RESEARCH ARTICLE

Tuberculosis Case Finding Using Self-Assessment Paradigm Through the E-TIBI Application in HIV Patients [version 1; peer review: awaiting peer review]

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v1 **First published:** 05 Jul 2024, **13**:750
https://doi.org/10.12688/f1000research.152632.1
Latest published: 05 Jul 2024, **13**:750
https://doi.org/10.12688/f1000research.152632.1

Abstract

Background

The goal of eliminating tuberculosis has not yet shown a bright spot. Specifically for HIV patients (PLHIV), WHO has made it a special category as a pillar for eliminating tuberculosis. The tuberculosis screening has not yet reached the national target because it is carried out manually by health workers, requiring optimization following technological developments. This study aims to determine the effectiveness of tuberculosis case finding using a self-assessment paradigm in HIV patients.

Methods

This research was cross-sectional. The data obtained from HIV patients before and after using the E-TIBI application for 3 months each was analyzed using the compare mean independent t-test. Then the Chi-squared test was carried out on the E-TIBI screening characteristic variables.

Result

In total, there were 921 respondents with 148 (16%) presumptive TB. It was found that there was a significant difference ($p<0.05$) in the number of presumptive TB cases found in HIV patients before and

Open Peer Review

Approval Status *AWAITING PEER REVIEW*

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after using the E-TIBI application. The person with presumptive TB showed 20 of 24 characteristic variables that were statistically significant ($p<0.05$).

Conclusion

E-TIBI can increase the tuberculosis case finding in HIV patients so it has the potential to be implemented as a screening tool in the PLHIV community.

Keywords
Tuberculosis, HIV, Case Finding, Self-Assessment, Digital Health

This article is included in the Innovations in Research Assessment collection.

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Author roles: Triyono EA: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Supervision, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; **Arini M**: Conceptualization, Data Curation, Formal Analysis, Methodology, Supervision, Writing – Original Draft Preparation, Writing – Review & Editing; **Tan F**: Data Curation, Formal Analysis, Investigation, Project Administration, Writing – Original Draft Preparation, Writing – Review & Editing; **Masyfufah L**: Data Curation, Formal Analysis, Methodology, Project Administration, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: The author(s) declared that no grants were involved in supporting this work.

How to cite this article: Triyono EA, Arini M, Tan F and Masyfufah L. **Tuberculosis Case Finding Using Self-Assessment Paradigm Through the E-TIBI Application in HIV Patients [version 1; peer review: awaiting peer review]** F1000Research 2024, **13**:750 https://doi.org/10.12688/f1000research.152632.1

First published: 05 Jul 2024, **13**:750 https://doi.org/10.12688/f1000research.152632.1

Introduction

The goal of eliminating tuberculosis (TB) by 2030 by WHO has not shown bright spots. This infectious disease is still a major health problem in the world. This disease is caused by *Mycobacterium tuberculosis* that very easily transmitted through air droplets released by sufferers. The risk of transmission increases many times in individuals with chronic immune problems such as in patients with HIV.[1,2] The group of people living with HIV (PLHIV) is specifically categorized by WHO as a pillar for eliminating tuberculosis because of the strong relationship of both.[3]

The tuberculosis epidemic has claimed more human lives than any other infectious disease. Globally, a total of 10.6 million people in the world are infected with tuberculosis, with an estimated 1.6 million deaths each year and the PLHIV group causes 200,000 deaths.[3] HIV disease is also a global health burden with a total of 70 million sufferers worldwide and 35 million reported dead. Tuberculosis infection in this population can increase the progression of disease to death.[4]

Currently, TB-HIV case detection is mostly done manually by taking anamnesis from health workers, TB-HIV cadre approaches, and community.[5,6] Manual case finding is still not effective due to limited personnel, lack of training, and lack of health officer motivation. Therefore, finding TB-HIV cases requires a more modern system following current developments in digital technology.[7,8]

The advanced development of digital technology can be utilized to optimize self-assessment-based disease case findings. Through the self-assessment paradigm, people can effectively and efficiently carry out screening independently and proceed to medical examinations if necessary.[9] Therefore, this research aims to determine the effectiveness of tuberculosis case finding using on self-assessment paradigm through the E-TIBI application in HIV patients (PLHIV) at Dr. Soetomo General Hospital, Surabaya so that it can reduce morbidity and mortality in TB-HIV patients.

Methods

This research method was cross-sectional with the population were all HIV patients undergoing outpatient therapy at Dr. Soetomo General Academic Hospital in Surabaya. The data were collected from the period October – December 2023 for data before (using medical record data filled in by health workers) and January – March 2024 for data after using the E-TIBI application. To assess the effectiveness of pre and post tuberculosis case findings among PLHIV tested using the compare means independent t-test. Then, the characteristic variables were tested using crosstab with a Chi-squared test.

