Patient Preference and Adherence

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ORIGINAL RESEARCH

Impact of the Internet Plus Health Education Model on Treatment Adherence, Disease Knowledge and Patient Satisfaction in Pulmonary Tuberculosis

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Objective: To evaluate the effect of an internet plus health education model on treatment adherence among patients with pulmonary tuberculosis (PTB).

Methods: A total of 75 patients diagnosed with PTB and meeting the inclusion criteria were recruited from Beijing Chest Hospital between October and November 2024. Participants were randomly assigned to either the control group or the intervention group using a random number table The control group received conventional health education, whereas the intervention group received additional education via a WeChat mini programme. Treatment adherence was measured through outpatient follow-up cognitive assessments. Patients' knowledge of core PTB prevention and control concepts was evaluated using a standardised knowledge assessment questionnaire. Patient satisfaction was assessed using a self-developed satisfaction survey. After a 6-month intervention period, clinical parameters were compared between the two groups.

Results: Compared with the control group, the intervention group demonstrated significantly higher treatment adherence ($P < 0.05$). The mean disease knowledge scores were 66.05 ± 7.18 in the control group and 83.51 ± 8.15 in the intervention group, indicating a statistically significant difference between the two groups ($P < 0.05$). The overall knowledge awareness rate in the intervention group (83.51%) was significantly higher than that in the control group (64.61%) ($P < 0.05$). The satisfaction rate of patients in the intervention group was significantly higher than that in the control group (93% vs 100%) ($P < 0.05$).

Conclusion: The internet plus health education model delivered via a WeChat mini programme can considerably improve treatment adherence, enhance disease knowledge and increase patient satisfaction among individuals with PTB. This model shows promise for broader application in tuberculosis wards.

Keywords: pulmonary tuberculosis, internet, adherence, patient satisfaction, outcome evaluation

Introduction

Pulmonary tuberculosis (PTB) is a major infectious disease that poses a serious threat to public health and individual well-being. According to the 2024 *Global Tuberculosis Report*,[1] PTB remains the leading cause of death from a single infectious agent worldwide. In 2023 alone, an estimated 10.8 million new PTB cases were reported globally, ranking it third among all infectious diseases in terms of incidence. Current treatment strategies for PTB include pharmacotherapy, surgical intervention, symptomatic management and adjunctive therapies. Chemotherapy remains the cornerstone of PTB treatment. However, adherence is often suboptimal due to the prolonged treatment duration, complex multidrug regimens, frequent adverse drug reactions (ADRs) and high treatment costs.[2]

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Conventional health education has played an important role in improving treatment adherence and controlling the spread of PTB. Nevertheless, it has several limitations, including a mismatch between patient needs and educational content and a lack of continuity in the delivery of health education. These shortcomings may result in reduced quality of life, poor treatment adherence and even disease relapse. The internet plus health education model, as an integral component of the broader internet plus healthcare services framework, offers a promising solution. This model delivers personalised real-time health education via mobile internet platforms, enabling remote monitoring and reminders tailored to individual needs. It has the potential to enhance patient awareness of PTB-related knowledge and improve adherence to interventions.[3,4] Previous studies have demonstrated the effectiveness of this model in other disease areas. Research on patients with breast cancer showed that through nursing care and health education delivered via the WeChat platform, the intervention group exhibited considerably higher levels of knowledge acquisition, treatment adherence and satisfaction than the control group.[5] Implementing a pre-hospital internet plus health education model for patients undergoing lung tumour surgery effectively enhances their self-management capabilities and alleviates negative emotions such as anxiety and depression.[6]

However, compared with other chronic diseases such as cancer and diabetes, clinical research on the internet plus health education model in the field of tuberculosis is relatively scarce, and the existing evidence is insufficient to fully support the promotion and application of this model in tuberculosis prevention and control. In addition, current research does not fully clarify the specific connotation of the internet plus health education model and does not clearly explain the core reason for choosing WeChat as the intervention platform. WeChat, as the largest social platform in China, has wide user coverage, high operational convenience and multiple functions such as small programmes and official accounts, and it can provide integrated services including health knowledge dissemination, online consultation and follow-up reminders, which offers a unique advantage for continuous health education. Previous research has not yet conducted an in-depth analysis of the basis for selecting this platform.

