Original Article

Factors associated with hesitancy toward a future tuberculosis vaccine among people living with HIV: A cross-sectional study in Indonesia

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Abstract

Evidence regarding factors associated with tuberculosis (TB) vaccine hesitancy among people living with HIV (PLHIV) in Indonesia remains limited. This study aimed to identify sociodemographic and clinical factors associated with hesitancy toward a future TB vaccine among PLHIV. This cross-sectional study included 346 PLHIV attending the Intermediate Care Unit and Infectious Disease Outpatient Clinic of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, from January to February 2026. Participants were recruited using consecutive sampling. Data were collected using a structured questionnaire and verified through electronic medical records. Associations were assessed using the Chi-square test, followed by multivariable logistic regression for variables with $p<0.25$ in the bivariate analysis. Of the 346 participants, 33.2% were hesitant, and 66.8% were willing to receive a future effective TB vaccine. In the bivariate analysis, female sex (OR: 3.04; 95%CI: 1.91–4.86; $p<0.001$), age 26–39 years (OR: 1.59; 95%CI: 1.00–2.52; $p=0.046$), unemployment (OR: 1.71; 95%CI: 1.07–2.73; $p=0.024$), and income below the regional minimum wage (OR: 1.85; 95%CI: 1.14–2.98; $p=0.011$) were associated with greater vaccine hesitancy. After adjustment, income below the regional minimum wage remained independently associated with hesitancy (adjusted OR: 2.14; 95%CI: 1.11–4.24; $p=0.025$). Socioeconomic disadvantage, particularly low income, may represent an important barrier to the acceptance of future TB vaccines among PLHIV. Socioeconomically tailored education and vaccination strategies should be considered for this population.

Keywords: HIV infection, people living with HIV, tuberculosis, vaccine hesitancy, social determinants of health

Introduction

Tuberculosis (TB) and human immunodeficiency virus (HIV) still pose a major health threat to several developing countries, including Indonesia [1]. In 2024, Indonesia had 17,136 cases of TB-HIV coinfection, indicating the increasing overlap between the two conditions [1]. On a global scale, TB continues to be the most common cause of death among people living with human immunodeficiency virus (PLHIV) due to HIV-induced immune suppression [2]. The dual

Received: May 19, 2026 - Accepted: July 10, 2026 - Published online: July 31, 2026

epidemic of TB and HIV requires urgent attention because each condition can worsen the clinical course and outcomes of the other [3]. Developing nations that have a high TB burden, such as Indonesia, may always be considered a top priority in the World Health Organization (WHO) strategy for TB/HIV prevention and treatment from 2021 to 2025 [4]. Despite having access to antiretroviral drugs, PLHIV are at a much greater risk of contracting TB than their non-HIV counterparts [5].

Vaccine hesitancy is defined as delaying or refusing vaccinations even when they are available [6]. Vaccine hesitancy among PLHIV may be influenced by concerns about vaccine safety, possible interactions with antiretroviral therapy, and perceived adverse effects on immune function [7]. Socioeconomic factors such as poor economic status and unemployment are well-established risk factors for vaccine hesitancy since socioeconomically disadvantaged people lack health literacy and knowledge of the importance of vaccinations due to the unavailability of information from reliable sources [8,9]. Evidence regarding the associations of sex, age, and educational attainment with vaccine hesitancy remains inconsistent, with some studies reporting significant associations and others finding none [8,10,11]. Evidence regarding the determinants of hesitancy toward future TB vaccination among PLHIV in Indonesia remains limited. Therefore, the aim of this study was to identify factors associated with TB vaccine hesitancy in this population. The findings may inform the development of evidence-based educational strategies and targeted interventions to improve acceptance of future TB vaccines among PLHIV.

Methods

Study design and setting

This observational analytical study used a cross-sectional design. It was conducted at the Intermediate Care Unit and Infectious Disease Outpatient Clinic of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, from January to February 2026. The main objective was to identify factors associated with hesitancy toward a future TB vaccine among PLHIV. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [12]. This study was conducted in accordance with the principles of the Declaration of Helsinki [13]. Before data collection, all participants received detailed explanations regarding the study objectives, potential risks, and benefits of participation. Written informed consent was obtained from all respondents willing to participate, and participants were informed of their right to withdraw from the study at any time without consequences. No financial incentives were provided to participants; however, educational materials regarding TB prevention were given as an indirect benefit.

