Content that addresses the probability of disease after exposure and the reliability of standard treatment would target the beliefs most strongly associated with stigma in this sample, but whether it would reduce stigma is an empirical question. Refutations that name a specific misconception and supply the correct account outperform expository information [28, 29], yet the effect can be short-lived; among educators, refutation texts reduced misconceptions immediately, but the effect vanished within 30 days and intended practice did not change [49]. Such content would therefore be one component alongside the multilevel approaches that stigma frameworks recommend [13], including a clear school policy, agreed with local health services, on the return to school of a child receiving treatment.

In Indonesia, the primary health center nurses who staff the school health program (*Usaha Kesehatan Sekolah*) are well placed to deliver and evaluate this work, since they are the health professionals most likely to be in a school when a case is identified, to conduct contact investigation, and to brief staff. They can explain that close contact seldom leads to disease, that six months of treatment cures the disease, and that a child receiving treatment can usually return to school on medical advice, and they can address the objections that teachers anticipate from parents. Whether such messages change attitudes is a question these data cannot answer, and the modest explained variance in the models indicates that most of what drives stigma here was not measured. Replication in other settings, followed

by an intervention study with an attitudinal or behavioral endpoint, preferably randomized by school, would be the appropriate next steps, and the close-contact belief offers such a study a specific hypothesis to test.

This study has several strengths, including proportional allocation across four school strata with random selection of teachers within schools, complete data on all 300 respondents, use of a stigma instrument with prior cross-cultural validation in Indonesia, adjustment for multiple testing at the item level, and a primary analysis that uses the full information in both scores.

The findings are also subject to several limitations. First, the cross-sectional design means that direction cannot be established; teachers with stigmatizing views may be less receptive to accurate information rather than the reverse. Second, both measures were self-reported, the stigma items were worded in the first person, and respondents were identifiable to the research team, so social desirability probably depressed stigma responses [24]; the prevalence figures should be read as lower bounds. Third, the item-level analysis was exploratory and used the median-split stigma outcome; only the close-contact item met the FDR threshold, and both beliefs require confirmation in an independent sample. In addition, the primary continuous model was adjusted only for age, sex, and information source, a smaller set than the item-level model, so residual confounding of that estimate by the other measured covariates cannot be excluded. Fourth, internal consistency of the knowledge index in the main sample was low (alpha=0.23), a consequence of strong ceiling effects, since eight of the sixteen items were answered correctly by over 90% of respondents. The total was treated as a formative count of correct answers, but if it is regarded as a reflective scale, its measurement error would bias associations towards the null, and the instrument needs revision, with more items of intermediate difficulty, and further validation before reuse. Fifth, generalizability is limited. Only public schools in four of the city's fourteen sub-districts were sampled, and these sub-districts were chosen because they had the most childhood TB cases. Schools were selected purposively for staff size rather than at random, the senior secondary and vocational strata were each represented by a single school, and private and Islamic schools were not represented. Sixth, teachers were clustered within schools, but the respondent's school was not recorded, so CIs could not be adjusted for clustering and may be too narrow [44]; unmeasured school-level factors, such as leadership or school health policy, may also confound the associations. Seventh, teachers with school health unit or physical education responsibilities were retained and may have raised aggregate knowledge. Eighth, sex was recorded as a binary self-report and gender was not measured, so the higher knowledge among women cannot be interpreted beyond that. Finally, prior TB training or personal acquaintance with a student who had TB was not measured, either of which could confound the observed associations.

Conclusion

Among 300 public schoolteachers in Yogyakarta City, TB knowledge was high overall and only weakly related to stigma towards students with TB. In the exploratory item-level analysis, the clearest signal was the belief that everyone in close contact with a person with TB will develop the disease. The belief that TB can be cured with herbal medicine showed a weaker association that did not meet the FDR threshold, and the commonest misconception, continued infectiousness after treatment, was not associated with stigma. Because the design is cross-sectional and the item-level analysis exploratory, these findings do not show that correcting particular beliefs would reduce stigma. They offer a specific hypothesis, and replication in other settings, followed by a school-based intervention study delivered by school health nurses and primary care teams, is needed before curriculum recommendations are made.

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Ethical Permissions: The study protocol was approved by the Medical and Health Research Ethics Committee, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, on April 17, 2023 (approval number: KE/FK/0643/EC/2023). Permission was obtained from the Yogyakarta City Education, Youth and Sports Agency and the provincial Youth and Sports Agency. All participants received written and verbal information about the study's purpose, benefits, risks, and confidentiality, and their right to withdraw at any point until data collection was complete, and all gave written informed consent. The study was conducted in accordance with the Declaration of Helsinki.

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