

Willingness to participate in tuberculosis screening and preventive treatment among college freshmen in China: a cross-sectional study based on the Health Belief Model

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Abstract

Background: Tuberculosis (TB) remains a major public health concern in university settings, where active screening and preventive treatment are key control strategies. However, their effectiveness depends largely on students'willingness to participate. This study examined TB-related knowledge, health beliefs, and their associations with willingness to undergo TB screening and preventive treatment among college freshmen.

Methods: A cross-sectional survey was conducted in April 2025 among first-year college students in Anhui Province, China, using a multistage stratified cluster random sampling method. Data were collected via an anonymous electronic questionnaire assessing sociodemographic characteristics, TB knowledge, and Health Belief Model (HBM) constructs. Willingness for TB screening and preventive treatment was measured using Likert-scale items. Multivariate linear regression analyses were performed to identify associated factors.

Results: A total of 9,790 valid responses were included. The overall awareness rate of TB core knowledge was 75.8%, with notable gaps in fundamental concepts. Willingness to accept preventive treatment (mean 4.72 ± 0.66) was slightly but significantly higher than willingness to undergo screening (4.61 ± 0.74; $p < 0.001$). TB knowledge, perceived benefits, self-efficacy, and cues to action were positively associated with both outcomes, while perceived barriers were negatively associated (all $p < 0.01$). In multivariate analyses, TB knowledge ($\beta = 0.255$) and perceived benefits ($\beta = 0.110$) were stronger predictors of preventive treatment willingness, whereas cues to action ($\beta = 0.170$) showed a stronger association with screening willingness.

Conclusions: Although willingness to participate in TB screening and preventive treatment was generally high, important gaps in knowledge and persistent perceived barriers remain. These findings suggest that differentiated strategies may be required: screening promotion should emphasize external cues and accessibility, whereas preventive treatment promotion should focus on knowledge enhancement and benefit communication.

Background

Tuberculosis (TB), caused by Mycobacterium tuberculosis, remains a major global public health challenge. According to the World Health Organization Global Tuberculosis Report 2024, TB continues to rank among the leading infectious causes of morbidity and mortality worldwide (1). China remains one of the countries with a high TB burden, accounting for a substantial proportion of global cases (1).

University campuses are characterized by high population density, close interpersonal contact, and high mobility, making them susceptible to TB transmission and cluster outbreaks (2, 3). School-based outbreaks not only threaten student health but also disrupt normal teaching activities. To address this, national guidelines in China recommend active TB screening among freshmen and preventive treatment for those diagnosed with latent TB infection (LTBI) (4).

However, the success of these strategies depends largely on individuals' willingness to participate. Previous studies have shown that insufficient knowledge, low perceived risk, stigma, and concerns about treatment side effects may reduce participation in TB-related health services among young populations (5–7).

The Health Belief Model (HBM) provides a useful framework for understanding health-related decision-making (8). It suggests that behavior is influenced by perceived susceptibility, severity, benefits, barriers, self-efficacy, and cues to action. This model has been widely applied in preventive health behaviors such as vaccination and screening (9–11).

Although previous studies have explored TB knowledge and attitudes among students (12–14), few have simultaneously examined screening and preventive treatment willingness within a unified theoretical framework. These two behaviors differ in nature: screening is typically a one-time action, whereas preventive treatment requires sustained adherence. Understanding their distinct determinants is essential for designing targeted interventions.

Methods

Study design and sample size

This cross-sectional study was conducted in April 2025 among first-year college students in Anhui Province, China. The required sample size was estimated based on a conservative assumption of the lowest reported awareness rate of core TB knowledge from previous national surveys, with a 95% confidence level and a margin of error of 2%. Considering a design effect due to cluster sampling and a potential non-response rate of 10%, the final sample size was adjusted upward accordingly to ensure adequate statistical power.

Sampling and participants

A multistage stratified cluster random sampling method was employed. First, 30 universities were selected based on geographic distribution and institutional type. Within each selected university, classes were randomly chosen as sampling clusters, and all freshmen in the selected classes were invited to participate.

A total of 9,829 questionnaires were distributed, and 9,790 valid responses were obtained, yielding a response rate of 99.6%.

