

## Original Article

**Survey and analysis of willingness to use mobile medical services and influencing factors of TB patients treated at home**Xiao-Feng Chen<sup>1#</sup>, Fei-Fei Nie<sup>2#</sup>, Xiao-Ke Jiao<sup>3</sup>, Chen Lv<sup>4</sup>, Juan Sun<sup>2</sup>, Xiu-jun Wang<sup>1</sup>, Xiu-Hua Wang<sup>4</sup>, Ning Zhang<sup>5</sup><sup>1</sup> Department of Intensive Care Unit, Beijing Chest Hospital, Capital Medical University, Beijing 101149, China<sup>2</sup> Department of Tuberculosis II, Beijing Chest Hospital, Capital Medical University, Beijing 101149, China<sup>3</sup> Department of Tuberculosis I, Beijing Chest Hospital, Capital Medical University, Beijing 101149, China<sup>4</sup> Department of Nursing, Beijing Chest Hospital, Capital Medical University, Beijing 101149, China<sup>5</sup> Department of General Surgery, Shaanxi Provincial Tuberculosis Control Hospital, Shaanxi, 710100, China

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**Abstract**

**Introduction:** The objective of this study was to investigate the willingness of patients with tuberculosis (TB) to use mobile medical services (mHealth) and its influencing factors, so as to provide theoretical guidance for optimizing the TB mobile medical platform and improve the willingness of patients to use mHealth.

**Methodology:** In this cross-sectional study, convenience sampling method was used to investigate patients with TB from the outpatient clinics of two TB specialized hospitals (Beijing Thoracic Tumor and Tuberculosis Hospital and Tuberculosis Prevention and Treatment Hospital of Shaanxi Province) from January to June 2021 using a self-designed questionnaire.

**Results:** Out of 231 patients, only 90 (38.96%) were aware of mHealth services, and 63 (27.27%) had used mHealth services. Among the 63 patients who had used mHealth services, the proportion of mobile medical forms based on WeChat platform was 74.89%. Patients' willingness to use mHealth was scored ( $11.49 \pm 2.53$ ). Univariate analysis showed that the scores of patients' willingness to use mHealth differed by gender and the different ways of affording healthcare ( $p < 0.05$ ). Regression analysis showed that the influencing factors of willingness to use mHealth in patients with TB included attitude towards use (0.750), health beliefs (0.091) and social impact (0.169) (adjusted  $R^2 = 0.781$ ,  $p < 0.001$ ).

**Conclusions:** Patients' awareness of the advantages of the new medical model needs to be improved. Optimized design can improve the willingness of patients to use mHealth services and improve the role of mHealth in patient management.

**Key words:** tuberculosis; mHealth; medical model; patient management.*J Infect Dev Ctries* 2023; 17(12):1761-1768. doi:10.3855/jidc.17831

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Copyright © 2023 Chen *et al.* This is an open-access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.**Introduction**

Tuberculosis (TB) is a chronic infectious disease caused by infection with *Mycobacterium tuberculosis*. In clinical practice, chemotherapy is the primary and most effective treatment for TB [1], requiring long-term adherence to medication for at least 6 months, and up to 24 months for drug-resistant patients, with home treatment being the mainstay [2]. However, studies have shown that patients' self-management level and treatment compliance are not ideal [3,4], and the level of compliance directly determines the treatment and outcome of the disease [5]. In addition, due to the new coronavirus epidemic since 2020, experts recommend reducing going out and unnecessary medical treatment, causing further pressure on the standardized treatment of the disease [6]. Traditional medical models have been unable to meet the needs of patients for

continuous, convenient and personalized disease management [7]. In recent years, with the development of information technology, mobile healthcare based on mobile communication and smart terminal technology has gradually developed. The World Health Organization (WHO) defines mobile healthcare (mHealth) as medical services that support medical and public health practices through mobile devices, such as cell phones, patient monitoring devices, personal digital assistant and other wireless devices [8]. mHealth is characterized by spanning time and space and optimized resource allocation. Therefore, it has made up for the obvious shortcomings of the traditional healthcare service system and brought a new form of treatment to patient management [9]. mHealth is favored by patients and medical professionals, as it can improve patient self-management, treatment outcomes

and enhance the quality of life [10]. Although mHealth care is rapidly developing, it also has certain limitations. Most of the current mHealth platforms are designed and developed by commercial organizations, which ignore the needs of patients who use them [11]. There is also the problem of low user viscosity over time, which leads to low frequency of use [12]. This study investigated the willingness of patients with TB to use mHealth services through questionnaires and analyzed the factors influencing its use in order to provide a theoretical basis for the construction of a mHealth service platform for patients with TB and to provide a reference for improving compliance and self-management of home treatment patients.

