

Determinants of tuberculosis treatment adherence through information, motivation, and behavioural skills: a study of TB patients in Serdang Bedagai

Nixson Manurung, Sarida Surya Manurung, Rostinah Manurung

Universitas Imelda Medan, Medan, Indonesia

Article Info

Article history:

Received Mar 10, 2026

Revised May 27, 2026

Accepted Jul 12, 2026

Keywords:

IMB model

Non-adherence

Revealing

Treatment failure

Tuberculosis

ABSTRACT

Patient non-compliance in undergoing treatment can increase the risk of therapy failure, transmission, and drug resistance. To analyse the treatment adherence strategies of tuberculosis patients through the information, motivation, behavioural skills (IMB) approach. The research uses a quantitative approach with a cross-sectional design. The research sample consists of tuberculosis patients in Serdang Bedagai Regency who were selected using the cluster random sampling technique at several community health centers. Data were collected using a questionnaire based on the variables of information, motivation, and behavioural skills, and then analysed by using structural equation modelling (SEM). The indicators of non-compliance are divided into three main components. The information component includes understanding tuberculosis, increasing nutritional intake, and cough and sneeze etiquette; the motivation component includes exercise and sunbathing, social interaction, and family support; the behavioural skill component includes regular control, mask use, sputum disposal etiquette, and medication schedules. The main findings indicate that information and motivation influence behavioural skills, with the impact of information being stronger than that of motivation. This study concludes that the IMB approach can be used as a basis for strategies to improve medication adherence among tuberculosis patients through the reinforcement of accurate information, sustained motivation, and the formation of regular medication behaviour.

This is an open access article under the [CC BY-SA](#) license.



Corresponding Author:

Nixson Manurung

Universitas Imelda Medan

Medan, Indonesia

Email: nixsonmanurung@gmail.com

1. INTRODUCTION

Tuberculosis remains a serious public health issue because it affects morbidity, mortality, productivity, and the quality of life of patients. This issue aligns with the sustainable development goals agenda, which places health as an important part of sustainable human development. WHO reports that tuberculosis is one of the leading causes of death due to infectious agents, and Indonesia remains among the countries with a high tuberculosis (TB) burden.

The government has implemented various programs, such as directly observed treatment (DOTS), find, treat, and cure tuberculosis/Temukan Obati Sampai Sembuh Tuberkulosis (TOSS TB), strengthening drug intake supervisor/pengawas menelan obat (PMO), and integrating TB services through healthcare facilities [1]-[3]. The DOTS strategy has proven to remain relevant in TB treatment, but its implementation can face obstacles such as costs, human resources, service access, and the burden of routine visits for patients

[4]-[7]. In the context of North Sumatra, the achievement of case detection and treatment adherence still shows issues that need serious attention.

The data presented in the manuscript indicate that Serdang Bedagai Regency has a relatively high burden of TB cases. Non-adherence to TB medication is influenced by several factors, including drug side effects, a perceived sense of recovery, forgetfulness, economic constraints, limited access to healthcare services, and social stigma. These findings highlight that adherence to TB treatment should be viewed not only as a medical issue but also as a health behavior issue shaped by patients' information, motivation, and behavioral skills.

This research is important because the success of tuberculosis therapy highly depends on the patient's adherence to regularly and completely consuming the medication. Irregularity in treatment can lead to therapy failure, relapse, continuous transmission, and the risk of drug-resistant tuberculosis [8]. The literature shows that TB treatment adherence is influenced by education, perception, socioeconomic status, the role of healthcare workers, access to services, and family support [2], [9]-[11]. Providing health information, health promotion, social support, and behaviour change communication also plays a role in improving TB patient adherence [5], [12]-[15].

Several studies emphasise that knowledge, physical and psychological pressure, cultural beliefs, work disruptions, and health system challenges can influence TB patients' treatment behaviour [15]-[18]. Adherence itself is a complex behaviour related to the patient's ability to follow therapy recommendations, maintain a healthy lifestyle, and adhere to medication rules [19]. Therefore, adherence interventions need to combine elements of information, motivation, and behavioural skills in a targeted manner [10], [19]-[22].

A quantitative approach is necessary to objectively test the relationships between these variables and to provide a basis for strategies that can be used to strengthen the TB program in Serdang Bedagai Regency. This study uses the information, motivation, and behavioural skills (IMB) model as the basis for analysing tuberculosis patients' treatment adherence. The IMB model explains that health behaviour change is formed through three main components, namely accurate information, strong motivation, and adequate behavioural skills.