Data collection and instrument

Data were collected using an anonymous, self-administered electronic questionnaire after obtaining informed consent from participants.

The questionnaire used in this study was developed by the research team based on the Health Belief Model (HBM) and relevant literature, and has not been previously published. It underwent pilot testing and expert review to ensure content validity and clarity. Internal consistency reliability was assessed using Cronbach's α coefficients.

The questionnaire included multiple domains, including sociodemographic characteristics, TB knowledge, HBM constructs, health behaviors, and information sources.

In the present study, the analysis focused on four sections:

1. Sociodemographic characteristics: sex, age, institution type, academic major, household registration, and TB contact history.

2. TB core knowledge: eight items derived from national TB control guidelines. Each correct response was scored as 1 point, with total scores ranging from 0 to 8. Higher scores indicated better knowledge (Cronbach's $\alpha = 0.72$).

3. Health beliefs (HBM constructs): including perceived susceptibility (2 items), perceived severity (2 items), perceived benefits (4 items), perceived barriers (7 items), self-efficacy (2 items), and cues to action (3 items). All items were rated on a 5-point Likert scale. Higher scores indicated stronger perceptions, except for perceived barriers (Cronbach's $\alpha = 0.76–0.89$).

4. Willingness outcomes: willingness to undergo TB screening and willingness to accept preventive treatment, each measured using a single Likert-scale item under hypothetical scenarios. Single-item measures were used because they are commonly applied in behavioral intention research and are considered appropriate for capturing overall intention in large-scale surveys.

Other domains (health behaviors and information sources) were not included in the present analysis.

The full questionnaire is provided as Supplementary File 1.

Statistical analysis

Data were analyzed using SPSS version 23.0. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages.

Common method bias was assessed using Harman's single-factor test. The first factor accounted for less than 40% of the total variance, suggesting that common method bias was not a serious concern.

Group differences were examined using independent-samples t-tests or one-way analysis of variance (ANOVA), as appropriate. Pearson correlation analysis was used to assess associations among TB knowledge, HBM constructs, and willingness outcomes.

Multivariate linear regression analyses were conducted to identify independent predictors of willingness for TB screening and preventive treatment. All variables with theoretical relevance were entered into hierarchical regression models, including sociodemographic variables, knowledge scores, and HBM constructs. Identical predictor sets were used for both outcomes to facilitate comparison. Prior to regression analyses, multicollinearity among independent variables was assessed using variance inflation factors (VIFs). Standardized regression coefficients (β) were reported to allow comparison of effect sizes. A two-sided P value < 0.05 was considered statistically significant.

This study was approved by the Ethics Committee of Anhui Chest Hospital (Approval No. KJ2024-015). The study was initially initiated at Anhui Chest Hospital and later conducted by the Anhui Provincial Center for Disease Control and Prevention following institutional integration.

Clinical trial number: not applicable.

Results

Participant characteristics

The sociodemographic characteristics of the 9,790 participants are presented in Table 1. The sample consisted of more males (59.1%) than females (40.9%). A majority were enrolled in junior colleges (70.8%) and reported rural household registration (76.6%). Engineering (33.7%) and science (26.1%) were the most common majors. Most students (82.2%) reported no known contact with a TB patient.

Table 1

Sociodemographic characteristics of participants (n = 9,790)

Characteristic	Category	n	%
Sex	Male	5,782	59.1
	Female	4,008	40.9
Institution Type	Undergraduate	2,857	29.2
	Junior College	6,933	70.8
Major	Liberal Arts	1,738	17.8
	Science	2,552	26.1
	Engineering	3,298	33.7
	Medical	1,534	15.7
	Other	668	6.8
Household Registration	Rural	7,499	76.6
	Urban	2,291	23.4
TB Contact History	Yes	114	1.2
	No	8,047	82.2
	Unsure	1,629	16.6

TB knowledge and health beliefs

The overall awareness rate of TB core knowledge was 75.8%. Awareness rates for individual items varied widely, from 49.6% for “TB is a chronic infectious disease” to 91.2% for “correct action after symptom onset” (Table 2).