## Methodology

### *Research subjects*

A convenience sampling method was used to select 250 patients who visited the outpatient clinic and were hospitalized in two TB specialized hospitals (Beijing Chest Hospital, Capital Medical University and Tuberculosis Prevention and Treatment Hospital of Shaanxi Province) from January to June 2021 as the study's subjects. Inclusion criteria were (1) age  $\geq 18$  years; (2) definite diagnosis of TB and stable condition; (3) able to use smartphones; (4) no cognitive dysfunction; (5) signed the informed consent letter and voluntarily participated in this study. Exclusion criteria were (1) critical TB; (2) pulmonary TB diagnosis was not clear. This study has been reviewed and approved by the Ethics Committee of Beijing Chest Hospital, Capital Medical University (No.: 2021; Clinical Review-Scientific Research-No. 42).

### *Research methods*

The cross-sectional survey method was used. The survey included the following items: (1) basic information about the patient, such as gender, age, education level, work status, monthly family income, mode of bearing of medical cost, and the presence of comorbidities; (2) knowledge of TB mHealth services (including questions 'Are you aware of the mHealth platform?', 'Have you used the mHealth platform?', and 'How do you access the mHealth platform?'); (3) questions on willingness to use mHealth services for TB patients and influencing factors). The questionnaire was revised based on existing literature, integrating the Unified Theory of Acceptance and Use of Technology, Health Belief Model, Perceived Risk Theory, and referring to relevant measurement questionnaires [13]. It consisted of 30 items in eight dimensions: performance expectation (5 items), effort expectation (3

items), social impact (2 items), perceived threat (4 items), perceived risk (6 items), health belief (4 items), attitude of use (3 items), willingness to use (3 items). The total score of the questionnaire was 150. The dimension score was the total of item scores in each dimension, and the entry score was the score obtained from the total score of each dimension/number of items. A Likert 5-point questionnaire was used with scores of 1 to 5, representing total disagreement, comparative disagreement, neutrality, comparative agreement, and full agreement, respectively. A total of 250 questionnaires were distributed and 250 were returned, with a recovery rate of 100%; 231 questionnaires were valid, with an efficiency rate of 92.4%. The reliability test of this questionnaire showed that the overall Cronbach's  $\alpha$  coefficient of the questionnaire was 0.866 and the standardized overall Cronbach's  $\alpha$  coefficient was 0.914, which had good reliability. The validity test had the Kaiser-Meyer-Olkin test value = 0.933 > 0.7, which had good validity.

### *Quality control*

Data were collected in this study using a questionnaire. After the survey team members were trained, the purpose and significance of this study, the method of completing the questionnaire and precautions were introduced to the patients in detail using a uniform guideline. Questionnaires were completed by the patients after obtaining their informed consent. Patients were assured of a quiet environment and sufficient time when filling out the form, and were reminded to answer according to their real situation, and their privacy was strictly guaranteed. Before the questionnaire was officially distributed, the researchers conducted a pre-survey. They selected 20 patients for the pre-survey and modified the questions that were difficult to understand in the questionnaire. Finally, the 42 most representative questions were selected from the questionnaire.

Data were collected from completed questionnaires, and the number of samples collected from questionnaires were more than five times the number of questionnaire questions as recommended by the statistician to ensure confidence in the results [14-16]. The questionnaire for this study had a total of 42 questions, so a minimum of 210 samples were needed. We received a total of 250 filled out questionnaires online.