E-TIBI application was a website-based application that can be accessed freely at https://dinkes.jatimprov.go.id/assesment-tbc/public/. After accessing the link an informed consent will appear. There were three main section of this screening. First the respondent must fill in the initial identity (determine the screening for her/him or someone else) and second the identity details (age, gender, occupation, and address). Next the screening question section that's contain 21 questions. After completing and submitting the form a result come out showing whether presumptive TB or Not. On the E-TIBI application, there was also a filling guide and video education.

Presumptive TB were determined according to the following criteria: Main symptom (Cough for more than two weeks) with or without additional symptoms, there were main symptoms or additional symptoms with a contact history, major symptoms or additional symptoms associated with risk factors. The questionnaire in this application was obtained from the Tuberculosis Symptom Screening from the Indonesian Ministry of Health 2022.[10]

E-TIBI application was manufactured by utilizing an information technology development standard that involves database connections with Hypertext Preprocessor (PHP)[11] and HTML based programming. The stylesheet language using CSS (Cascading style sheets) with Asynchronous JavaScript and XML (AJAX). Additional tools used was Vue.js, PostgreSQL, VueX, and Vite. The prototype design using Figma and Sketch. The device used in manufacturing this application was a laptop with processor Core i5-7th gen, 8GB RAM with Windows 10 Operating System, 64-bit, SSD 128GB.

This website-based application has been registered as copyright of the Ministry of Law and Human Rights of the Republic of Indonesia with number EC00202365785.

Result

The total number of HIV patients (PLHIV) who accessed the E-TIBI application was 921 people with 148 (16%) presumptive tuberculosis. In Table 1 it was found that there was a significant difference ($p<0.05$) with difference means -43.000 in the number of presumptive TB case findings in HIV patients (PLHIV) before and after using the E-TIBI application. Table 2 shows the characteristics of the E-TIBI screening results, the person with presumptive tuberculosis showed 20 of 24 characteristic variables that were statistically significant ($p<0.05$).

Table 1. **Differences in the number of presumptive TB case findings in PLHIV.**

	Screening Result		p-Value
	Presumptive TB	Non-Presumptive TB	
Pre E-TIBI	20	6310	**0.002**
Post E-TIBI	148	773	

Difference means: -43.000.

Table 2. **Characteristics of E-TIBI screening results.**

Variable (n=921)	Presumptive TB		Non-presumptive TB		Total		*p*
	n	%	n	%	n	%	
Age							0.360
Adolescent (10-18 y.o)	1	0.1	1	0.1	2	0.2	
Adult (19-59 y.o)	140	15.2	743	80.7	883	95.9	
Elderly (>60 y.o)	7	0.8	29	3.1	36	3.9	
Gender							
Man	105	11.4	537	58.3	642	69.7	0.720
Woman	43	4.7	236	25.6	279	30.3	
Body Mass Index (BMI)							**0.005**
Severely Underweight (<17)	10	1.1	24	2.6	34	3.7	
Underweight (17-18.5)	14	1.5	36	3.9	50	5.4	
Normal (18.5-25)	97	10.5	491	53.3	588	63.8	
Overweight (25-27)	13	1.4	114	12.4	127	13.8	
Obese (>27)	14	1.5	108	11.7	122	13.2	
Cough >2 weeks							**0.000**
Yes	21	2.3	0	0.0	21	2.3	
No	127	13.8	773	83.9	900	97.7	
Bleeding cough							**0.000**
Yes	6	0.7	0	0.0	6	0.7	
No	142	15.4	773	83.9	915	99.3	
Cough <2 weeks							**0.000**
Yes	31	3.4	2	0.2	3.6	33	
No	117	12.7	771	83.7	888	96.4	
Weight loss							**0.000**
Yes	46	5.0	1	0.1	47	5.1	
No	102	11.1	772	83.8	874	94.9	
Decreased appetite							**0.000**
Yes	25	2.7	0	0.0	25	2.7	
No	123	13.4	773	83.9	896	97.3	
Fever							**0.000**
Yes	11	1.2	0	0.0	11	1.2	
No	137	14.9	773	83.9	910	98.8	
Fatigue							**0.000**
Yes	76	8.3	2	0.2	78	8.5	
No	72	7.8	772	83.7	843	91.5	