Table 2

TB core knowledge awareness among participants (n = 9,790)

Knowledge Item	Correct Answer	n	Awareness Rate (%)
Nature of TB	Chronic infectious disease	4,852	49.6
Main transmission route	Respiratory droplets	8,324	85.0
Recognition of suspect symptoms	Cough for ≥ 2 weeks or bloody sputum	7,682	78.5
Effective preventive behaviors	All of the above (e.g., covering cough)	8,622	88.1
Cure possibility	Mostly curable	6,380	65.2
Correct action after symptoms	Report and avoid attending class	8,933	91.2
Main purpose of screening	All of the above (case finding, LTBI identification, education)	7,825	79.9
Management of LTBI	Preventive treatment upon medical advice	6,768	69.1
Overall Awareness Rate	-	**59,386**	**75.8**

Descriptive statistics for HBM constructs are shown in Table 3. Participants reported relatively high scores for perceived benefits, self-efficacy, and cues to action (mean > 4.1), and a moderate score for perceived barriers.

Table 3

Descriptive statistics for Health Belief Model constructs(n = 9,790)

HBM Construct	No. of Items	Score Range	Mean ± SD
Perceived Susceptibility	2	1–5	3.94 ± 0.78
Perceived Severity	2	1–5	3.90 ± 0.80
Perceived Benefits	4	1–5	4.32 ± 0.69
Perceived Barriers	7	1–5	3.17 ± 1.03
Self-efficacy	2	1–5	4.15 ± 0.71
Cues to Action	3	1–5	4.21 ± 0.70

Willingness for TB screening and preventive treatment

The mean willingness scores for TB screening and preventive treatment were 4.61 ± 0.74 and 4.72 ± 0.66, respectively, with willingness for preventive treatment being significantly higher ($t = -20.097$, $P < 0.001$).

Correlations among key variables

As shown in Table 4, both willingness outcomes were positively correlated with TB knowledge, perceived benefits, self-efficacy, and cues to action (all $p < 0.01$), and negatively correlated with perceived barriers. Similar correlation patterns were observed for both outcomes.

Table 4

Correlation analysis of knowledge, health beliefs, and willingness among college freshmen (r values, n = 9,790)

Variable	Correlation with Screening Willingness (r)	Correlation with Preventive Treatment Willingness (r)
Knowledge Level		
Knowledge Total Score	0.311**	0.353**
Health Belief Constructs		
Perceived Benefits	0.293**	0.311**
Cues to Action	0.309**	0.301**
Self-efficacy	0.277**	0.272**
Perceived Susceptibility	0.164**	0.155**
Perceived Severity	0.146**	0.144**
Perceived Barriers	-0.061**	-0.074**
Note: **$p < 0.01$ for all correlations.		

Multivariate predictors of willingness

The results of the hierarchical regression analyses are summarized in Table 5. The final models explained 16.3% and 18.6% of the variance in screening and preventive treatment willingness, respectively (both F-tests $p < 0.001$).

For screening willingness, significant positive predictors in the final model included TB knowledge ($\beta = 0.213$, $p < 0.001$), cues to action ($\beta = 0.170$, $p < 0.001$), perceived benefits ($\beta = 0.055$, $p = 0.001$), and self-efficacy ($\beta = 0.049$, $p = 0.007$). Perceived barriers were a significant negative predictor ($\beta = -0.084$, $p < 0.001$). Female sex ($\beta = 0.029$, $p = 0.003$) and having no TB contact history ($\beta = -0.043$, $p < 0.001$) were also significant demographic predictors. Perceived susceptibility and severity were not significant.

For preventive treatment willingness, significant positive predictors were TB knowledge ($\beta = 0.255$, $p < 0.001$), perceived benefits ($\beta = 0.110$, $p < 0.001$), cues to action ($\beta = 0.120$, $p < 0.001$), and self-efficacy ($\beta = 0.040$, $p = 0.025$). Perceived barriers remained a significant negative predictor ($\beta = -0.082$, $p < 0.001$). Significant demographic predictors were female sex ($\beta = 0.042$, $p < 0.001$), attending an undergraduate institution ($\beta = 0.030$, $p = 0.001$), and having no TB contact history ($\beta = -0.035$, $p < 0.001$). Perceived susceptibility and severity were again non-significant.