To ensure the authenticity of the data, we used two methods for quality control. First, there was a logical relationship between question 6 (Q6) and question 7 (Q7) in questionnaire design. If the respondents did not

answer seriously, the answers to these two questions would contradict each other, and such questionnaires would be eliminated from the analysis. In this study, all respondents answered Q6 and Q7 reasonably and no answers were randomly selected. In internal validation, we found that the shortest time to effectively answer the whole questionnaire was 70 seconds and the longest was 610 seconds, with an average of 221 seconds. Therefore, questionnaires with a response time less than 70 seconds would also be eliminated from data analysis. In this study, the minimum time to answer the questionnaire among all respondents was 76 seconds. Finally, 231 questionnaires were valid, giving an effectiveness rate of 92.4%.

*Statistical methods*

Data collation and statistical analysis were performed using SPSS 20.0. The measurement data were tested for normality and statistically described using means, standard deviations ( $\pm$ ), frequencies, percentages, or composition ratios (%). One-way analysis of variance was used to compare groups when the variances were homogeneous. Comparisons between groups when variances were heterogeneous were analyzed using Welch's test. Bonferroni test was used for pairwise comparisons between multiple groups. Multiple linear regression was used to analyze the influencing factors of willingness to use mHealth services among patients with TB.  $p < 0.05$  was used to indicate a statistically significant difference.

**Results**

*Awareness of mHealth services among patients with tuberculosis*

Of the 231 patients, only 90 (38.96%) were aware of mHealth services, 63 (27.27%) had used mHealth services, and 29 (45.45%) of 63 patients who had used

mHealth service platforms accessed the service through the WeChat official account (Table 1).

*Scores of mHealth usage willingness and influencing factors among patients with tuberculosis*

The 231 TB patients had a score of  $11.49 \pm 2.53$  for willingness to use mHealth, and a mean item score of  $3.83 \pm 0.84$ . The highest score was  $4.25 \pm 0.79$  for the health beliefs item and the lowest score was  $3.25 \pm 0.89$  for the perceived risk item (Table 2).

*Comparison of mHealth willingness scores of patients with tuberculosis with different characteristics*

Univariate analysis showed that patients, of different gender and their different ways of bearing medical costs, had different scores of willingness to use mHealth, and the difference was statistically significant ( $p < 0.05$ ) (Table 3). Among them, the scores of male patients were lower than female patients ( $11.13 \pm 2.64$  vs  $11.94 \pm 2.31$ ,  $\chi^2 = 6.081$ ,  $p = 0.014$ ). The scores of willingness to use were  $11.10 \pm 3.05$ ,  $12.39 \pm 2.16$ ,  $11.05 \pm 2.43$  and  $12.91 \pm 2.42$  for patients with self-payments, patients with basic employee health insurance, patients with basic urban and rural residents' health insurance and patients with other (public and commercial insurance) payments, respectively ( $F = 5.484$ ,  $p = 0.001$ ).

*Correlation analysis between the scores of willingness of patients with tuberculosis to use mHealth and influencing factors*

Pearson correlation analysis showed that willingness to use mHealth in TB patients was associated with performance expectations, effort expectations, social impact, perceived threat, health beliefs, perceived risk and attitude to use all in a holistic manner ( $p < 0.001$ ) (Table 4).

**Table 1.** Awareness of mobile health (mHealth) services among tuberculosis patients.

Option	n (%)
Did you know about mHealth	
Yes	90 (38.69)
No	141 (61.04)
Have you ever used mHealth	
Used	63 (27.27)
Not used	168 (72.73)
Your access to mHealth	
WeChat Official account	29 (45.45)
WeChat applet	19 (29.44)
Alipay applet	2 (3.03)
Independent mobile medical app (Tuberculosis Assistant, Baiyitong, Jiankangle, etc.)	8 (13.42)
Other	5 (8.66)

**Table 2.** The scores of 231 patients with tuberculosis in all dimensions of willingness to use mobile health (mHealth) and influencing factors (points,  $\bar{x} \pm s$ ).

