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*ORIGINAL ARTICLE*

# EARLY DETECTION OF TUBERCULOSIS APPLICATION (E-TIBI): A NEW PARADIGM TO DETECT NEW CASE OF TUBERCULOSIS

***Aplikasi Deteksi Dini Tuberkulosis (E-TIBI): Paradigma Baru untuk Menemukan Kasus Baru Tuberkulosis***

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**ABSTRACT**

**Background:** Tuberculosis (TB) is still one of the major health problems in the world, especially in countries with dense populations. Indonesia is listed among the top three countries with the highest burden of tuberculosis worldwide. The low coverage of case detection in Indonesia is one of the reasons for ineffective TB control. Therefore, this disease remains a threat to spread in today's Indonesian society. Digital technology can be used to increase the effectiveness and efficiency of case detection. This study aims to create a new paradigm for detecting new cases of tuberculosis using a self-assessment website-based application. **Methods:** This descriptive quantitative research used univariate analysis. Respondents for this research were sampled from all East Java people who filled out the E-TIBI application. **Result:** In total, there were 4,658 E-TIBI users in East Java, with 20.80% suspected of tuberculosis. The most frequent symptoms found in the respondents were fatigue, cough for > 2 weeks, and weight loss. **Discussion:** A self-assessment paradigm based on digital technology was applied to the design of this E-TIBI application. From this application, the public can quickly determine whether they or others are suspected of having tuberculosis. This result shows that the whole community can easily access the E-TIBI application for initial tuberculosis screening. **Conclusion:** Through this application, direct community participation can increase the detection of new cases to support the government and WHO programs in eliminating tuberculosis by 2030.

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***ABSTRAK***

***Latar Belakang:*** *Tuberkulosis masih menjadi salah satu masalah kesehatan yang signifikan di dunia, terutama di negara-negara dengan penduduk padat. Indonesia masuk dalam tiga besar negara dengan beban tuberkulosis tertinggi di dunia. Rendahnya cakupan penemuan kasus di Indonesia menjadi salah satu penyebab belum efektifnya pengendalian penyakit tuberkulosis. Oleh karena itu, penyakit ini masih menjadi ancaman penyebaran pada masyarakat Indonesia saat ini. Penggunaan teknologi digital dapat meningkatkan efektifitas dan efisiensi dalam suatu kegiatan sehingga tercapai dengan lebih cepat. Penelitian ini bertujuan untuk menciptakan paradigma baru dalam menemukan kasus baru tuberkulosis melalui aplikasi self-assessment berbasis website.* ***Metode:*** *Penelitian ini bersifat deskriptif kuantitatif dengan menggunakan analisis univariat. Responden penelitian menggunakan total sampling yang mencakup seluruh masyarakat Jawa Timur yang mengisi aplikasi E-TIBI.* ***Hasil:*** *Secara total, terdapat 4.658 pengguna E-TIBI di Jawa Timur, dengan 20,8% diduga tuberkulosis. Keluhan pengguna terbanyak adalah kelelahan, batuk >2minggu dan penurunan berat badan.* ***Pembahasan:*** *Paradigma self-assessment berbasis teknologi digital diterapkan dalam perancangan aplikasi E-TIBI ini. Dari aplikasi ini, masyarakat dapat dengan cepat menentukan apakah dirinya atau orang lain diduga menderita TBC. Hasil ini menunjukkan bahwa seluruh masyarakat dapat dengan mudah mengakses aplikasi E-TIBI untuk skrining awal tuberkulosis.* ***Kesimpulan:*** *Melalui aplikasi ini partisipasi langsung masyarakat dapat meningkatkan penemuan kasus baru untuk mendukung program pemerintah dan WHO dalam eliminasi tuberkulosis pada tahun 2030.*



## INTRODUCTION

Tuberculosis remains a major health issue that is extremely complicated from a medical, social, economic, and cultural standpoint in Indonesia. Chronic infectious disease can affect the lungs and other vital organs. When someone coughs, sneezes, or speaks without a mask, *Mycobacterium tuberculosis* germs easily spread through the air. If not treated properly, this condition can spread to other individuals and may cause death (1–3).