This study is guided by the knowledge, attitude and practice (KAP) theoretical framework, which holds that knowledge is the foundation for forming correct attitudes and that positive attitudes promote the development of healthy behaviours (practice). Based on this, we designed the internet plus health education model, which covers knowledge transfer, attitude guidance and behaviour intervention. We aim to systematically explore the impact of this model on the treatment adherence of patients with tuberculosis while analysing its role in patients' disease knowledge and satisfaction, providing evidence-based support for nursing interventions for this patient population and filling the gap in clinical research in this field.

Participants and Methods

General Information

This prospective study enrolled 75 patients with PTB who met the inclusion criteria and were treated at Beijing Chest Hospital, Capital Medical University, between October and November 2024. Participants were randomly assigned using a random number table to either the control group (n = 40) or the intervention group (n = 40). During the study, 2 patients in the control group and 3 in the intervention group were lost to follow-up, resulting in a final sample of 75 patients: 38 in the control group and 37 in the intervention group. The inclusion criteria were as follows: (1) aged between 18 and 60 years; (2) confirmed diagnosis of PTB according to standard diagnostic criteria;[7] (3) absence of other serious physical or psychiatric comorbidities; (4) ability to communicate effectively with study personnel; (5) proficiency in using a smartphone; (6) residence within the Beijing metropolitan area; and (7) provision of written informed consent. The exclusion criteria were as follows: (1) critically ill status due to PTB; (2) history of severe psychiatric disorders or cognitive impairment; and (3) refusal to participate in the study. This study was approved by the Ethics Committee of Beijing Chest Hospital, Capital Medical University. Written informed consent was obtained from all participants.

Sample Size Calculation

Based on data regarding treatment adherence in patients with tuberculosis from a previous similar study,[8] and assuming a 60% adherence rate in the control group and an 85% adherence rate in the intervention group, with $\alpha = 0.05$ (two-tailed test) and $\beta = 0.2$ (80% test power), the minimum sample size required for each group was calculated using PASS 15.0

(NCSS, Kaysville, UT, USA) software to be 35 cases. Accounting for a 10% loss to follow-up rate, the final sample size was determined to be 40 patients per group, totalling 75 patients, which met the study design requirements.

Allocation Concealment and Blinding

Allocation concealment was achieved through a centralised randomisation scheme: Non-researchers generated a computer-based random number sequence, matched patient codes with group assignments and sealed these in opaque envelopes. The researchers opened the envelopes to determine group assignments only after the patients completed the inclusion assessments, preventing premature disclosure of group information.

Given the study design as a health education intervention, blinding was not feasible for patients or the nurses delivering the intervention. However, a single-blind approach was implemented for outcome assessors: Researchers responsible for collecting follow-up data, conducting knowledge assessments and evaluating satisfaction were unaware of patient group assignments.

Health Education Methods

Control Group

Health education for the control group was delivered by the primary nurse based on the standardised PTB education record form developed by the hospital's nursing department. Education was provided during hospitalisation and at discharge, covering the following aspects: (1) for newly admitted patients and their families, explanation of hospital visitation policies, daily routines, the importance of smoking cessation and fall prevention measures; (2) principles and proper methods of disinfection, isolation and mask usage; (3) basic knowledge of PTB; (4) instructions on correct sputum collection techniques and associated precautions; (5) information on venous thromboembolism, including prevention and risk factors; (6) purpose, importance and precautions related to specialised diagnostic procedures (eg bronchoscopy, computed tomography-guided biopsy) and interventions (eg lumbar puncture, thoracentesis); (7) guidelines for the use of anti-tuberculosis medications and possible ADRs; (8) the relationship between diet, rest and disease recovery; (9) for discharged patients and their families, home-based disinfection and isolation protocols, medication adherence, recognition and management of potential ADRs, follow-up schedules and important considerations for home care.