In the context of TB, information includes the patient's understanding of the disease, treatment, transmission, side effects of the medication, and the consequences if the treatment is stopped prematurely [23]. Motivation includes the internal drive of the patient, family support, social acceptance, and the belief that treatment needs to be completed until recovery. Behavioural skills include the patient's ability to manage their medication schedule, routine check-ups, use of masks, apply cough etiquette, and properly dispose of phlegm. Previous research has shown that the IMB model has been used in HIV prevention interventions, antiretroviral medication adherence, smoking prevention, and substance abuse prevention [24]. However, the application of the IMB model to formulate the determinants of TB treatment adherence in Serdang Bedagai Regency still needs to be studied more specifically.

2. METHOD

This study uses a quantitative approach with a cross-sectional design. The study aims to measure the relationship between the variables of information, motivation, and behavioural skills on the medication adherence of tuberculosis patients at a single point in time of data collection. The research was conducted in Serdang Bedagai Regency, North Sumatra, because this area has a relatively high number of TB patients and shows issues with treatment adherence that are relevant to the focus of the study. The research population consists of all TB patients in Serdang Bedagai Regency, recorded as 3,447 patients during the period from 2016 to 2020. The research sample was taken using the probability sampling technique with a cluster random sampling approach. From 20 community health centers, 6 were selected through a lottery system, with a composition of 2 centers categorised as high TB prevalence, 2 centers categorised as medium, and 2 centers categorised as low. The number of respondents analysed was 230 TB patients, with characteristics including age, gender, occupation, marital status, and treatment category.

The research instrument used a structured questionnaire based on the IMB approach. The questionnaire contained items that measured three main constructs: information, motivation, and behavioural skills in TB treatment adherence. The information construct included respondents' understanding of TB disease, treatment duration, transmission, disease impact, visit schedule, medication schedule, medication side effects, and the importance of completing treatment. The motivation construct included information support, reward support, instrumental support, financial support, sources of support, social interaction, barriers during treatment, reasons for adhering to treatment, motivation to recover, family roles, and family coping mechanisms. The behavioural skills construct included respondents' ability to perform behaviours that support recovery, such as managing medication schedules, increasing nutritional intake, undergoing regular check-ups, using masks, applying cough and sneeze etiquette, and properly disposing of sputum. Each item

in the questionnaire is designed to measure the level of adherence based on the indicators established in the IMB model. Adherence measurement is categorised as good if the score reaches 75% or more, while a score below 75% is categorised as poor. Before being used in the main data collection, the questionnaire was tested on 40 respondents with characteristics similar to the research sample. The initial test results indicate that the instrument meets the validity requirements with a significance level of 5% and a validity value greater than 0.312. The initial reliability test also shows that the Cronbach's Alpha value for the information variable is 0.833, for the motivation variable is 0.825, and for the behavioural skill variable is 0.815, making the questionnaire suitable for use in the main data collection.

The stages of data collection were carried out systematically. The first stage is the identification of research variables, namely information, motivation, and behavioural skills as the basis for explaining TB patients' treatment adherence. The second stage is the determination of research subjects, namely TB patients who are in the intensive treatment phase or the continuation phase at selected community health centers. The third stage is the selection of cluster locations through community health centers that have been grouped based on the number of TB patients: high, medium, and low. The fourth stage is providing an explanation to potential respondents regarding the purpose of the research, the benefits of the research, data confidentiality, and the respondents' right to agree or disagree to participate. The fifth stage is the completion of the consent form or informed consent by respondents who are willing to participate in the research. The sixth stage is data collection using a structured questionnaire filled out based on respondents' answers regarding information, motivation, and behavioural skills in undergoing TB treatment. The seventh stage is checking the completeness of the answers, assigning data codes, and preparing the data for analysis. The eighth stage is data processing using the partial least square-based structural equation model (SEM-PLS) approach to test the relationships between variables in the IMB model. The data analysis technique uses SEM-PLS because this research examines the relationships between latent constructs and their indicators, as well as the relationships between variables in the TB treatment adherence model.

3. RESULT

This study used 230 people with tuberculosis and still in treatment. Details can be seen in Table 1. Studies respondents showed that based on age traits, tuberculosis patients were maximum inside the 51-60 category as many as 67 human beings or 29.1% and the bottom had been in the 31-40 class as many as 36 humans or 15.6%. Based on intercourse traits, the most male intercourse becomes 166 humans or 72.2%, at the same time as the female intercourse turned into 64 people or 27.8%.

Primarily based at the traits of the paintings, the most tuberculosis sufferers are self-employed such as farmers/fishermen/ranchers/laborers as many as a hundred and forty-four humans or 62.6% and the bottom within the class of no longer running as many as 9 people or 3.9%. Primarily based on the reputed characteristics, tuberculosis patients are most in marital popularity as many as 162 people or 70.4% and the bottom class with scholar fame or college students as many as 18 people or 7.8%. Primarily based at the remedy traits of all tuberculosis patients who have been respondents on this study inside the remedy class one as many as 230 human beings or 100%.