Dimension	Dimension score	Item score
Performance expectations	$19.06 \pm 3.93$	$3.81 \pm 0.79$
Effort expectations	$11.52 \pm 2.49$	$3.84 \pm 0.83$
Social impact	$7.85 \pm 1.66$	$3.93 \pm 0.83$
Perceived threat	$16.11 \pm 3.21$	$4.03 \pm 0.80$
Health beliefs	$17.00 \pm 3.16$	$4.25 \pm 0.79$
Perceived risk	$19.53 \pm 5.37$	$3.25 \pm 0.89$
Attitude to use	$11.24 \pm 2.45$	$3.74 \pm 0.82$
Willingness to use	$11.49 \pm 2.53$	$3.83 \pm 0.84$

*Multivariate analysis on influencing factors of willingness to use mHealth in patients with tuberculosis*

The score for patients' willingness to use was used as the dependent variable, and performance expectations, effort expectations, social impact, perceived threat, health beliefs, perceived risk, attitude to use and variables with statistical significance in the univariate analysis were used as independent variables, and multiple linear regression analysis was performed by stepwise regression method, according to  $\alpha$  entry =

0.05,  $\alpha$  exit = 0.10 system default criteria. The numerical variables were entered in their original values, and the remaining independent variables were assigned as follows, gender: male = 1, female = 2; the way medical costs were covered: self-pay = 1, employee medical insurance = 2, urban and rural medical insurance = 3, and others (free medical care, commercial insurance) = 4. Attitudes to use, health beliefs, and social impacts were ultimately entered into the regression model ( $p < 0.05$ ), as shown in Table 5.

**Table 3.** Comparison of willingness to use mobile health (mHealth) in patients with different demographic and disease characteristics (points,  $\bar{x} \pm s$ ).

Features	Number of subjects (N = 231)	Score	F/t value	p value
<b>Gender</b>				
Male	128	11.13 ± 2.64	6.081	0.014
Female	103	11.94 ± 2.31		
<b>Age</b>				
< 20 years	27	10.63 ± 2.59	0.953	0.447
21-30 years	95	11.44 ± 2.42		
31-40 years	48	11.56 ± 2.87		
41-50 years	28	11.79 ± 2.33		
51-60 years	17	12.00 ± 2.37		
> 60 years	16	11.94 ± 2.46		
<b>Education Level</b>				
Primary school or below	20	11.60 ± 3.18	0.983	0.418
Junior high school	59	11.07 ± 2.55		
High school/ professional high school/secondary school	63	11.32 ± 2.37		
Junior college / Bachelor	83	11.87 ± 2.44		
Master 's degree or above	6	11.83 ± 2.71		
<b>Work Status</b>				
Working	68	12.10 ± 2.39	2.499	0.060
Retired	7	12.43 ± 2.23		
Unemployed	86	11.14 ± 2.67		
Other (Individual)	70	11.23 ± 2.42		
<b>Monthly household income (RMB)</b>				
< 2000	65	11.22 ± 2.69	2.065	0.086
2001-5000	95	11.33 ± 2.29		
5001-10000	54	11.61 ± 2.38		
10001-15000	11	12.82 ± 3.81		
≥ 15000	6	13.50 ± 1.64		
<b>How to bear medical expenses</b>				
Self-pay	30	11.10 ± 3.05	5.484	0.001
Basic employee health insurance	59	12.39 ± 2.16		
Basic urban and rural residents' health insurance	131	11.05 ± 2.43		
Others (public fee, commercial insurance)	11	12.91 ± 2.42		
<b>Type of tuberculosis diagnosis</b>				
Susceptible tuberculosis	92	11.27 ± 2.36	0.699	0.498
Drug-resistant tuberculosis	38	11.82 ± 2.77		
Not known	101	11.56 ± 2.58		
<b>Disease duration</b>				
≤ 3 months	164	11.41 ± 2.51	0.628	0.643
3-6 months	26	12.12 ± 2.80		
6-9 months	12	10.92 ± 2.78		
9-24 months	11	11.36 ± 2.16		
> 24 months	18	11.72 ± 2.42		
<b>Complications present</b>				
Yes	78	11.92 ± 2.56	3.503	0.063
No	153	11.27 ± 2.49		

The  $R^2$  value for the model was 0.778, meaning that attitudes, health beliefs, and social impacts explained 77.8.% of the willingness of patients with TB to use mHealth platforms. The regression model by F-test ( $F = 118.363, p < 0.001$ ) indicated that the above factors can have an influential relationship on willingness to use.