Intervention Group

Patients in the intervention group received a 6-month internet plus health education model, implemented as follows:

1. establishment of the internet plus health education team: A multidisciplinary team was formed, comprising one staff member from the nursing department, one head nurse from the tuberculosis ward, five primary nurses and two network engineers. All team members possessed extensive experience in either PTB nursing management or information technology. The nursing department staff member was responsible for quality control; the head nurse oversaw the evaluation of health education outcomes; the primary nurses were tasked with delivering online health education, handling patient inquiries and collecting and managing data; and the network engineers were responsible for developing and maintaining the internet plus health education model platform. All team members underwent standardised training on platform usage and passed a competency assessment, and regular feedback meetings were held to address implementation challenges and drive continuous quality improvement.
2. Development of the internet plus health education content:[9] Based on patient needs and grounded in the KAP theoretical framework, the team consulted five experts from different domains to develop a structured and practical health education programme. The programme consisted of three major modules: A) PTB knowledge education, including guidance on basic disease information, diagnostic procedures, treatment options, medication use and lifestyle recommendations; B) belief-oriented education, including psychological support, family support and social support; C) behavioural education, including instructions on disinfection and isolation, follow-up routines, behaviour tracking and functional rehabilitation. The authority coefficient of the expert panel was 0.92, and the final educational framework was deemed standardised, practical and feasible.

3. Development and implementation of the internet plus health education model platform: The platform consisted of three functional interfaces – a system management terminal, a healthcare provider terminal and a patient terminal. A) System management terminal: This interface supported the overall configuration and operation of the platform, including system setup, healthcare staff management, patient management, health education administration, patient inquiries and communication and push notifications. It was responsible for platform maintenance and technical updates. B) Healthcare provider terminal: This interface included modules for patient record management, health consultations, information dissemination and health follow-up. Primary nurses used the platform as a new media tool to deliver patient-centred care. In the patient record management module, nurses created and maintained individual health profiles. In the health consultation module, nurses responded to patient queries within 12 hours. The information dissemination module delivered electronic educational materials (including text and images) based on the structured internet plus health education model content, allowing patients to access information at any time. The health follow-up module was used to send automated appointment reminders to patients' mobile phones 3 days before scheduled follow-up visits, as determined at the time of discharge. C) Patient terminal: The patient interface included modules for health records, health education, health consultation and peer communication. Patients could access educational materials pushed through the health education module, submit inquiries based on their individual needs through the health consultation module and engage with other patients in the peer communication module, where they could share personal treatment experiences and participate in online peer support activities. This feature was designed to foster a sense of community and enhance patients' confidence in managing and overcoming the disease.

Evaluation Methods

Treatment Adherence

Treatment adherence was measured using a multidimensional assessment approach rather than relying solely on follow-up attendance: (1) Follow-up compliance was confirmed through outpatient registration records and telephone follow-ups and categorised as follows: timely follow-up, defined as attendance within ±1 day of the scheduled appointment; delayed follow-up, defined as attendance 1–7 days after the scheduled appointment; and missed follow-up, defined as no attendance or contact within 7 days of the scheduled appointment. The timely follow-up rate was then calculated. (2) Medication adherence was assessed using the Morisky Medication Adherence Scale (MMAS-8), which comprises 8 items with a total score of 0–8. A score of 8 was taken to indicate full adherence, 6–7 to indicate partial adherence and <6 to indicate non-adherence. Verification was conducted using medication check-in records (intervention group) and home medication container inspections (control group). (3) Lifestyle adherence was assessed to determine whether patients followed health recommendations such as smoking cessation, regular sleep patterns and a balanced diet through combined follow-up interviews and family feedback. Assessment items included five criteria, such as whether smoking cessation had been maintained in the past month, whether 8 hours of sleep were ensured daily and whether a high-protein diet was followed as advised. Each "full adherence" item was scored 2 points, "partial adherence" was scored 1 point and "non-adherence" was scored 0 points. A total score of ≥8 points was defined as complete lifestyle adherence.