Table 1. Informant demographic data

Characteristics	Category	Amount (n)	Percentage (%)
Age	<30	38	16.5
	31-40	36	15.6
	41-50	51	22.2
	51-60	67	29.1
	>60	38	16.5
	Total	230	100
Gender	Male	166	72.2
	Female	64	27.8
	Total	230	100
Employee	Teacher/lecturer/civil servant	19	8.3
	Unemployment	9	3.9
	Self-employed	144	62.6
	Housewife	40	17.4
	College/student	18	7.8
	Total	230	100
Status	Married	162	70.4
	Widow	50	21.8
	College/student	18	7.8
	Total	230	100
Treatment	Category I	230	100
	Category II	0	0
	Total	230	100

3.1. Outer model

In this study, the outer model tests whether the indicators on the variables of information, motivation, and behavioural skill are suitable for measuring the construct of medication adherence in tuberculosis patients. The results of the convergent validity test show that all indicators have a loading factor value above 0.6. This value indicates that each indicator is capable of representing the measured variable. Discriminant validity also shows good results. The AVE value for the behavioural skill variable is 0.523, for information is 0.614, and for motivation is 0.594. All of these values are above the threshold of 0.5. This means that each construct has a sufficient ability to explain its own indicators compared to other constructs. The cross-loading results also show that each indicator has a stronger value on the appropriate construct. Thus, the indicators for the information variable more accurately measure the aspect of information, the indicators for motivation more accurately measure the aspect of motivation, and the indicators for behavioural skill more accurately measure behavioural skills. These results confirm that each variable in the model has clear conceptual boundaries and does not overlap in measurement.

Figure 1 shows the outer measurement model, including the indicator loadings, the relationships among the latent constructs, and the R^2 value for the endogenous construct. The reliability of the instrument also meets the established criteria. The composite reliability values for behavioural skill are 0.812, for information 0.826, and for motivation 0.811. All these values are above 0.7, so the constructs in the model can be considered reliable. The Cronbach's Alpha test also supports these results, with behavioural skill at 0.734, information at 0.701, and motivation at 0.717. Based on the results of validity and reliability, the outer model in this study can be declared to meet the measurement criteria. In other words, the measurement model is suitable for continuing the analysis at the inner model stage.

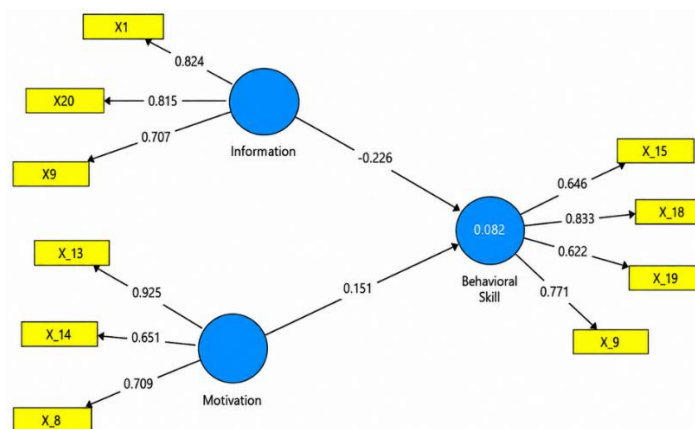


Figure 1. Outer model

3.2. Inner model

The inner model is used to assess the structural relationships between latent variables in the research. In this study, the inner model examines the influence of information and motivation on the behavioural skills of tuberculosis patients' medication adherence. Before assessing the influence between variables, a multicollinearity test was conducted to ensure that there is no excessively high correlation between the independent variables. The VIF test results show that the value of information on behavioural skill is 1.014 and the value of motivation on behavioural skill is 1.014. These values are less than the threshold of 5, indicating that there is no multicollinearity issue. This means that information and motivation can be used simultaneously in the model without causing disturbances in the relationships between independent variables. Thus, the structural model is worthy of further analysis to see the strength of the influence of both variables on behavioural skill.

The R-square results show that the behavioural skill variable has an R-square value of 0.082 and an Adjusted R-square of 0.074. This value indicates that the variables of information and motivation can explain changes in behavioural skill by 8.2%. Meanwhile, the remaining factors are influenced by other elements outside the research model. Substantively, these results indicate that information and motivation do play a role in shaping the behavioural skills of TB treatment adherence, but their contribution is still limited. This may occur because TB treatment adherence can also be influenced by other factors, such as access to healthcare services, family support, economic conditions, medication side effects, distance to healthcare facilities, stigma, and experiences during treatment.