A key comparative finding is the differing strength of certain predictors: Knowledge and perceived benefits were stronger predictors for preventive treatment willingness, whereas cues to action was a stronger predictor for screening willingness.

Table 5

Hierarchical multiple linear regression analyses predicting willingness for TB screening and preventive treatment (n = 9,790)

Predictor	Screening Willingness	Preventive Treatment Willingness
	Final Model β (p-value)	Final Model β (p-value)
Step 1: Demographics		
Sex (Female vs. Male)	**0.029 (.003)**	**0.042 (< .001)**
Institution (Undergrad. vs. Junior College)	0.013 (.179)	**0.030 (.001)**
Major (Ref: Liberal Arts)	n.s.	n.s.
Contact History (Yes vs. No)	**-0.043 (< .001)**	**-0.035 (< .001)**
Step 2: TB Knowledge		
Knowledge Total Score	**0.213 (< .001)**	**0.255 (< .001)**
Step 3: Health Beliefs		
Perceived Benefits	**0.055 (.001)**	**0.110 (< .001)**
Perceived Barriers	**-0.084 (< .001)**	**-0.082 (< .001)**
Self-efficacy	**0.049 (.007)**	**0.040 (.025)**
Cues to Action	**0.170 (< .001)**	**0.120 (< .001)**

β = Standardized regression coefficient. * p < .001. n.s. = not significant in final model (p > 0.05). For brevity, non-significant demographic coefficients for major and household registration are not shown.

Predictor	Screening Willingness	Preventive Treatment Willingness
	Final Model β (p-value)	Final Model β (p-value)
Perceived Susceptibility	0.008 (.514)	-0.004 (.761)
Perceived Severity	0.013 (.319)	0.019 (.143)
Model Statistics		
R^2 / Adjusted R^2 (Final Model)	0.163 / 0.162	0.186 / 0.185
F (df)	158.89 (12, 9777)*	186.16 (12, 9777)*

β = Standardized regression coefficient. * $p < .001$. n.s. = not significant in final model ($p > 0.05$). For brevity, non-significant demographic coefficients for major and household registration are not shown.

Discussion

Using the Health Belief Model as a theoretical framework, this study systematically examined factors associated with willingness to participate in TB screening and preventive treatment among college freshmen. Although overall willingness levels were relatively high, our findings suggest that important cognitive gaps and perceived barriers persist, and that distinct mechanisms may underlie different preventive behaviors.

The overall awareness rate of TB core knowledge (75.8%) was below the national target, consistent with previous studies conducted among student populations in China and other countries (12, 15, 16). Notably, knowledge distribution was uneven: while awareness of practical preventive actions was relatively high, understanding of fundamental concepts—such as the chronic and infectious nature of TB—remained insufficient. Similar patterns have been reported in prior studies, suggesting that health education efforts often emphasize actionable behaviors while overlooking conceptual understanding (13, 15). From a behavioral perspective, inadequate foundational knowledge may limit risk appraisal and weaken motivation for sustained preventive actions, particularly for interventions requiring long-term adherence, such as LTBI treatment (17, 18).

Consistent with the Health Belief Model, perceived benefits, self-efficacy, and cues to action were positively associated with willingness, whereas perceived barriers showed a negative association. These findings align with a substantial body of literature on preventive health behaviors, including vaccination and screening, where perceived

benefits and self-efficacy are consistently identified as key facilitators (9, 10, 19). Meanwhile, perceived barriers—such as concerns about inconvenience, potential side effects, or social stigma—remain significant obstacles to engagement, as widely reported in TB-related contexts (17, 20, 21). These findings suggest that, beyond improving knowledge, it is equally important to address structural and psychological constraints to enhance participation in TB prevention programs.

A key strength of this study lies in its comparative analysis of screening and preventive treatment willingness. Although both behaviors are situated within the same prevention continuum, they appear to be influenced by different decision-making processes. TB knowledge demonstrated a stronger association with preventive treatment willingness than with screening willingness. This is consistent with previous evidence indicating that knowledge plays a more critical role in decisions involving sustained commitment and perceived risk, such as adherence to LTBI treatment (18, 22). Preventive treatment requires prolonged medication use and involves greater uncertainty regarding benefits and risks, making cognitive evaluation more central to decision-making.