Treatment adherence was ultimately categorised into three levels: full compliance (100% timely follow-up rate, MMAS-8 score ≥8, full lifestyle adherence), partial adherence (≥80% but <100% timely follow-up rate, MMAS-8 score 6–7, partial lifestyle adherence) and non-adherence (failing to meet the partial adherence criteria). The full adherence rate served as the primary compliance indicator.

Disease Knowledge

The revised version of the Assessment Questionnaire on Core Information and Key Knowledge Points for Tuberculosis Prevention and Control, developed by Lee, Y et al,[10] was adopted. This questionnaire comprises 20 multiple-choice questions, each worth 5 points, with a maximum score of 100 points. Higher scores indicate better knowledge mastery.[11] The questionnaire demonstrated good reliability and validity, with a Cronbach's α coefficient of 0.804, a standardised Cronbach's α coefficient of 0.796 and a KMO value of 0.837 ($P < 0.001$).

Knowledge awareness rate calculation method: Each correct response to an item was counted as one instance of awareness. The total number of correct responses across all patients was calculated and then divided by the product of the total number of items (20) and the total number of participants to obtain the overall knowledge awareness rate. Simultaneously, awareness rates for each dimension (causes and transmission, treatment and care, preventive measures) were calculated to comprehensively reflect patients' knowledge mastery.

Because both knowledge assessment and satisfaction evaluation relied on patient self-reports, two types of bias were possible: recall bias (patients answering known content incorrectly due to poor memory or answering unknown content correctly by guessing) and social desirability bias (patients overestimating satisfaction or knowledge mastery to gain healthcare provider approval). To minimise these biases, the following measures were implemented: 1) Knowledge assessment employed an immediate recall + prompt-assisted approach, providing non-answer prompts (eg "this topic was covered in health education on the third day before discharge") for uncertain items; 2) during the intervention period, key knowledge points (eg identifying adverse reactions to anti-tuberculosis drugs, home disinfection methods) were pushed monthly via a WeChat mini programme to reinforce patient recall; 3) satisfaction assessments employed an anonymous completion method, with patients explicitly informed that there are no right or wrong answers and that responses are solely for service improvement, thereby reducing social desirability bias.

Patient Satisfaction

Based on relevant literature[12] and the intervention content of this study, a patient satisfaction questionnaire was independently designed. It comprised 15 items rated on a 3-point Likert scale: "Very satisfied" (3 points), "moderately satisfied" (2 points) and "dissatisfied" (1 point). The total score ranged from 15 to 45 points, with scores ≥36 indicating satisfaction. The questionnaire demonstrated good reliability and validity, with a Cronbach's α coefficient of 0.842, a standardised Cronbach's α coefficient of 0.815 and a KMO value of 0.914 ($P < 0.001$).

Data Collection

Electronic versions of the disease knowledge questionnaire and the satisfaction questionnaire were distributed to patients via a WeChat mini programme at two time points: upon enrolment (pre-intervention) and 6 months post-intervention (post-intervention). For patients unable to complete the questionnaires online, researchers assisted with paper versions during outpatient follow-up visits, ensuring independent completion and avoiding leading responses.

Treatment adherence data were collected through the following methods. (1) Follow-up adherence: Hospital outpatient registration records were reviewed and confirmed by telephone follow-up. (2) Medication adherence: Medication check-in records (intervention group), remaining medication in home pill boxes and patient self-reports of medication intake were examined. (3) Lifestyle adherence: Information was obtained through structured interviews during follow-up visits, with questions such as "Have you maintained smoking cessation over the past month?" and "Have you adjusted your diet as recommended?".

Statistical Methods

In this study, independent samples t-tests were used for intergroup comparisons of quantitative data such as knowledge scores and satisfaction scores.