The model fit results show an NFI value of 0.467. In the research manuscript, an NFI value greater than 0.1 is considered to indicate that the model is acceptable. Based on these criteria, the structural model can be used to explain the relationship between information, motivation, and behavioural skill. The direct effect results show that information has a greater influence on behavioural skill compared to motivation. The influence value of information on behavioural skill is 3.326, while the influence value of motivation on behavioural skill is 2.049. These findings indicate that the increase in information is a more dominant factor in shaping the behavioural skills of TB patients' treatment adherence. The most significant information is related to the understanding of tuberculosis, increased nutritional intake, and cough and sneeze etiquette. Meanwhile, motivation continues to play a role in improving adherence, especially through exercise and sunbathing, social interaction, and family support.

Based on the overall results of the outer model and inner model, the IMB model in this study can be used to explain the treatment adherence strategies of tuberculosis patients in Serdang Bedagai Regency. The outer model shows that the indicators used are valid and reliable for measuring the constructs of information, motivation, and behavioural skill. The inner model indicates that information and motivation influence behavioural skill, although the explanatory power of the model is still low. The most important finding is that information has a stronger influence compared to motivation. Therefore, strategies to improve TB treatment adherence need to place patient education as a primary component. The education needs to include an understanding of TB disease, the benefits of complete treatment, the risks of treatment interruption, management of side effects, medication schedules, cough etiquette, mask usage, and regular check-ups. Motivation needs to be reinforced through family support, healthcare worker support, and a social environment that does not stigmatise TB patients.

As shown in Figure 2, it can be explained that the variable records observed 3 indicators, specifically X1 (drug side consequences) with a price of 7,043, X20 (nutrients) with a price of 6,407 and X9 (ailment effect) with a cost of 4,818. In the motivation variable, there had been three indicators X13 (provider distance) with a cost of 3,924, X14 (network guide) with a value of 2,426 and X8 (family aid) with a value of 3,139. Within the behavioral ability variable, there are four signs with X15 (control schedule) with a price of 4,624, X18 (masks use) with a value of 10,570, X19 (phlegm disposal ethics) with a value of 4,108 and X9 (medicine time table) with a fee of 8,726.

It could be defined that the best affect is proven in the influence of variable information on behavioral talents with a cost of 3.326 and the most dominant indicator in influencing statistics is X1 then followed by means of X20 and eventually is X9. Then the second largest influence is the influence of motivation variables on behavioral abilities with a cost of 2.049 with the maximum dominant indicator X13 then X8 and finally X14. In endogenous variables, namely behavioral skill signs whose most dominant impact is X18, then accompanied through X9, then X15, and eventually X19. Based totally on these outcomes and outlines, it may be concluded that the entire model in this variable has a fantastic route coefficient price. This can be known because the extra the price of the route coefficient, the more potent the have an effect on or dating among the impartial variable and the dependent variable.

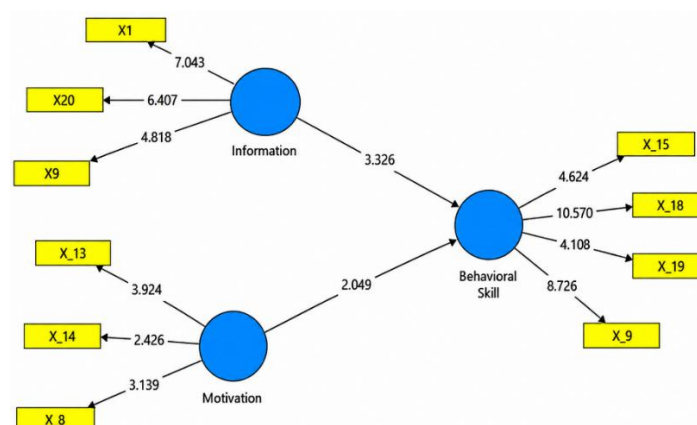


Figure 2. Inner model

The results of the direct effect test show that the information variable has a significant effect on behavioural skill. This is evident from the t-statistic value of 3.326 and a p-value of 0.001. Since the t-statistic value is greater than 1.96 and the p-value is less than 0.05, the hypothesis stating that information affects behavioural skill can be accepted. However, the original sample value of -0.226 indicates a negative

direction of the relationship. Statistically, this means that changes in the information variable are significantly related to changes in behavioural skills, but the direction of the relationship is opposite. If the information score is arranged as a positive score, then an increase in information is actually related to a decrease in behavioural skills. However, if the information items are coded as indicators of risk or non-compliance, then a negative coefficient can mean that the lower the information problem, the better the patient's behavioural skills. Therefore, the direction of this coefficient needs to be carefully explained according to the questionnaire scoring system.