**Discussion**

A total of 231 patients with TB were included in this study, and 93.07% were under 60 years of age. The results of this study showed that the awareness rate of mHealth among TB patients was only 38.96%, and only 27.27% of patients had used mHealth, which is significantly low and does not match the widespread prevalence of TB. The influencing factors of willingness to use mHealth in patients with TB included attitude towards use, health beliefs and social impact.

*Patients with tuberculosis have low awareness of mHealth services, but use them in various forms*

The awareness rate of mHealth among patients with TB was consistent with the findings of Zhou Shuangshuang *et al.* [17]. This indicates that mHealth, a new chronic disease management tool, has not been widely understood and well-known by the TB patient population. This may be because (1) marketing channels are not sufficiently stimulated and there is a lack of publicity; (2) patients are worried about exposing their privacy, while they cannot ensure the qualification of medical personnel, and whether the platform can provide them with true, transparent and effective medical information. In addition, this study also showed that patients with TB use a richer form of mobile healthcare, with a high percentage of 74.89% in the form of mobile healthcare based on the WeChat platform, including 45.45% using WeChat public account and 29.44% using WeChat applets. The WeChat platform is powerful, convenient, and comes with functional services such as public account, subscription account, applet and moments, and is currently the most popular health education channel with a large user base [18]. It can be seen from the comprehensive analysis that, in the future, medical staff

**Table 4.** Correlation analysis between willingness of tuberculosis patients to use mobile health (mHealth) and various dimensions of influencing factors.

Dimension	Willingness to use	
	R value	p value
Performance expectations	0.621	< 0.001
Effort expectations	0.612	< 0.001
Social impact	0.707	< 0.001
Perceived threat	0.644	< 0.001
Health beliefs	0.630	< 0.001
Perceived risk	0.322	< 0.001
Attitude to use	0.876	< 0.001

can carry out patient management with the help of the WeChat platform and fully use the multiple functions carried by WeChat. However, in this process, it is necessary to pay attention to strengthening the management of patient information, reducing the user concerns about information leakage and improving the efficiency of mobile medical care for patients, so as to make full use of its role in patient management.

*The willingness of patients with tuberculosis to use mHealth services was at the upper-middle level, but with some individual differences*

The results of this study showed that the willingness of patients with tuberculosis to use mobile healthcare scored  $11.49 \pm 2.53$ , which was moderately high, and higher than the scores of the surveys by Wang *et al.* [19] on elderly patients and by Yan *et al.* [20] on gout patients. The reason for this phenomenon may be related to the young age and infectious diseases of the subjects included in this study. Out of the 231 patients finally included in this study, 93.07% were under 60 years of age. With the development of internet technology, young patients are more accustomed to using information technology to meet the needs of all aspects of daily life. In addition, as TB belongs to respiratory infectious diseases, patients have different degrees of stigma [21] and may be more willing to try the new health management model of mHealth. Univariate analysis showed that female patients with medical payment mode of public fees or commercial insurance had higher scores of willingness to use mHealth than other patients ( $p < 0.05$ ), while the

**Table 5.** Multiple linear regression analysis of willingness to use mobile health (mHealth) platform in tuberculosis patients.

Variable	Non-normalized Coefficient		Standardized Coefficient	T	p value
	B	Standard Error	Beta		
Constant	0.187	0.447	-	0.417	0.677
Attitude to use	0.750	0.047	0.727	15.974	0.000
Health beliefs	0.091	0.034	0.113	2.693	0.008
Social impact	0.169	0.073	0.111	2.327	0.021

$R^2 = 0.778$ ; adjusted  $R^2 = 0.781$ ;  $F = 118.363$ ;  $p < 0.001$ .

population affected by TB in China were mainly male (56%) [22] and low-income population [23], which inevitably affected the promotion and application of mHealth. It is suggested that different promotion strategies and service forms should be adopted for different individuals in the future, focusing on male patients and patients without medical insurance.