Statistical power estimation: Statistical power was estimated using PASS 15.0 software. With treatment adherence (the primary outcome measure) as the core variable, a 25% difference in adherence rates between groups was assumed (control group 60%, intervention group 85%), with $\alpha = 0.05$ (two-tailed test). The calculated power was 82.3% (>80%), indicating that the study sample size (35 patients per group, adjusted to 40 per group to account for potential loss to follow-up) was sufficient to meet testing requirements and to avoid false negatives due to inadequate power.

Timeline Description

Patient recruitment was conducted from October to November 2024. The intervention period lasted 6 months and concluded with intervention completion and data collection in April–May 2025. The 2024 *Global Tuberculosis Report* cited in this study was published by the World Health Organisation in October 2024, before the start of patient recruitment,

and serves as background material. Reference[8] (Modern Nursing, 2025) is an article published online in advance. Its research content is relevant to the internet plus health education model design of this study. The authenticity and scientific validity of the article were verified at the time of citation, and no logical contradictions exist within the study timeline.

Results

Comparison of Patient Characteristics Between the Groups

There were no statistically significant differences in baseline sociodemographic characteristics between the two groups, indicating comparability (See Table 1). As shown in Table 1, the two patient groups did not differ significantly in age (control group: 43.21 ± 9.26 years vs intervention group: 39.14 ± 10.88 years, t = 1.748, $P = 0.085$), gender (68.42% men in the control group vs 62.16% men in the intervention group, $\chi^2 = 0.324$, $P = 0.569$), educational attainment ($\chi^2 = 6.283$, $P = 0.179$), disease duration ($\chi^2 = 3.847$, $P = 0.146$) and other key baseline demographic indicators. These findings confirm that the two groups were highly comparable and suitable for subsequent intervention effect analyses.

Comparison of Treatment Adherence Between the Groups

After 6 months of intervention, the treatment adherence rate in the intervention group was significantly higher than that in the control group ($P < 0.05$). Across all adherence dimensions, the intervention group showed higher rates of timely follow-up, medication adherence and lifestyle adherence than the control group. Notably, the differences in medication adherence and lifestyle adherence were statistically significant ($P < 0.05$) (See Table 2 and Figure 1).

Table 1 Comparison of General Information Between Groups

Demographic Characteristics	Control (n = 38)	Intervention (n = 37)	t/χ^2	*P*-value
Age (years, $\bar{x} \pm s$)	43.21±9.26	39.14±10.88	t=1.748	0.085
Sex (n[%])			χ^2=0.324	0.569
Male	26 (68.42)	23 (62.16)		
Female	12 (31.58)	14 (37.84)		
Residence			χ^2=0.644	0.422
Urban	22 (57.89)	18 (48.65)		
Rural	16 (42.11)	19 (51.35)		
Education Level (n[%])			χ^2=6.283	0.179
Junior high school or lower	20 (52.63)	11 (29.74)		
Senior high school/Secondary technical school	9 (23.69)	8 (21.62)		
Junior college	6 (15.79)	9 (24.32)		
University and higher	3 (7.89)	9 (24.32)		
Marital Status			χ^2=6.949	0.074
Unmarried	4 (10.53)	12 (32.43)		
Married	29 (76.32)	22 (59.46)		
Divorced	3 (7.89)	3 (8.11)		
Widowed	2 (5.26)	0 (0)		
Medical Insurance Type (n[%])			χ^2=5.363	0.252
UEBMI	1 (2.63)	1 (2.70)		
NRCMS	13 (34.22)	15 (40.54)		
Commercial health insurance	17 (44.74)	9 (24.32)		
Out-of-pocket	4 (10.53)	10 (27.03)		
Others	3 (7.89)	2 (5.41)		
Employment Status			χ^2=3.847	0.146
In-service	6 (15.79)	12 (32.43)		
Between jobs	32 (84.21)	25 (67.57)		

Abbreviations: UEBMI, Urban Employee Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme.