The results of the direct effect test also show that the motivation variable has a significant effect on behavioural skill. The t-statistic value of 2.049 and the p-value of 0.041 indicate that the relationship is statistically significant. Because the p-value is less than 0.05, the hypothesis stating that motivation affects behavioural skill can be accepted. The original sample value of 0.151 indicates a positive relationship direction. This means that the higher the patient's motivation, the better the behavioural skills that support medication adherence. In the context of TB treatment, motivation can encourage patients to be more regular with check-ups, more disciplined in taking medication, better at managing obstacles, and more consistent in practicing transmission prevention behaviours.

If compared based on the t-statistic value, the influence of information on behavioural skill is stronger than the influence of motivation on behavioural skill. The t-statistic value of information is 3.326, which is higher than the t-statistic value of motivation at 2.049. This indicates that the information aspect is a more statistically dominant factor in explaining the behavioural skills of TB treatment adherence. However, when looking at the path coefficient values, information has a coefficient of -0.226, while motivation has a coefficient of 0.151. This difference in direction needs to be an important point of discussion. Researchers need to double-check whether the information items are scored positively or negatively. Errors in reading the direction of the coefficients can lead to misinterpretation of the research results. Overall, the statistical results indicate that the IMB model can be used to explain the treatment adherence of tuberculosis patients through the variables of information, motivation, and behavioural skill. The research instruments have proven to be valid and reliable.

The relationships between variables are also statistically significant. Information and motivation have been proven to influence behavioural skills. However, the explanatory power of the model is still low because the R square value is only 8.2 percent and the Q square is only 2.9 percent. Therefore, the results of this study support the importance of patient education and motivation, but also indicate that TB treatment adherence cannot be sufficiently explained by just these two factors. Strategies to improve adherence need to continue incorporating other factors, such as family support, access to services, the role of PMO, drug side effects, stigma, and the patient's socio-economic conditions.

4. DISCUSSION

Accelerated remedy adherence to tuberculosis patients' method efforts to encourage tuberculosis patients to take remedy frequently actively until declared cured [16]. Enhancing adherence ought to be achieved proactively thru identifying feasible boundaries at some point of treatment and making plans how to overcome them perfectly. Increasing treatment adherence in tuberculosis patients can manage and reduce the occurrence of tuberculosis so that it has an impact on improving the first-class of community biology. Tuberculosis manipulate is all health struggles that prioritize promoting and prevention without neglecting healing and rehabilitative to shield the people, lessen morbidity, lessen demise and incapacity, smash the chain of transmission, prevent treatment resistance, and decrease the poor effects experienced by means of residents because of tuberculosis. Tuberculosis manipulate must be achieved collectively by means of related to all tiers of people, medical examiners, community agencies, religion organizations, government, and debris. All must synergize to jointly use the intention of eradicating tuberculosis [16].

The research findings identified ten main indicators divided into three constructs: information, motivation, and behavioural skill. In the information construct, the indicators that emerged are understanding of TB, increased nutritional intake, and cough and sneeze etiquette. In the motivation construct, the indicators that emerged are exercise and sunbathing, community interaction, and family support. In the behavioural skill construct, the indicators that emerged are regular check-ups, routine mask-wearing, sputum disposal etiquette, and medication schedules. These findings answer the research question about the indicators that shape TB treatment adherence through the IMB model. Theoretically, these results align with Fisher and Fisher's idea that complex health behaviours require adequate information, strong motivation, and behavioural skills that can be executed by individuals. These results also support the literature stating that adherence is a complex behaviour that requires interventions in the aspects of information, motivation, and patient behavioural skills. Thus, the results of this study reinforce the position of the IMB model as an

appropriate analytical framework for understanding TB treatment adherence, particularly in contexts with significant behavioural and social barriers such as Serdang Bedagai.

The influence of information on behavioural skills was addressed through statistical tests that showed information has a significant impact on behavioural skills. The t-statistic value of 3.326 and the p-value of 0.001 indicate that this influence is statistically significant. These findings mean that information plays an important role in shaping the patients' ability to engage in behaviours that support medication adherence. The strongest indicator in the information construct is the understanding of tuberculosis with a value of 7.043, followed by an increase in nutritional intake of 6.407, and cough and sneeze etiquette of 4.818. Substantively, these findings indicate that patients who understand TB, the goals of treatment, the risks of treatment interruption, ways to prevent transmission, and the importance of maintaining their physical condition will be more prepared to correctly follow treatment behaviours. These results are in line with Putera *et al.* [25] who stated that knowledge affects the regularity of TB patients' medication adherence. This finding is also consistent who emphasised that adherence information needs to be directed at the knowledge gaps of patients, particularly regarding the disease, treatment, transmission, drug side effects, and drug interactions. Moreover, these results support the views of [14] that communication of behaviour change plays a crucial role in the prevention and treatment of TB. However, the direction of the information coefficient in the statistical results is negative, namely -0.226. This needs to be read carefully according to the questionnaire scoring system. If the information score is arranged as an indicator of non-compliance or lack of information, then a negative coefficient can be interpreted as meaning that the lower the information problem, the better the behavioural skills of the subject. Thus, these results still highlight the importance of information reinforcement, but the researchers need to clarify the scoring direction so that readers do not misinterpret the statistical relationship.