Table 2. *Continued*

Variable (n=921)	Presumptive TB		Non-presumptive TB		Total		*p*
	n	%	n	%	n	%	
Night sweats							**0.000**
Yes	16	1.7	0	0.0	16	1.7	
No	132	14.3	773	83.9	905	98.3	
Dyspnea							**0.000**
Yes	21	2.3	1	0.1	22	2.4	
No	127	13.8	772	83.8	899	97.7	
Chest pain							**0.000**
Yes	19	2.1	0	0.0	19	2.1	
No	129	14.0	773	83.9	902	97.9	
Neck lump							**0.000**
Yes	8	0.9	0	0.0	8	0.9	
No	140	15.2	772	83.8	912	99.0	
TB in a family member							**0.000**
Yes	8	0.9	0	0.0	8	0.9	
No	140	15.2	773	83.9	913	99.1	
Home Contact							**0.000**
Yes	28	3.0	0	0.0	28	3.0	
No	120	13.0	773	83.9	893	97.0	
Room contact							**0.000**
Yes	28	3.0	0	0.0	28	3.0	
No	120	13.0	773	83.9	893	97.0	
Diabetes Mellitus							**0.020**
Yes	9	1.0	14	1.5	23	2.5	
No	139	15.1	759	82.4	898	97.5	
Malnutrition							**0.001**
Yes	17	1.8	37	4.0	54	5.9	
No	131	14.2	736	79.9	867	94.1	
Smoking							**0.000**
Yes	39	4.2	93	10.1	132	14.3	
No	109	11.8	680	73.8	789	85.7	
Pregnant							0.490
Yes	2	0.2	6	0.7	8	0.9	
No	146	15.9	767	83.3	913	99.1	
Elderly > 60 years							0.612
Yes	6	0.7	25	2.7	31	3.4	
No	142	15.4	748	81.2	890	96.6	
History of complete TBC treatment							**0.000**
Yes	57	6.2	132	14.3	189	20.5	
No	91	9.9	641	69.6	732	79.5	
History of incomplete TBC treatment							**0.001**
Yes	6	0.7	6	0.7	12	1.3	
No	142	15.4	767	83.3	909	98.7	

Discussion

Since 2011, WHO has recommended that people living with HIV (PLHIV) undergo routine tuberculosis screening. If 4 cardinal symptoms are found consisting of cough, fever, night sweats and weight loss, PLHIV must undergo a molecular diagnostic examination such as Xpert MTB/RIF/Ultra11.[12] This research is an investigative effort towards a new paradigm to increase TB case finding in key populations. As far as researchers' best research is concerned, this research is the first to be conducted in Indonesia. In general, this research illustrates the potential benefits of technology as a new approach to finding a person with presumptive TB.

In Indonesia, the tuberculosis case findings still rely on health workers who are assisted by trained cadres in health facilities. The Ministry of Health, through active and passive approaches, is trying to increase the acceleration of case finding. Active case finding is carried out by tracking contact, epidemiological investigations and mass screening of at-risk groups, while passive case finding is by examining patients who come to health facilities.[13] Through E-TIBI a new paradigm is formed by emphasizing public participation as the main actor who initiates the initial examination. It is believed that this public participation can increase the tuberculosis case findings, especially in the PLHIV group. Health facilities will also receive notification and be given the authority to follow up if there is presumptive TB in their working area. Apart from that, E-TIBI is also a medium for information and education about tuberculosis and its management.

In this study, from the screening results, 148 (16%) presumptive TB were found. This result compared with other studies was quite varied. Gersh (2021) found 48 (12.6%) participants with TB symptom, Santos (2020) found 15.4% patients with three symptoms WHO screening, Owiti's research (2019) found 4160 (0.7%) patients with presumptive symptoms of tuberculosis, Bjerrum (2016) found 12.6-20% tuberculosis suspicion, and Burmen (2016) found 96 (16%) PLHIV patients needed further examination.[14–17] The use of E-TIBI shows a significant relationship with the number of presumptive TB in PLHIV patients who undergo TB screening. The number of presumptive TB from the E-TIBI self-assessment results is seven-fold higher when compared to manual screening. This is possible because the use of electronic screening is much simpler and can reduce delay by answering questions that are available on the website application, while manual screening must be carried out at the clinic, this is also found in Woliansky (2024) and Blink (2022) study.[18,19]

The result found cough, weight loss, decreased appetite, fever, fatigue, night sweats, dyspnea, chest pain, and lumps in the neck were statistically significant with presumptive tuberculosis. Based on current research these signs and symptoms are often found in TB patients.[17] In HIV patients (PLHIV) these symptoms become more varied depending on the severity and immunosuppression of the patient.[20]

Our study indicated that BMI or body mass index is quite influential in combined TB-HIV infection. Several studies state that patients with a BMI below normal have a three-fold higher risk of being infected with TB than HIV patients compared to those with a normal BMI.[21] Apart from that, a low BMI also has a worse prognosis, increasing the risk of death up to three-fold higher.[22] This is because patients with a BMI below normal are assumed to experience malnutrition which aggravates their immunocompromised condition and leads to death.[23]

History of contact with TB sufferers is important in TB screening, as this study shows. Household contact research by Karbito (2022) said that spending five hours or more with active TB patients increases the risk of latent TB infection by three-fold higher compared to less than five hours a day.[24] Laghari's research (2019) states that household contact increases the risk of TB infection by up to fifteen-fold higher.[25]