Recently, based on the WHO Global Tuberculosis Report in 2022, a total of 10.6 million people in the world suffer from tuberculosis, and an estimated 1,6 million people die each year. Indonesia is one of the countries with the highest tuberculosis burden in the world, with an estimated number of people falling ill from tuberculosis reaching 969,000 with a mortality rate of 150,000. The national tuberculosis control program was implemented more than 70 years ago but Indonesia is still ranked in the top three countries with a tuberculosis burden in the world. Tuberculosis data in Indonesia in 2022 shows that most cases occur in productive ages of 15-54 years (68%), indicating that immediate efforts need to be made to eliminate tuberculosis (4,5).

Indonesia is also committed to achieving tuberculosis elimination by 2030, with a target of reducing tuberculosis incidence to 65/per 100,000 population through the Presidential Decree Number 67 of 2021. One of the crucial objectives of the sustainable development goals (SDGs) to build a prosperous and equal nation is to end the tuberculosis epidemic. Consequently, ongoing tuberculosis incidence reduction requires efforts to eradicate the disease. Tuberculosis must be eliminated because it is easily transmitted, and the treatment is neither easy nor cheap. Not being handled thoroughly may cause new problems, such as drug resistance and increasing transmission (5,6).

The current problem of the fight against tuberculosis in Indonesia is the detection of tuberculosis cases that have not been able to reach the target in 2021 in Indonesia, where only 45.70%

of the target of 85% can be met, and no province in Indonesia has reached this target (7). The result of the ineffective detection of tuberculosis cases is a threat for the disease to spread in society and will continue to grow in cases, and complicate the handling of tuberculosis cases in Indonesia. Therefore, it is necessary to accelerate and increase the detection of suspected tuberculosis cases independently in the community, based on self-assessment. Self-assessment is an independent assessment that is very useful for increasing the number of people who feel at risk so they can assess their own condition and carry out a medical examination (8). Therefore, this study aimed to create a new paradigm to screen new cases of tuberculosis using a self-assessment website-based application.

## METHODS

This research method was descriptive and quantitative using univariate analysis. Descriptive quantitative research aimed to describe observed phenomena through numbers. Descriptive quantitative research only describes the content of a variable in research, not intended to test certain hypotheses (9). The studied variables were the distribution of E-TIBI achievement in East Java, characteristics, symptoms, and risk factors presented by respondents. The data were statistically analyzed using IBM SPSS Statistics version 20.0. The association between symptoms and suspected results were analyzed using the chi-square test.

The tables and narratives in this study were used to describe the research findings. Respondents for this research were total sampling covering all East Java people who filled out the E-TIBI from April 2022 to February 2023. A questionnaire was used in the E-TIBI application. The questionnaire was obtained from the Tuberculosis Symptom Screening Form issued by the Indonesian Ministry of Health 2022. Suspected and non-suspected cases were determined according to the following criteria:

1. Main symptom (cough for more than two weeks) without or with additional symptoms.
2. There were main symptoms or additional symptoms with a contact history.
3. Major symptoms or additional symptoms associated with risk factors

Every E-TIBI application user is required to fill in the National Identity Number so that the system could track the accuracy of the data. On the E-TIBI website there was also a filling guide in the form of FAQs and video tutorials.

### E-TIBI Application Design and Development

E-TIBI is a website-based application specially designed for ease of use. This application aims to make it easier for users to independently screen for tuberculosis by filling out the form. The final results can be obtained through this application to determine whether the user is suspected of tuberculosis.

This application can be accessed at https://dinkes.jatimprov.go.id/assessment-tbc/public/. After clicking on the E-TIBI menu screen, an informed consent link will appear before conducting the screening. Upon agreeing, the user will be directed to fill in the initial identity to determine whether the screening is for him/herself or someone else. Then, the user is directed to fill out personal details, such as age, gender, occupation, and address, so that it is straightforward to track later. Finally, the user fills out the screening form containing 21 questions. After completing all the fillings and submitting responses, a result indicating the user is suspected (or not) of tuberculosis will appear. When someone obtains the results of suspected tuberculosis, it is recommended to go to the nearest healthcare center or healthcare facility immediately. In addition, community healthcare centers (Puskesmas) can monitor whether there was tuberculosis suspected in their working area, and will follow up on it. Figure 1 shows the E-TIBI system flowchart that explains how this application works.