The influence of motivation on behavioural skills is also addressed through the results of statistical tests. The t-statistic value of 2.049 and the p-value of 0.041 indicate that motivation has a significant effect on behavioural skills. The path coefficient value of 0.151 shows a positive relationship direction. This means that the better the motivation of the patients, the better the behavioural skills that support medication adherence. In the context of this research, motivation is not only understood as a personal drive to recover but also includes family support, social interactions, exercise, sunbathing, and environmental acceptance. The strongest indicators of motivation are exercise and sunbathing with a value of 3.924, followed by family support at 3.139, and community interaction at 2.426. These findings are in line with [5], [12], [13], who emphasise that family support and social environment can shape social support for TB patients. These findings also reinforce which show that psycho-emotional and socio-economic interventions are important for supporting treatment adherence. In this study, motivation proved to be significant, but its influence was smaller compared to information. This indicates that TB patients may need social and family encouragement, but such encouragement is not sufficient without a proper understanding of the disease and treatment. In other words, motivation works more effectively when patients have clear information about why treatment must be completed and how treatment behaviour should be carried out. This result is also consistent with the IMB framework, which places motivation as one of the important components in health behaviour change, but not the only determining factor of behaviour.

The role of behavioural skills as a result of the influence of information and motivation. In this study, behavioural skills are reflected through four indicators, namely regular control, routine use of masks, etiquette for spitting, and medication schedule. The strongest indicator is the routine use of masks with a value of 10.570, followed by the medication schedule at 8.726, regular control at 4.624, and spitting etiquette at 4.108. These findings indicate that TB treatment adherence is not only measured by taking medication but also by the patient's ability to engage in transmission prevention behaviours and health monitoring. The important meaning of this finding lies in the expansion of the concept of adherence. Adherence is not solely measured by whether the patient takes the medication or not. Adherence also needs to be viewed from the patient's ability to maintain schedules, conduct controls, use masks, and apply transmission prevention ethics. This is in line with [19], who view adherence as behaviour in following medication rules and healthy lifestyle patterns according to therapy recommendations. These findings also support [8], who identified non-compliance as one of the serious issues in TB control. Thus, the contribution of this research is to provide a clearer operational framework on how TB adherence can be understood through concrete behaviours. This result is important for the development of public health science because it connects the psychosocial construct of IMB with observable action indicators in TB programs.

The research results show that the influence of information on behavioural skills is greater than that of motivation, namely 3.326 compared to 2.049. This means that the compliance strategy in Serdang Bedagai needs to prioritise patient education as the main entry point. The education needs to emphasise understanding TB disease, the importance of completing the medication, managing side effects, the risk of drug resistance, nutrition, cough etiquette, and prevention of transmission. After the information is reinforced, motivation needs to be built through family support, PMO support, social acceptance, and communication that reduces

stigma. This strategy aligns with previous research findings that indicate that increased information and motivation can enhance behavioural skills, as explained by [2], [11]. This strategy is also relevant to the literature that shows that access to services, economic conditions, distance to healthcare facilities, and experiences of relocating can hinder compliance [2], [11]. This strategy needs to be designed as an intervention package that combines education, family motivation, PMO reinforcement, schedule reminders, side effect counselling, and patient behaviour monitoring. The theoretical contribution of this research lies in the use of the IMB model in the context of tuberculosis treatment adherence. Previous literature shows that the IMB model has been widely used in HIV prevention, antiretroviral adherence, smoking cessation, and substance abuse prevention [24]. This study extends the use of the IMB model to the field of TB control, particularly in the aspect of treatment adherence that requires long-term behavioural consistency. The novelty of this research lies in the formulation of a TB patient adherence behaviour strategy involving patients, families, healthcare workers, and policymakers, as well as producing ten IMB-based non-adherence indicators. This research has several limitations that need to be acknowledged; however, these limitations do not diminish the value of the study but rather indicate directions for future research development. Further research can add other variables that are closer to the service conditions and socio-economic status of the patients, as well as test the IMB strategy in the form of direct interventions to see its impact on TB treatment adherence more strongly.