Similarly, perceived benefits were more strongly associated with preventive treatment willingness, suggesting that individuals are more likely to weigh expected outcomes when considering long-term interventions. This finding is consistent with behavioral research indicating that benefit perception becomes increasingly important as the perceived cost or complexity of an intervention rises (23).

In contrast, cues to action emerged as the strongest predictor of screening willingness. This suggests that screening behavior is more responsive to external prompts, such as institutional arrangements, peer influence, or service accessibility. This pattern is consistent with behavioral “nudge” theory, which emphasizes the role of environmental cues in facilitating low-cost, one-time health actions (24, 25). Therefore, strengthening organizational support and optimizing service delivery may be particularly effective in promoting screening uptake.

Notably, perceived susceptibility and severity were not significant predictors in the multivariate models. This may reflect an optimistic bias among young adults, who tend to underestimate their personal risk of disease (26). Similar findings have been reported in studies of TB and other infectious diseases among university populations (27). In such contexts, risk perception alone may be insufficient to drive behavioral change, and interventions may need to rely more on external cues and benefit framing.

Demographic differences were also observed. Female students demonstrated higher willingness to participate in both screening and preventive treatment, consistent with evidence that women are generally more likely to engage in preventive health behaviors (28, 29).Students in undergraduate institutions showed greater willingness to accept preventive treatment, which may reflect higher levels of health literacy and access to health information. In contrast, students without a history of TB contact exhibited lower willingness, possibly due to reduced perceived relevance of the disease. Previous research has highlighted the roles of both health literacy and perceived risk in shaping preventive health behaviors (19, 30, 31).

This study has several limitations. First, the cross-sectional design precludes causal inference. Second, data were self-reported and may be subject to recall or social desirability bias. Third, the study was conducted in a single province, which may limit the generalizability of the findings to other regions.

From a practical perspective, the findings of this study have important implications for intervention design. Strategies to promote TB screening should prioritize strengthening external cues to action and improving service accessibility. In contrast, efforts to increase acceptance of preventive treatment should focus more on enhancing knowledge and clearly communicating expected benefits. Across both domains, reducing perceived barriers remains essential.

Conclusions

In conclusion, although college freshmen demonstrated relatively high willingness to participate in TB screening and preventive treatment, important gaps in knowledge and persistent perceived barriers remain. The findings suggest that these two preventive behaviors are influenced by different underlying mechanisms, highlighting the need for differentiated intervention strategies. Screening programs should prioritize strengthening external cues to action and improving service accessibility, whereas preventive treatment promotion should focus on enhancing knowledge and clearly communicating benefits. Future studies should further explore the translation of intention into actual behavior and assess the effectiveness of targeted interventions in real-world settings.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Anhui Chest Hospital (Approval No. KJ2024-015). All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the Declaration of Helsinki. The study was initially initiated at Anhui Chest Hospital and subsequently conducted by the Anhui Provincial Center for Disease Control and Prevention following institutional integration. All participants provided informed consent prior to participation. Participation was voluntary and anonymous.

Consent for publication

Not applicable.

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Authors’contributions

YS conceived and designed the study. JYJ participated in the study. GZY and XC participated in the study design. ZXX and CXP contributed to data collection and statistical analysis. HLL and KR contributed to manuscript revision. BFJ served as the corresponding author and provided overall guidance. All authors revised the manuscript critically and approved the final version.

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Authors’ information

Not applicable.

Author Contribution

YS conceived and designed the study, conducted the study, performed the statistical analyses, and drafted the manuscript. JLJ contributed to data collection and study implementation. GYZ and XC participated in the study design. XXZ and XPC contributed to data collection and statistical analysis. KR and HLL contributed to manuscript revision. FJB served as the corresponding author and provided overall guidance. All authors revised the manuscript critically and approved the final version.

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Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Supplementary Files

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- SupplementaryFile1Questionnaire.pdf