In the result found Diabetes mellitus (DM) was statistically significant with presumptive tuberculosis. The risk of TB in patients with DM increases to three-fold higher.[26] Diabetes mellitus has also been shown to increase the risk of multi-drug-resistant TB. Uncontrolled diabetes mellitus as assessed by high HbA1c and GDP is closely related to TB susceptibility and worsens treatment prognosis.[27] This is also exacerbated by Indonesia being in the top three countries with the highest TB burden in the world and the top 10 countries with DM sufferers in the world. Pathophysiologically, DM itself worsens TB infection through many mechanisms ranging from increasing the risk of infection, increasing the risk of latent TB reactivation, increasing the risk of relapse, and worsening treatment to death.[28] TB infection also often causes temporal hyperglycemia, which is caused by stress, prolonged inflammation, changes in glucose and lipid metabolism, and insulin resistance syndrome.[29]

A history of TB treatment or infection is a risk factor that also has an influence, especially in the HIV population, as found in this study. Based on several works of literature, it is stated that the risk of latent TB reactivation becoming active TB in PLHIV is up to twenty-fold higher.[30] Other research states that tuberculosis infections in PLHIV are more likely to be caused by reactivation than by new infections.[31] This is mainly caused by the depletion of $CD4^+$ cells in untreated PLHIV

patients. Apart from that, it was also reported that functional disruption of TB-specific T cells, increased regulation of TB receptors on macrophages, manipulation of macrophage bactericidal pathways, deregulation of chemotaxis, and deregulation of macrophage apoptosis by TNF were the reasons why reactivation increased.[32]

Smoking is also a risk factor that has a significant relationship with TB-HIV infection. These results are supported by research which states that smoking increases the risk of TB up to three-fold higher and people who have ever smoked up to two-fold higher compared to those who have never smoked in PLHIV.[33] Exposure to cigarette smoke also significantly increases the risk of transmitting TB to family or close contacts. In addition, the prevalence of smoking has doubled in TB patients compared to the general population.[34] Apart from that, smoking also worsens TB symptoms, increases the risk of drug resistance, increases the risk of cardiovascular disease, worsens treatment outcomes and even death.[35]

In the future, the research team plans to develop this application not only limited to screening but into a complete TB-HIV management system, through an account application that is used to carry out TB screening in PLHIV, update patient data, namely the results of diagnosis confirmation, drug taking visits and evaluation until completion of treatment. And then this application is also expected to be implemented in all tuberculosis key populations and the wider community.

Strengths and limitation

The tuberculosis case finding using self-assessment through the E-TIBI application is a new paradigm of disease screening conducted in Indonesia. With the help of technological advances through E-TIBI, tuberculosis screening can be done easily and quickly by anyone, anytime and wherever they are. This research has limitations, not all HIV patients (PLHIV) can access the E-TIBI service because some patients do not bring cellphones that have an internet connection and some of them cannot use internet technology.

Conclusion

E-TIBI has the potential to be a tuberculosis screening tool because the number of TB case findings in HIV patients (PLHIV) before and after using the E-TIBI application was a significant increase ($p<0.05$). The presumptive tuberculosis showed 20 of 24 characteristic variables that were statistically significant ($p<0.05$). It is hoped that this application can be implemented widely as a screening tool in the PLHIV community.

Ethical considerations

This research was registered at the Ethical Committee in Health Research Dr. Soetomo General Academic Hospital, Surabaya, Indonesia (0920/KEPK/II/2024 dated February 19, 2024).

Consent: In this study, before the participant undergo screening, written informed consent will appear in the website application and if participants agree, they must click “willing” before they can carry out screening.

Data availability

Underlying data

Figshare: Tuberculosis Case Finding Using Self-Assessment Paradigm Through the E-TIBI Application in HIV Patients_ Raw Data E-TIBI. https://doi.org/10.6084/m9.figshare.25953712.v2[36]

This project contains the following underlying data:

- Raw Data Spss E-TIBI.xlsx (Anonymised answers to questionnaire, correct answer +1 incorrect answer 0)

Extended data

Figshare: Tuberculosis Case Finding Using Self-Assessment Paradigm Through the E-TIBI Application in HIV Patients_Screening form, https://doi.org/10.6084/m9.figshare.26082367.v3[37]

This project contains the following extended data:

- Screening form.docx (Blank Indonesian version of questionnaire.

Reporting guidelines

Figshare: Tuberculosis Case Finding Using Self-Assessment Paradigm Through the E-TIBI Application in HIV Patients_ STROBE.docx, https://doi.org/10.6084/m9.figshare.25991857.v2[38]

Acknowledgments

The researchers would like to thank the East Java Provincial Health Office, Indonesia and the Department of Internal Medicine, Dr. Soetomo General Academic Hospital Surabaya, Indonesia

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