This study was approved by the Health Research Ethics Committee at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, with reference number 1314/LOE/301.4.2/V/2023 dated May 17, 2023.

## RESULTS

### E-TIBI Implementation

The total results of the E-TIBI application implementation in East Java from April 2022 to February 2023 was 4.658 users. Table 1 shows the age of users, where the youngest age is one year old, and the oldest is eighty-three years old.

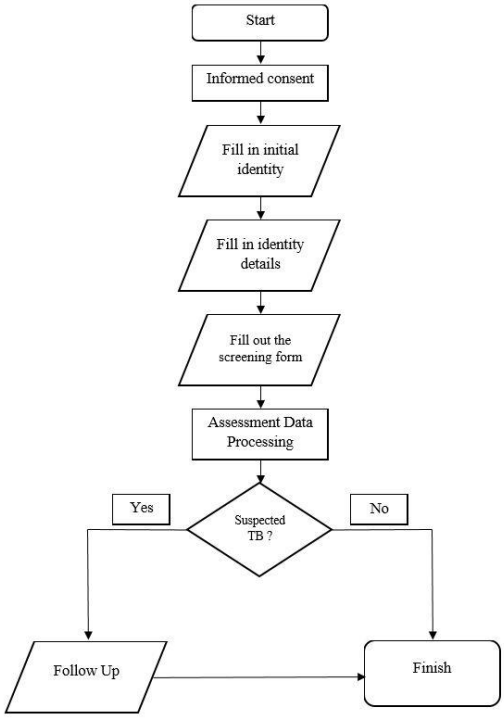


**Figure 1.** E-TIBI System Flowchart

**Table 1**
Age and BMI E-TIBI Application User

| Variable | Mean ± SD | Median (Min-Max) |
|---|---|---|
| Age | 32.82 ± 14.762 | 32.96 (1-83) |
| BMI | 23.57 ± 4.648 | 23.05 (15-45) |

Table 2 shows that 20.80% of the E-TIBI application users suspected with tuberculosis. Application users were dominated by females (65.10%). Most occupation were students (21.80%) and housewives (19.60%). The majority of the user were from Surabaya (22.60%).

**Table 2**
Final Result and E-TIBI Application User Identity

| Variable (n=4,658) | n | % |
|---|---|---|
| **Final Results** | | |
| Suspect | 971 | 20.80 |
| Not suspected | 3,687 | 79.20 |
| **Gender** | | |
| Female | 3,032 | 65.10 |
| Male | 1,626 | 34.90 |
| **Occupation** | | |
| Student | 1,014 | 21.80 |
| Housewife | 914 | 19.60 |
| Private employees | 679 | 14.60 |
| Government employees | 528 | 11.30 |
| Entrepreneur | 387 | 8.30 |

(*Continued*)

**Table 2**
Continue

| Variable (n=4,658) | n | % |
|---|---|---|
| **Occupation** | | |
| No Work | 200 | 4.30 |
| Nurse | 189 | 4.10 |
| Farmer | 151 | 3.20 |
| Teacher | 146 | 3.10 |
| Midwife | 84 | 1.80 |
| Salesman | 55 | 1.20 |
| Labor | 49 | 1.10 |
| Doctor | 38 | 0.80 |
| Driver | 22 | 0.50 |
| Pharmacist | 15 | 0.30 |
| Others | 187 | 4.00 |
| **Address** | | |
| Surabaya | 1,055 | 22.60 |
| Trenggalek | 851 | 18.30 |
| Blitar | 496 | 10.60 |
| Kediri | 295 | 6.30 |
| Malang | 187 | 4.00 |
| Tulungagung | 162 | 3.50 |
| Sidoarjo | 149 | 3.20 |
| Pacitan | 131 | 2.80 |
| Lumajang | 131 | 2.80 |
| Pasuruan | 129 | 2.80 |
| Bojonegoro | 125 | 2.70 |
| Jember | 99 | 2.10 |
| Tuban | 93 | 2.00 |
| Magetan | 85 | 1.80 |
| Gresik | 84 | 1.80 |
| Mojokerto | 81 | 1.70 |
| Batu | 80 | 1.70 |
| Probolinggo | 71 | 1.50 |
| Ponorogo | 65 | 1.40 |
| Madiun | 48 | 1.00 |
| Bondowoso | 38 | 0.80 |
| Jombang | 36 | 0.80 |
| Nganjuk | 34 | 0.70 |
| Banyuwangi | 31 | 0.70 |
| Ngawi | 23 | 0.50 |
| Situbondo | 20 | 0.40 |
| Lamongan | 14 | 0.30 |
| Bangkalan | 14 | 0.30 |
| Pamekasan | 12 | 0.30 |
| Sumenep | 10 | 0.20 |
| Sampang | 9 | 0.20 |