Table 2 Comparison of Treatment Compliance Between the Two Groups of Patients (n, %)

Compliance Indicators	Control Group (n=38)	Intervention Group (n=37)	χ^2	P
Complete treatment compliance	18 (47.4)	29 (78.4)	8.925	0.003
Regular follow-up rate	30 (78.9)	34 (91.9)	3.218	0.073
Medication compliance rate	22 (57.9)	33 (89.2)	10.564	0.001
Lifestyle compliance rate	20 (52.6)	31 (83.8)	9.632	0.002

Comparison of Pulmonary Tuberculosis Knowledge Awareness Between the Groups

As shown in Table 3, there was no significant difference in disease knowledge scores between the two groups before intervention (t = 0.315, P = 0.754). After 6 months of intervention, scores in both groups improved significantly compared with pre-intervention levels (both $P < 0.001$).

Among the knowledge dimensions, the intervention group demonstrated significantly higher awareness of disease transmission (81.5 ± 7.6) than the control group (62.1 ± 8.3, t = −9.532, $P < 0.001$). Similarly, their awareness of treatment and care (84.2 ± 8.1) was significantly higher than that of the control group (65.3 ± 7.8, t = −9.964, $P < 0.001$), and knowledge of preventive measures (84.8 ± 7.9) was significantly higher than that of the control group (66.8 ± 7.5, t = −10.058, $P < 0.001$).

Comparison of Patient Satisfaction Between the Groups

After 6 months of intervention, satisfaction in the control group was 97.37% (37/38), whereas the intervention group achieved 100% (37/37). The intervention group demonstrated higher satisfaction than the control group, with a statistically significant difference (χ^2 = 8.962, P = 0.011). Across satisfaction dimensions, the intervention group scored higher than the control group in "practicality of educational content", "timeliness of consultation responses" and "platform ease of use", with statistically significant differences ($P < 0.05$) (see Tables 4 and 5 for details).

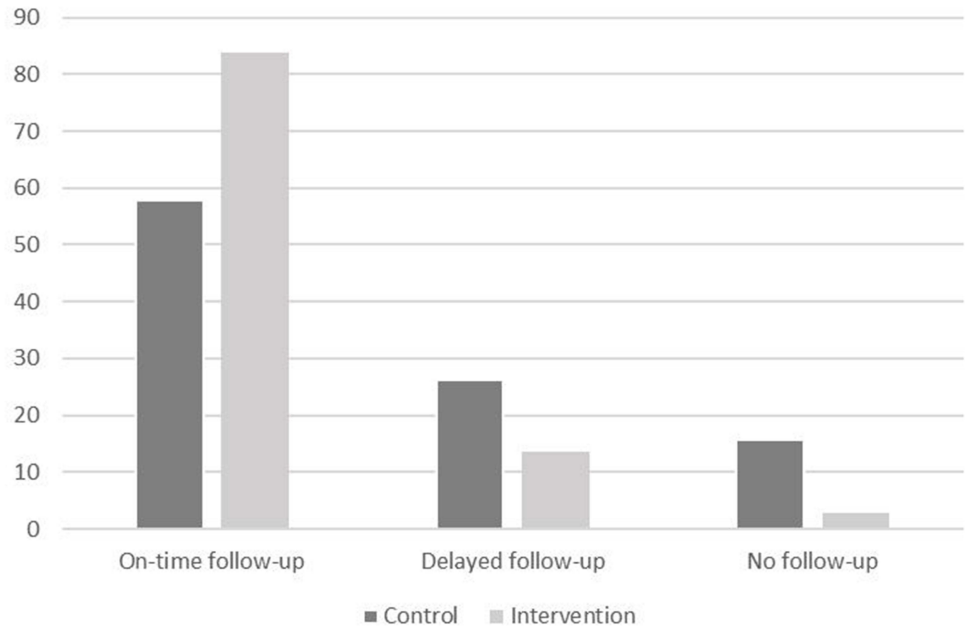

Figure 1 Comparison of treatment adherence between groups.