Participants and eligibility criteria

Participants were eligible if they were aged ≥18 years, had been diagnosed with HIV, were receiving care at the Intermediate Care Unit and the Infectious Disease Outpatient Clinic of Dr. Soetomo General Academic Hospital, and provided written informed consent. Participants who did not complete the questionnaire or had incomplete data were excluded from the analysis.

Data collection

Data were collected at the Intermediate Care Unit and Infectious Disease Outpatient Clinic of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, from January to February 2026. Eligible participants were approached during routine outpatient visits, and data were obtained through interviewer-administered structured questionnaires and review of electronic medical records (EMRs). The questionnaire collected information on sociodemographic characteristics, clinical history, anxiety level, and willingness to receive a future effective TB vaccine. Relevant clinical information, including HIV diagnosis and histories of chronic disease and sexually transmitted infections, was verified against the participants' EMRs and available medical documentation. When discrepancies were identified between questionnaire responses and medical records, the information was reconfirmed with the participant and cross-checked using the available documentation. Before data collection, the questionnaire underwent validity and

reliability testing to assess the appropriateness, consistency, and reliability of the study instrument.

Study variables

The primary dependent variable was hesitancy toward a future TB vaccine. Hesitancy toward TB vaccination was defined as an individual's doubt or uncertainty regarding receiving a TB vaccination if a new TB vaccine proven to be effective became available. This variable was measured using a 5-point Likert scale through the question, "If a new TB vaccine proven to be effective becomes available, would you like to receive the new TB vaccination?" with scores ranging from 1 (strongly disagree) to 5 (strongly agree). Responses were subsequently categorized into not willing (scores 1–2), hesitant (score 3), and willing (scores 4–5). Score 3 was categorized as hesitant because it reflected uncertainty or the absence of a decision regarding vaccination acceptance [14]. For the binary logistic regression analysis, participants who were not willing were combined with the hesitant group.

The explanatory variables included sociodemographic and clinical characteristics. Sociodemographic variables comprised sex, age, educational attainment, place of residence, marital status, employment status, and monthly income relative to the regional minimum wage. Clinical variables included a history of chronic disease, a history of sexually transmitted infection, and anxiety level. Each variable was subsequently categorized according to the specified groups. Anxiety was assessed using the seven-item Generalized Anxiety Disorder scale (GAD-7). The total GAD-7 score was categorized as none-to-mild anxiety (<10) or moderate-to-severe anxiety (≥10) [15].

Statistical analysis

Data were presented as frequencies and percentages (n, %). Bivariate analysis using the Chi-square test was performed to assess associations between demographic and clinical variables and hesitancy toward TB vaccination among PLHIV. Variables with $p<0.25$ in the bivariate analysis were subsequently included in multivariate logistic regression analysis to identify factors independently associated with TB vaccination hesitancy. The results were presented as odds ratios (OR) with 95% confidence intervals (CI). A $p<0.05$ was considered statistically significant. All statistical analyses were performed using GraphPad Prism (GraphPad Software Inc., California, USA).

Results

Characteristics of participants

A total of 346 PLHIV were included in the analysis, and their characteristics according to TB vaccine willingness are presented in **Table 1**. More than half were male (53.8%) and aged ≥40 years (55.2%). Most participants had completed high school or a lower level of education (72.0%), resided in Surabaya (74.6%), and were employed (65.3%). Married participants accounted for 46.2% of the study population. Regarding income, 40.8% reported having no fixed income, 29.5% earned below the regional minimum wage, and 29.8% earned above the regional minimum wage. Most participants had no history of chronic disease (83.5%) or sexually transmitted infection (70.2%), and 95.7% had none-to-mild anxiety based on the Generalized Anxiety Disorder-7 assessment. Overall, 115 (33.2%) of participants were hesitant toward receiving a future effective TB vaccine, whereas 231 (66.8%) were willing to receive it.

Bivariate analysis of factors associated with TB vaccine hesitancy among PLHIV

The results of bivariate analysis of factors associated with TB vaccine hesitancy among PLHIV are presented in **Table 1**. Female participants had greater odds of TB vaccine hesitancy than male participants (OR: 3.04; 95%CI: 1.91–4.86; $p<0.001$). Participants aged 26–39 years had greater odds of hesitancy than those in the other age groups (OR: 1.59; 95%CI: 1.00–2.52; $p=0.046$). Unemployed participants also had greater odds of hesitancy than participants in the other employment categories (OR: 1.71; 95%CI: 1.07–2.73; $p=0.024$). Regarding income, participants earning below the regional minimum wage had greater odds of hesitancy than those in the other

income categories (OR: 1.85; 95%CI: 1.14–2.98; p=0.011), whereas those earning above the regional minimum wage had lower odds of hesitancy (OR: 0.51; 95%CI: 0.31–0.87; p=0.010). No statistically significant associations were observed for the other age categories, educational attainment, place of residence, marital status, student status, history of chronic disease, history of sexually transmitted infection, or anxiety level.