Figure 2 shows the number of new users of the E-TIBI application in the first year after launch. There was a spike in the second month to 2,537 new users.

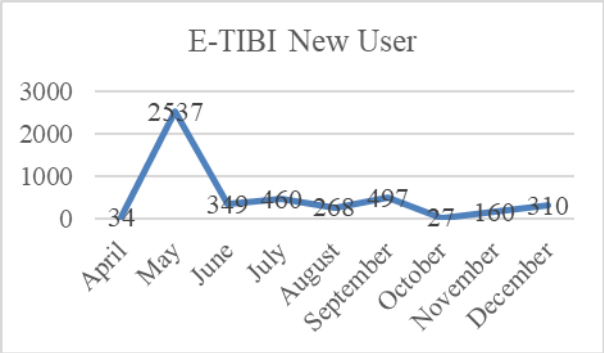


**Figure 2.** E-TIBI New User in 2022

Table 3 shows that the most common symptoms of E-TIBI application users were fatigue (15.90%), cough for <2 weeks (12.50%), and weight loss (7.30%). In addition, people with HIV (20.60%) and smokers (16.60%) were also identified. There was no statistically significant association between the symptoms and suspected results.

## DISCUSSION

### Requirement Analysis

The national strategy for eliminating tuberculosis includes increasing access to tuberculosis services and innovations in the field of tuberculosis control. Ending the tuberculosis epidemic is one of the important targets of the country's Sustainable Development Goals (SDGs), which is to be prosperous and equal. One way to accelerate the elimination of tuberculosis is by optimizing active, massive, and passive intensive case detection with the hope of preventing the transmission/spread in the community so that patients can receive early treatment. Passive case finding is carried out by examining patients with tuberculosis symptoms that come to health care facilities, while active case finding is carried out by health workers and health cadres through tracing, examining close contacts, and mass screening of the vulnerable and at-risk groups (5).

Even though active and passive optimizations of case detection were carried out, treatment coverage or coverage of tuberculosis detection in Indonesia was still far below WHO standards in 2021, with only 45.70% from 85% and East Java itself at 49.40% (7). Tuberculosis elimination requires an approach beyond the health sector. Cross-sectoral contributions and collaborations ranging from professional organizations, community leaders, health facilities, regional apparatus organizations, ministries, community organizations, communities, cadres, higher education academics, and the general public are key amid increasingly rapid technological advances (10).

Advances in technology in today's all-digital era have facilitated all forms of human activity and work on all aspects, including health. Changes in the digital era have made digital technology increasingly sophisticated and information disclosure has become widespread. Technological advances in the health sector are believed to bring about changes and improve health services (11–13).

Therefore, the detection of tuberculosis cases in the community can take advantage of advances in digital technology to increase its effectiveness and efficiency. The self-assessment paradigm has long been used in the world of health by emphasizing the participation of the public as the main actors in the early detection of certain diseases before going to healthcare facilities (14). The self-assessment paradigm based on digital technology is applied in designing this E-TIBI application. Through this application, the public can quickly determine whether they or others are suspected of having tuberculosis and the use of E-TIBI can reach more groups so that more people do the screening. The more people who undergo screening, the more new cases of tuberculosis will be found (15).

### Feasibility

The E-TIBI application is a self-assessment service that everyone can access freely. The feasibility of an application can be seen from the acceptance, usability, involvement, satisfaction, or compliance of users, which can be improved with other human or technical support (16). An indicator that the application is expected to be used continuously is the accumulation of new users that are stable as long as they are available in the first year (17). Figure 2 shows the number of application users, which was quite close to linear even though it experienced a large spike in the second month of launching. The spike in the early month of new technology shows the psychological specificity of the user for using the application for two reasons, i.e., usefulness and ease of use (18).