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Table 3 Comparison of Disease Knowledge Scores and Awareness Rates Between the Two Patient Groups ($\bar{x} \pm s$, %)

Knowledge Indicators	Time Point	Control Group (n=38)	Intervention Group (n=37)	*t*	P value
Knowledge Score (score)	Before Intervention	52.3±6.8	51.8±7.2	t=0.315	0.754
	After Intervention	66.05±7.18	83.51±8.15	t=−9.849	<0.001
	t	8.923	15.672		
	P value	<0.001	P<0.001		
Total Awareness Rate (%)	Before Intervention	52.3±6.8	51.8±7.2	t=0.315	0.754
	After Intervention	64.61±7.02	83.51±8.05	t=−10.217	<0.001
	t	8.751	15.983		
	P value	<0.001	<0.001		
Awareness Rate of Etiological Transmission (%)	Before Intervention	52.1±6.9	51.6±7.1	t=0.320	0.765
	After Intervention	62.1±8.3	81.5±7.6	t=−9.532	<0.001
	t	7.892	14.561		
	P value	<0.001	<0.001		
Awareness Rate of Treatment and Nursing (%)	Before Intervention	52.2±6.7	51.7±7.0	t=0.308	0.682
	After Intervention	65.3±7.8	84.2±8.1	t=−9.964	<0.001
	t	8.124	15.107		
	P value	<0.001	<0.001		
Awareness Rate of Preventive Measures (%)	Before Intervention	52.4±6.8	51.9±7.3	t=0.316	0.796
	After Intervention	66.8±7.5	84.8±7.9	*t=−10.058*	<0.001
	t	8.345	14.893		
	P value	<0.001	<0.001		

Table 4 Comparison of Patient Satisfaction Between Groups After Six months of Intervention (n[%])

Group	Very Satisfied	Satisfied	Not Satisfied	Overall Satisfaction Rate (%)
Control (n = 38)	24 (63.16)	13 (34.21)	1 (2.63)	97.37%
Intervention (n = 37)	34 (91.89)	3 (8.11)	0 (0)	100%
χ^2				8.962
P-value				0.011

Notes: Values outside parentheses indicate the number of patients; values in parentheses indicate the percentage (%).

Table 5 Comparison of Patient Satisfaction Scores Between the Two Groups (Points, $\bar{x} \pm s$)

Satisfaction Dimensions	Control Group (n=38)	Intervention Group (n=37)	t	P
Practicality of educational content	2.72±0.31	2.91±0.18	−3.256	0.002
Timeliness of consultation response	2.65±0.35	2.93±0.15	−4.518	<0.001
Convenience of platform operation	2.68±0.33	2.89±0.20	−3.672	<0.001
Overall satisfaction	38.2±3.5	42.8±2.1	−6.892	<0.001

Discussion

The results of this study indicate that the internet plus health education model based on a WeChat mini programme can considerably improve treatment adherence, disease knowledge levels and satisfaction among patients with PTB, providing an effective intervention plan for health education in this population.

Core Research Findings

After 6 months of intervention, the full treatment adherence rate in the intervention group (78.4%) was significantly higher than that in the control group (47.4%), with particularly notable improvements in medication adherence (89.2%) and lifestyle adherence (83.8%) ($P < 0.05$). The disease knowledge score (83.51 ± 8.15) and overall awareness rate (83.51%) in the intervention group were significantly higher than those in the control group (66.05 ± 7.18 and 64.61%, respectively) ($P < 0.05$). The satisfaction rate in the intervention group (100%) was also higher than that in the control group (97.37%) ($P < 0.05$), with major advantages in dimensions such as the practicality of educational content and the timeliness of consultation responses, consistent with previous research.[13]

Mechanism Analysis of How the Internet Plus Health Education Model Improves Patient Outcomes