Table 1. Bivariate analysis of factors associated with tuberculosis (TB) vaccine hesitancy among people living with HIV (PLHIV)

Variable	TB vaccine hesitancy, n (%)		Odds ratio (OR)	95% confidence interval (CI)	p-value
	Hesitant n=115	Willing n=231			
Gender					
Male	41 (35.7)	145 (62.8)	0.33	0.21–0.52	<0.001*
Female	74 (64.3)	86 (37.2)	3.04	1.91–4.86	<0.001*
Age					
≤25 years	6 (5.2)	18 (7.8)	0.65	0.26–1.61	0.374
26–39 years	52 (45.2)	79 (34.2)	1.59	1.00–2.52	0.046*
≥40 years	57 (49.6)	134 (58.0)	0.71	0.45–1.11	0.136
Education level					
High school or below	84 (73.0)	165 (71.4)	1.08	0.65–1.82	0.752
Diploma	7 (6.1)	13 (5.6)	1.09	0.42–2.64	0.863
Bachelor's degree	20 (17.4)	50 (21.7)	0.76	0.43–1.34	0.353
Postgraduate degree	4 (3.5)	3 (1.3)	2.74	0.72–10.98	0.174
Place of residence					
Surabaya	87 (75.7)	171 (74.0)	1.09	0.66–1.83	0.743
Outside Surabaya	28 (24.3)	60 (26.0)	0.92	0.55–1.52	0.743
Marital status					
Single	46 (40.0)	85 (36.8)	1.15	0.73–1.82	0.562
Married	55 (47.8)	105 (45.5)	1.10	0.70–1.72	0.676
Widowed/divorced	14 (12.2)	41 (17.7)	0.64	0.34–1.23	0.181
Employment status					
Employed	68 (59.1)	158 (68.4)	0.67	0.42–1.05	0.088
Student	2 (1.7)	10 (4.3)	0.39	0.08–1.72	0.214
Unemployed	45 (39.2)	63 (27.3)	1.71	1.07–2.73	0.024*
Income					
Below regional minimum wage	44 (38.3)	58 (25.1)	1.85	1.14–2.98	0.011*
Above regional minimum wage	24 (20.9)	79 (34.2)	0.51	0.31–0.87	0.010*
No fixed income	47 (40.8)	94 (40.7)	1.01	0.63–1.59	0.974
History of chronic disease					
Yes	24 (20.9)	33 (14.3)	1.58	0.87–2.78	0.119
No	91 (79.1)	198 (85.7)	0.63	0.36–1.15	0.119
History of STI					
Yes	36 (31.3)	67 (29.0)	1.12	0.69–1.80	0.659
No	79 (68.7)	164 (71.0)	0.90	0.55–1.45	0.659
Anxiety level (GAD-7)					
None–mild (<10)	110 (95.7)	221 (95.7)	1.00	0.36–2.67	0.993
Moderate–severe (≥10)	5 (4.3)	10 (4.3)	1.01	0.37–2.75	0.993

GAD-7, Generalized Anxiety Disorder-7; STI: sexually transmitted infection
* Statistically significant at p<0.05

Multivariable analysis of factors associated with TB vaccine hesitancy among PLHIV

In the multivariable logistic regression analysis, income below the regional minimum wage remained independently associated with TB vaccine hesitancy after adjustment for the other variables included in the model (adjusted OR: 2.14; 95%CI: 1.11–4.24; p=0.026) (**Table 2**). Unemployed participants showed greater adjusted odds of hesitancy, although the association did not reach statistical significance (adjusted OR: 4.60; 95%CI: 0.99–33.53; p=0.075). Similarly, participants without a history of chronic disease had lower adjusted odds of hesitancy, but this association was not statistically significant (adjusted OR: 0.58; 95%CI: 0.32–1.07; p=0.079). Sex, age group, educational attainment, marital status, employment status, income above the regional minimum wage, and history of chronic disease were not independently associated with TB vaccine hesitancy. Detailed results of the multivariable logistic regression analysis are presented in **Table 2**.