5. CONCLUSION

The adherence to tuberculosis treatment among patients in Serdang Bedagai Regency can be explained through the IMB approach. The main findings indicate that the variables of information and motivation influence the behavioural skills of treatment adherence. The influence of information is stronger than that of motivation, making the information aspect an important factor in shaping compliant treatment behaviour. Relevant information includes understanding TB, the importance of completing treatment, increasing nutritional intake, and cough and sneeze etiquette. Motivation also plays a role through family support, social interaction, exercise, and sunbathing habits. Meanwhile, behavioural skills are evident in the patient's ability to perform routine check-ups, use masks, properly dispose of phlegm, and adhere to the medication schedule.

This research reinforces the use of the IMB model as a framework for understanding TB treatment adherence in a more measurable way. Its theoretical contribution lies in affirming that adherence is not only influenced by medical factors but also by the quality of information, motivational drives, and patients' behavioural skills. Practically, the results of this research can serve as a foundation for developing more targeted TB education strategies at community health centers, focusing on information dissemination and the concrete process of fostering compliant behaviour. These results also provide input for healthcare workers, families, and PMOs to strengthen patient support during the treatment period. Further research is recommended to use a longitudinal design so that changes in adherence behaviour can be observed from the beginning to the end of treatment.

FUNDING INFORMATION

This research did not receive any specific grant from funding agencies in the public, commercial, or not for profit sectors.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Nixson Manurung	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sarida Surya Manurung		✓		✓		✓		✓	✓	✓	✓	✓		
Rostinah Manurung	✓		✓	✓	✓		✓			✓	✓		✓	✓

C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

The author has no conflict of interest to declare.

INFORMED CONSENT

All respondents have been asked for their consent by signing the provided consent form.

ETHICAL APPROVAL

This research has been approved by the Research and Community Service Institute of Universitas Imelda Medan, Medan, Indonesia.

DATA AVAILABILITY

Data is available from the corresponding author upon reasonable request.