**Table 3**
E-TIBI User Symptoms

| Variable (n=4,658) | Suspected | | Not Suspected | | Total | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| **Cough > 2 weeks** | | | | | | | |
| Yes | 234 | 24.10 | 0 | 0.00 | 234 | 5 | 0.40 |
| No | 737 | 75.90 | 3687 | 100 | 4,424 | 95 | |
| **Bleeding cough** | | | | | | | |
| Yes | 79 | 8.10 | 0 | 0.00 | 79 | 1.70 | 0.24 |
| No | 892 | 91.90 | 3,687 | 100 | 4,579 | 98.30 | |
| **Weight loss** | | | | | | | |
| Yes | 282 | 29 | 60 | 1.60 | 342 | 7.30 | 0.39 |
| No | 689 | 71 | 3,627 | 98.40 | 4,316 | 92.70 | |
| **Decreased appetite** | | | | | | | |
| Yes | 251 | 25.80 | 78 | 2.10 | 329 | 7.10 | 0.35 |
| No | 720 | 74.20 | 3,609 | 97.90 | 4,329 | 92.90 | |
| **Fever** | | | | | | | |
| Yes | 129 | 13.30 | 48 | 1.30 | 177 | 3.80 | 0.24 |
| No | 842 | 86.70 | 3,639 | 98.70 | 4,481 | 96.20 | |
| **Fatigue** | | | | | | | |
| Yes | 491 | 50.60 | 251 | 6.80 | 742 | 15.90 | 0.43 |
| No | 480 | 49.40 | 3,436 | 93.20 | 3,916 | 84.10 | |
| **Night sweats** | | | | | | | |
| Yes | 172 | 17.70 | 44 | 1.20 | 216 | 4.60 | 0.30 |
| No | 799 | 82.30 | 3,643 | 98.80 | 4,442 | 95.40 | |
| **Hard to breathe** | | | | | | | |
| Yes | 140 | 14.40 | 32 | 0.90 | 172 | 3.70 | 0.28 |
| No | 831 | 85.60 | 3,655 | 99.10 | 4,486 | 96.30 | |
| **Chest pain** | | | | | | | |
| Yes | 171 | 17.60 | 50 | 1.40 | 221 | 4.70 | 0.29 |
| No | 800 | 82.40 | 3,637 | 98.60 | 4,437 | 95.30 | |
| **Neck lump** | | | | | | | |
| Yes | 92 | 9.50 | 18 | 0.50 | 110 | 2.40 | 0.23 |
| No | 879 | 90.50 | 3,669 | 99.50 | 4,548 | 97.60 | |
| **Tuberculosis in family member** | | | | | | | |
| Yes | 63 | 6.50 | 19 | 0.50 | 82 | 1.80 | 0.18 |
| No | 908 | 93.50 | 3,668 | 99.50 | 4,576 | 98.20 | |
| **Home contact** | | | | | | | |
| Yes | 121 | 12.50 | 36 | 1 | 157 | 3.40 | 0.25 |
| No | 850 | 87.50 | 3,651 | 99 | 4,501 | 96.60 | |
| **Room contact** | | | | | | | |
| Yes | 302 | 31.10 | 171 | 4.60 | 473 | 10.20 | 0.33 |
| No | 669 | 68.90 | 3,516 | 95.40 | 4,185 | 89.80 | |
| **Diabetes Mellitus** | | | | | | | |
| Yes | 87 | 9 | 71 | 1.90 | 158 | 3.40 | 0.15 |
| No | 884 | 91 | 3,616 | 98.10 | 4,500 | 96.60 | |
| **Malnutrition** | | | | | | | |
| Yes | 138 | 14.20 | 39 | 1.10 | 177 | 3.80 | 0.26 |
| No | 833 | 85.80 | 3,648 | 98.90 | 4,481 | 96.20 | |

(*Continued*)