Table 2. Multivariable logistic regression analysis of factors associated with tuberculosis (TB) vaccine hesitancy among people living with HIV (PLHIV)

Variable	TB vaccine hesitancy, n (%)		Adjusted odds ratio (aOR)	95% confidence interval (CI)	*p*-value
	Hesitant n=115	Willing n=231			
Gender					
Male	41 (35.7)	145 (62.8)	1 (Ref)		
Female	74 (64.3)	86 (37.2)	0.70	0.40–1.21	0.207
Age					
26–39 years	52 (45.2)	79 (34.2)	1.72	0.60–5.43	0.330
≥40 years	57 (49.6)	134 (58.0)	0.95	0.33–3.02	0.926
Education level					
Postgraduate degree	4 (3.5)	3 (1.3)	3.27	0.64–18.3	0.150
Marital status					
Widowed/Divorced	14 (12.2)	41 (17.7)	0.91	0.48–1.69	0.771
Employment status					
Employed	68 (59.1)	158 (68.4)	1.88	0.43–13.23	0.447
Unemployed	45 (39.2)	63 (27.3)	4.6	0.99–33.53	0.075
Income					
Below regional minimum wage	44 (38.3)	58 (25.1)	2.14	1.11–4.24	0.025*
Above regional minimum wage	24 (20.9)	79 (34.2)	0.82	0.38–1.75	0.599
History of chronic disease					
Yes	24 (20.9)	33 (14.3)	1 (Ref)		
No	91 (79.1)	198 (85.7)	0.58	0.32–1.07	0.079

Ref: reference group
* Statistically significant at $p<0.05$

Discussion

This study examined the prevalence of and factors associated with hesitancy toward a future effective TB vaccine among PLHIV in Indonesia. Approximately one-third of the participants were hesitant to receive the vaccine, indicating that vaccine acceptance may remain an important challenge even among individuals at increased risk of TB. After adjustment for the other variables included in the multivariable model, only income below the regional minimum wage remained independently associated with TB vaccine hesitancy.

The proportion of participants reporting TB vaccine hesitancy was broadly consistent with previous global evidence demonstrating considerable variation in vaccine acceptance among PLHIV [14,16]. Although these earlier studies primarily examined COVID-19 vaccination, they suggest that vaccine hesitancy remains an important concern in this population. Previous research has identified concerns about vaccine safety, potential interactions with antiretroviral therapy, and vaccine-related adverse events as possible contributors to vaccine refusal [17,18]. Similar concerns have also been reported for non-COVID-19 vaccines in comparable settings [19, 20]. PLHIV may perceive newly introduced vaccines as particularly uncertain because of concerns about their potential effects on HIV-related clinical outcomes, including viral suppression and immune function [21]. Limited health literacy and inadequate access to reliable vaccine information may further contribute to uncertainty, particularly among socially and economically vulnerable populations [22]. However, these factors were not directly assessed in the present study.

In the bivariate analysis, female sex, age 26–39 years, unemployment, and income below the regional minimum wage were associated with greater odds of TB vaccine hesitancy. However, after adjustment for the other variables included in the multivariable model, only income below the regional minimum wage remained independently associated with hesitancy. This finding is broadly consistent with previous evidence indicating that socioeconomic disadvantage may contribute to vaccine hesitancy through limited access to healthcare services, reliable health information, and opportunities to discuss vaccination concerns with healthcare professionals [8,23]. Financial constraints may also increase the perceived indirect costs of vaccination, including transportation expenses, time away from work, and the anticipated costs of managing possible adverse events, even when the vaccine itself is provided free of charge [8,23,24]. Although income above the regional minimum wage was associated with lower odds of hesitancy in the bivariate analysis, this association did not remain statistically significant

after adjustment and should therefore not be interpreted as an independent protective factor. Similarly, the absence of significant adjusted associations for sex, age, educational attainment, and employment status suggests that financial disadvantage may be more closely associated with TB vaccine hesitancy than the other sociodemographic characteristics assessed in this study.