1. Addressing the limitations of conventional health education: Conventional health education is mainly delivered through one-time or short-term guidance during hospitalisation and lacks continuity. In contrast, the internet plus health education model enables long-term dynamic health guidance through a WeChat mini programme. Patients can access educational materials at any time, and nurses regularly push personalised content, overcoming the interruption of education after discharge. In addition, interactive features of the platform, such as online consultations and peer communication, meet patients' individual needs and enhance the relevance and acceptance of educational content.[14]
2. The scientific guiding role of the KAP theoretical framework: This study was guided by the KAP theory in designing the intervention content. Through the knowledge education module, patients' disease awareness was enhanced; through the attitude guidance module, positive attitudes towards treatment were fostered; and ultimately, the behavioural intervention module promoted the development of healthy behaviours. This progressive KAP intervention aligns with the patterns of health behaviour change in patients and helps fundamentally improve treatment adherence.[15,16] For example, after understanding the risks of missing anti-tuberculosis medication (knowledge), patients develop the attitude that timely medication is key to a cure, which in turn leads them to actively log their medication intake (behaviour), creating a positive cycle.
3. Unique advantages of the WeChat platform: As a widely used social platform, WeChat is easy to operate and does not require additional app downloads, lowering the barrier to use, especially for middle-aged and elderly patients. The platform's notification functions enable follow-up and medication reminders, reducing missed appointments and doses due to forgetfulness.[5] Furthermore, the peer communication module provides emotional support, alleviating the loneliness and anxiety caused by the disease and boosting patients' confidence in treatment. This aligns with previous research findings that social support can improve adherence in patients with chronic diseases.[17]

Study Limitations

1. Limited sample size and scope: This study included only 75 patients from a single hospital in Beijing. The small sample size and urban focus may limit the generalisability of the findings to rural areas or other hospitals. Future multicentre, large-sample studies are needed to validate the intervention effects.
2. Short follow-up period: The intervention lasted only 6 months, making it impossible to assess the long-term effects of the internet plus health education model on treatment adherence (eg over 1 year or more) or disease recurrence rates. Longer-term follow-up is needed.
3. Limitations in outcome assessment: Although a multi-dimensional approach was used to assess treatment adherence, reliance on self-reporting and follow-up records may introduce information bias. Objective indicators, such as blood drug concentration monitoring, were not included to assess medication adherence. Future studies could incorporate such objective measures to improve assessment accuracy.

Comparison with Other Studies and Implications

Previous studies on the internet plus health education model for patients with breast cancer and lung tumours have shown that it can substantially improve patient knowledge levels and adherence.[5,6] This study reached similar conclusions in patients with PTB, further confirming the model's applicability in chronic disease management. However, unlike other diseases, tuberculosis is infectious and its health education must emphasise disinfection, isolation and transmission prevention. This study specifically included a preventive measures education module in the intervention, aligning with the disease's characteristics and providing a reference for health education in other infectious diseases.

Additionally, some research suggests that the effectiveness of the internet plus health education model is influenced by patients' digital literacy.[18,19] The patients in this study were all proficient in using smartphones, which may have introduced selection bias. Future efforts should focus on patients with lower digital literacy by simplifying platform operations and providing one-to-one guidance to ensure the equity and accessibility of the intervention.

Conclusion

The internet plus health education model based on WeChat mini programmes shows potential to effectively improve treatment adherence, disease knowledge acquisition, and patient satisfaction among patients with tuberculosis. This model is operationally convenient and cost-effective, suggesting promising application prospects in clinical tuberculosis care. However, this study has limitations, including a small sample size and a short follow-up period. The generalisability and long-term efficacy of the findings require validation through additional high-quality research. Future research can optimise study designs by expanding sample sizes, extending follow-up periods, and incorporating multicentre approaches. Concurrently, exploring the integration of artificial intelligence technologies (eg, ChatGPT) to deliver personalised health education content could further enhance intervention effectiveness and provide stronger support for tuberculosis prevention and control efforts.

Data Sharing Statement

All data generated or analyzed during this study are included in the article.

Ethics Approval and Consent to Participate

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

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Disclosure

The authors report no conflicts of interest in this work.

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