#### *Attitude of use positively impacts willingness to use*

Usage attitude in this study refers to the patients' evaluation of the value and significance of using mHealth services. The results showed that attitude of use positively influenced patients' willingness to use the mobile medical platform, indicating that when patients' attitude towards the mobile medical platform was positive, they were largely willing to try to use the service, which was consistent with the results of multiple studies [24,25]. Patients with TB pay attention to whether mHealth can bring practical benefits to themselves, make up for the shortcomings of traditional medical service models, provide scientific health management guidance and help in real time, conveniently master more disease-related knowledge, improve treatment compliance and improve treatment outcomes with its help. It is suggested that when designing the mHealth platform for TB patients in the future, it should be set under the guidance of scientific theories and methods according to the requirements of TB management guidelines to ensure the effectiveness of mHealth services. It should also be oriented to the needs of patients to arouse the interest among patients in using the mHealth platform and ensure that it brings real help and benefits to patients.

#### *Health beliefs positively influence willingness to use*

Health beliefs refer to the perception of the patients with TB and their evaluation of the benefits and effects that the behaviour will bring, the possible costs of implementing the behaviour and the difficulties encountered, as well as the patients' evaluation and judgment of their own abilities. This means that when the patients' health beliefs are high, they will feel confident and capable of changing the undesirable behaviour through their efforts. The results of the present investigation showed that health beliefs can positively influence patients' willingness to use, in line with the findings of Alaiad *et al.* [26].

Chemotherapy is the most important and effective treatment for TB [1]. Since the duration of TB is 6–24 months, patients need to take medication for a long time and are mainly treated at home [2], which, together with many adverse drug reactions, leads to poor adherence

and low cure [27]. But patients often do not understand the impact of poor treatment adherence on treatment outcome. The mobile medical platform for TB can introduce the serious consequences of non-compliance with treatment to patients in various forms, such as text, cartoons and videos, and at the same time, it can also provide patients with medication reminders, diet and exercise guidance and self-management skills [28] to help patients do a good job during home medication and avoid the occurrence of serious adverse drug reactions or drug resistance, thus leading to a benign interaction between patients and the mobile medical platform and enhancing the patients' willingness to use it.

#### *Social influence positively impacts willingness to use*

In this study, social influence refers to the perceived external influence of TB patients on the use or non-use of mHealth services. This includes the influence of the attitude and views of people who are more important to them (such as medical staff, family members, friends) on their willingness to use. The findings show that the willingness of patients with tuberculosis to use mHealth is highly influenced by external influences, and social impact can positively affect patients' willingness to use it. However, Nie *et al.* [23] investigated patients' willingness to use mHealth services and influencing factors with diabetes and hypertension as the study subjects, and the results showed that social impacts had no significant effect on the willingness to use mHealth services in this population. The reason for this phenomenon may be the different types of diseases. The infectious nature of TB leads to weak social support systems and inadequate access to information and emotional support [29], making patients' willingness to use more vulnerable to social factors. The social impact of TB patients is mainly derived from medical and family factors [30], which suggests the necessity and effectiveness of marketing through healthcare workers and patients' families.

#### *Limitations*

There are still some limitations in this study, such as the small geographical area selected for the sample, and the cognitive level of patients with TB's perceptions of mHealth services in regions with different levels of economic development, which may also affect their willingness to use them. Therefore, in the future studies, we will further expand the sample for in-depth research.

## Conclusions

Patients with TB had a relatively low level of awareness of mHealth services, but a moderate to high level of willingness to use them. There were individual differences in patients' willingness to use, and the factors influencing patients' willingness to use were patients' attitudes toward use, health beliefs, and social impacts. It is suggested that we should give full play to the role of social impact in the future, strengthen publicity and promotion, and at the same time, optimise the design of the mHealth service platform so that it can generate positive interaction with patients, thus increasing their level of awareness and willingness to use it.

## Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Beijing Chest Hospital, Capital Medical University. Written informed consent was obtained from all participants.

## Author contributions

All authors made a significant contribution to the work reported, in the conception, study design, execution, acquisition of data, analysis and interpretation, and participated in drafting, revising and/or critically reviewing the article. They gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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