The association between low income and vaccine hesitancy may be interpreted using the Health Belief Model, which proposes that health-related decisions are influenced by perceived susceptibility, perceived disease severity, perceived benefits, perceived barriers, cues to action, and self-efficacy [25,26]. Among PLHIV with limited financial resources, practical and perceived barriers—such as transportation costs, long waiting times, difficulty obtaining reliable information, and concerns about vaccine-related adverse events—may outweigh the perceived benefits of receiving a future TB vaccine [27]. Limited contact with trusted healthcare professionals may also reduce exposure to appropriate cues to action, whereas greater exposure to misinformation may increase uncertainty regarding newly introduced vaccines [28,29]. In addition, socioeconomic disadvantage may be accompanied by lower health-related self-efficacy and limited social support, which could make it more difficult for individuals to evaluate vaccine information and make confident vaccination decisions [30,31]. These mechanisms were not directly measured in the present study and should therefore be regarded as possible explanations rather than confirmed mediating pathways. Nevertheless, the findings support the consideration of interventions that reduce practical barriers, strengthen individual counselling, provide accessible community-based education, and integrate discussions about future TB vaccines into routine HIV care, particularly for PLHIV from socioeconomically disadvantaged groups [32,33].

This study has some strengths and potential clinical and public health implications. Identifying income below the regional minimum wage as the only factor independently associated with TB vaccine hesitancy highlights the importance of considering socioeconomic circumstances when preparing future vaccination programs for PLHIV. Incorporating a brief assessment of financial and access-related barriers into routine HIV care may help healthcare providers identify individuals who could benefit from additional counselling and practical support before vaccination is offered. Such support may include clear information regarding vaccine safety and effectiveness, flexible appointment scheduling, reduced waiting times, and assistance in overcoming transportation or other indirect costs. Although unemployment was associated with hesitancy in the bivariate analysis, it did not remain statistically significant after adjustment; therefore, employment-based interventions should be considered cautiously and directed toward specific access barriers rather than employment status alone. The findings also contribute local evidence regarding attitudes toward future TB vaccination among PLHIV in Indonesia, an area in which empirical data remain limited. As new TB vaccines become available, these findings may inform the development of socioeconomically responsive educational and service-delivery strategies. Socioeconomic information routinely recorded in clinical systems may also support the identification of patients requiring additional vaccine-related counselling. However, developing and validating a formal risk-prediction system would require further research.

Some limitations should be considered when interpreting the findings. The cross-sectional design precluded assessment of temporal or causal relationships; therefore, the observed relationships should be interpreted as associations rather than evidence that socioeconomic disadvantage causes vaccine hesitancy. Recruitment from a single referral hospital in Surabaya may limit the generalizability of the findings to PLHIV receiving care in primary healthcare facilities, rural settings, or other regions of Indonesia. Responses obtained through interviewer-administered questionnaires may have been affected by social desirability and interviewer biases, particularly because participants may have felt pressure to provide responses perceived as acceptable to healthcare professionals or researchers. Potentially relevant psychosocial and contextual factors—including health literacy, previous vaccination experiences, family and social support, perceived discrimination in healthcare settings, trust in healthcare providers, and exposure to vaccine-related information or misinformation—were not assessed. Residual confounding may therefore remain. Hesitancy was measured using a single Likert-scale item concerning a hypothetical future TB vaccine rather than a validated multidimensional instrument. Consequently, the outcome reflects stated intention under a hypothetical scenario rather than actual vaccine uptake and may not capture the full complexity of vaccine hesitancy.

Conclusion

Approximately one-third of PLHIV in this study were hesitant to receive a future effective TB vaccine. After adjustment for the other variables included in the model, income below the regional minimum wage was the only factor independently associated with greater vaccine hesitancy. These findings highlight the potential importance of socioeconomic barriers in shaping willingness to receive future TB vaccines among PLHIV. Vaccination strategies should therefore consider accessible education, tailored counselling, and practical support for socioeconomically disadvantaged individuals. Further multicenter and longitudinal studies using validated multidimensional measures of vaccine hesitancy are needed to confirm these findings and assess whether stated intentions correspond to actual vaccine uptake.

Ethics approval

The protocol of this study was approved by the Ethics Committee of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, with approval number 1509/KEPK/I/2026, and was conducted in accordance with the principles of the Declaration of Helsinki.

Acknowledgments

None.

Competing interests

The authors declare that there are no conflicts of interest.

Funding

This study received no external funding.

Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

Artificial intelligence tool, Kimi AI, was used for language refinement. Authors confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity and reliability of the results. The final decisions and interpretations presented in this article were made solely by the authors.

How to cite

Yuanita A, Soegiarto G, Rusli M, *et al.* Factors associated with hesitancy toward a future tuberculosis vaccine among people living with HIV: A cross-sectional study in Indonesia. Narra Intern Med 2026; 1 (2): e12 - http://doi.org/10.52225/narraim.v1i2.12.

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