**Table 3**
Continue

| Variable (n=4,658) | Suspected | | Not Suspected | | Total | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| **People with HIV** | | | | | | | |
| Yes | 290 | 29.90 | 670 | 18.20 | 960 | 20.60 | 0.11 |
| No | 681 | 70.10 | 3,017 | 81.80 | 3,698 | 79.40 | |
| **Smoking** | | | | | | | |
| Yes | 403 | 41.50 | 368 | 10 | 771 | 16.60 | 0.32 |
| No | 568 | 58.50 | 3,319 | 90 | 3,887 | 83.40 | |
| **Pregnant** | | | | | | | |
| Yes | 53 | 5.50 | 48 | 1.30 | 101 | 2.20 | 0.11 |
| No | 918 | 94.50 | 3,639 | 98.70 | 4,557 | 97.80 | |
| **Elderly > 60 years** | | | | | | | |
| Yes | 102 | 10.50 | 83 | 2.30 | 185 | 4 | 0.16 |
| No | 869 | 89.50 | 3,604 | 97.70 | 4,473 | 96 | |

Table 4 shows a report of tuberculosis in East Java, with the results indicating an increase in suspect findings and treatment coverage in 2022 (19). The improvement before and after the implementation of E-TIBI shows that this application can be a solution for findings new cases of tuberculosis in the community.

**Table 4**
East Java Tuberculosis Report 2021-2022

| Indicator | | 2021 | 2022 |
|---|---|---|---|
| Suspected Finding | Number of suspected findings | 264,634 | 549,757 |
| | Achievement of TB Suspected Minimum Service Standards (%) | 56.78% | 111.85% |
| Treatment Coverage | Number of treatment coverage | 43,039 | 61,956 |
| | Achievement of treatment coverage | 44.86% | 64.66% |

Source: East Java Provincial Health Office, 2023

**Characteristics of Users**

The E-TIBI application can be accessed easily through devices connected to the internet. Regarding the proportion of occupations, students were the largest application users. This category was generally dominated by young people and university students, which were characteristics of early adopters based on cosmopolitan strata (20).

Based on the proportion of user addresses, this application can reach all regions in East Java. This shows that the digital application can be implemented effectively and accurately in all regions without geographical or linguistic restrictions (21). Therefore, it is hoped that E-TIBI application can be applied throughout Indonesia in the future.

**User Symptoms**

The most common symptoms in E-TIBI application users were fatigue, cough for <2 weeks and weight loss. Based on some literature, symptoms are a risk factor for tuberculosis infection (22–24). Tobacco smokers have a close relationship with tuberculosis infection through various pathways, including ciliary dysfunction, decreased immune response and defects in macrophages. In addition, the mortality rate also increases in smokers (25).

Simultaneously, the HIV epidemic shows a strong relationship with the increasing tuberculosis epidemic worldwide, which has increased the number of tuberculosis cases in the community (26). Tuberculosis is one of the most common complications that often occur in HIV patients, and if it is not well treated, it can increase the risk of death for people with HIV (27). These two health problems are the biggest challenges in tuberculosis control because HIV infection can increase the risk and transmission of TB drug resistance. Based on several pieces of literature, it is stated that good HIV control will increase the success of tuberculosis control (28–30).

**Research Limitation**

This study can contribute to the tuberculosis elimination program because the E-TIBI

application is very easy to use and accessible from anywhere and everywhere. The limitation of this study was the lack of follow-up data for patients suspected of tuberculosis to confirm whether they were true positive, proven by results of laboratory examinations, because the results of follow-up were the responsibility of the local health service.

## CONCLUSION

The E-TIBI (Early Detection of Tuberculosis) application is a website-based application that is very easily accessible by the whole community to help carry out initial tuberculosis screening. Through this application, direct community participation can increase the detection of new TB cases to support the government and WHO programs in eliminating tuberculosis by 2030.

## CONFLICT OF INTEREST

The authors state there is no conflict of interest in this study.

## AUTHOR CONTRIBUTION

All authors have actively participated in this study. EAT contributed to the conceptualization, study design, data curation, formal analysis, data interpretation, methodology, supervision, manuscript writing, and content revision. M contributed to the conceptualization, study design, and data interpretation. SDA contributed to the conceptualization, methodology, and investigation. HM contributed to the conceptualization, study design, and formal analysis. WDP contributed to the conceptualization, methodology, and project administration. CY contributed to the conceptualization, study design, data interpretation, and manuscript writing. FT contributed to the conceptualization, analysis, data interpretation, investigation, methodology, project administration, manuscript writing, and content revision. LM contributed to the conceptualization, manuscript writing, and content revision.

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