REFERENCES

- [1] S. R. Osborne *et al.*, "Beyond the black stump: rapid reviews of health research issues affecting regional, rural and remote Australia," *Medical Journal of Australia*, vol. 213, no. S11, Dec. 2020, doi: 10.5694/mja2.50881.
- [2] Y. Ruru *et al.*, "Factors associated with non-adherence during tuberculosis treatment among patients treated with DOTS strategy in Jayapura, Papua Province, Indonesia," *Global Health Action*, vol. 11, no. 1, Jan. 2018, doi: 10.1080/16549716.2018.1510592.
- [3] S. S. Sajjad, N. Sajid, A. Fatimi, N. Maqbool, N. B. Ansari, and F. Amanullah, "The impact of structured counselling on patient knowledge at a private TB program in Karachi," *Pakistan Journal of Medical Sciences*, vol. 36, no. 1, Nov. 2019, doi: 10.12669/pjms.36.ICON-Suppl.1713.
- [4] R. S. Garfein and R. P. Doshi, "Synchronous and asynchronous video observed therapy (VOT) for tuberculosis treatment adherence monitoring and support," *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*, vol. 17, p. 100098, Dec. 2019, doi: 10.1016/j.jctube.2019.100098.
- [5] X. Li *et al.*, "Effectiveness of comprehensive social support interventions among elderly patients with tuberculosis in communities in China: a community-based trial," *Journal of Epidemiology and Community Health*, vol. 72, no. 5, pp. 369–375, May 2018, doi: 10.1136/jech-2017-209458.
- [6] H. Bhatnagar, "User-experience and patient satisfaction with quality of tuberculosis care in India: A mixed-methods literature review," *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*, vol. 17, p. 100127, Dec. 2019, doi: 10.1016/j.jctube.2019.100127.
- [7] B. Ilievska-Poposka, M. Zakoska, and V. Mitreski, "Evaluation of the directly observed treatment's acceptance by tuberculosis patients in the Republic of Macedonia," *Open Access Macedonian Journal of Medical Sciences*, vol. 6, no. 5, pp. 896–900, May 2018, doi: 10.3889/oamjms.2018.204.
- [8] A. Rondags, A. B. ud. Himawan, J. F. m. Metsemakers, and T. N. u. Kristina, "Factors influencing non-adherence to tuberculosis treatment in Jepara, central Java, Indonesia," *The Southeast Asian Journal of Tropical Medicine and Public Health*, vol. 45, no. 4, pp. 859–868, 2014.
- [9] D. Cadosch, P. Abel zur Wiesch, R. Kouyos, and S. Bonhoeffer, "The role of adherence and retreatment in De Novo Emergence of MDR-TB," *PLOS Computational Biology*, vol. 12, no. 3, p. e1004749, Mar. 2016, doi: 10.1371/journal.pcbi.1004749.
- [10] D. Ajema, T. Shibru, T. Endalew, and S. Gebeyehu, "Level of and associated factors for non-adherence to anti-tuberculosis treatment among tuberculosis patients in Gamo Gofa zone, southern Ethiopia: cross-sectional study," *BMC Public Health*, vol. 20, no. 1, p. 1705, Dec. 2020, doi: 10.1186/s12889-020-09827-7.
- [11] T. T. Woimo, W. K. Yimer, T. Bati, and H. A. Gesesew, "The prevalence and factors associated for anti-tuberculosis treatment non-adherence among pulmonary tuberculosis patients in public health care facilities in South Ethiopia: a cross-sectional study," *BMC Public Health*, vol. 17, no. 1, p. 269, Dec. 2017, doi: 10.1186/s12889-017-4188-9.
- [12] T. Hussain *et al.*, "Prevalence, risk factors and health seeking behaviour of pulmonary tuberculosis in four tribal dominated districts of Odisha: Comparison with studies in other regions of India," *PLoS One*, vol. 15, no. 4, p. e0227083, Apr. 2020, doi: 10.1371/journal.pone.0227083.
- [13] N. Raizada *et al.*, "Catalysing progressive uptake of newer diagnostics by health care providers through outreach and education in four major cities of India," *PLoS One*, vol. 13, no. 3, p. e0193341, Mar. 2018, doi: 10.1371/journal.pone.0193341.
- [14] H. Almossawi, C. Longacre, Y. Pillay, and N. Kak, "A social and behavior change communication framework for addressing delays to appropriate TB care and treatment," *Journal of Lung Health and Diseases*, vol. 3, no. 4, pp. 1–7, 2019, doi: 10.29245/2689-999x/2019/4.1156.
- [15] K. D. Gashu, K. A. Gelaye, and B. Tilahun, "Adherence to TB treatment remains low during continuation phase among adult patients in Northwest Ethiopia," *BMC Infectious Diseases*, vol. 21, no. 1, p. 725, Dec. 2021, doi: 10.1186/s12879-021-06428-6.
- [16] O. Aibana *et al.*, "Patients' perspectives of tuberculosis treatment challenges and barriers to treatment adherence in Ukraine: a qualitative study," *BMJ Open*, vol. 10, no. 1, p. e032027, Jan. 2020, doi: 10.1136/bmjopen-2019-032027.
- [17] A. Ridho *et al.*, "Digital health technologies to improve medication adherence and treatment outcomes in patients with tuberculosis: systematic review of randomized controlled trials," *Journal of Medical Internet Research*, vol. 24, no. 2, p. e33062, Feb. 2022, doi: 10.2196/33062.
- [18] M. Ameri, E. Movahed, and J. Farokhzadian, "Effect of information, motivation, and behavioral skills model on adherence to medication, diet, and physical activity in HIV/AIDS patients: A health promotion strategy," *Journal of Education and Health Promotion*, vol. 9, Jan. 2020, doi: 10.4103/jehp.jehp_188_20.
- [19] L. V. Bonadonna, M. J. Saunders, R. Zegarra, C. Evans, K. Alegria-Flores, and H. Guio, "Why wait? The social determinants underlying tuberculosis diagnostic delay," *PLoS One*, vol. 12, no. 9, p. e0185018, Sep. 2017, doi: 10.1371/journal.pone.0185018.

- [20] L. Du, R. Wu, X. Chen, J. Xu, H. Ji, and L. Zhou, "Role of treatment adherence, doctor-patient trust, and communication in predicting treatment effects among tuberculosis patients: difference between urban and rural areas," *Patient Preference and Adherence*, vol. 14, pp. 2327–2336, Nov. 2020, doi: 10.2147/PPA.S277650.
- [21] Z. S. Nezenega, L. Perimal-Lewis, and A. J. Maeder, "Factors influencing patient adherence to tuberculosis treatment in Ethiopia: a literature review," *International Journal of Environmental Research and Public Health*, vol. 17, no. 15, p. 5626, Aug. 2020, doi: 10.3390/ijerph17155626.
- [22] V. Overbeck *et al.*, "Understanding the impact of pandemics on long-term medication adherence: directly observed therapy in a tuberculosis treatment cohort pre- and post-COVID-19 lockdowns," *BMC Infectious Diseases*, vol. 24, no. 1, p. 1154, Oct. 2024, doi: 10.1186/s12879-024-09994-7.
- [23] N. Pooranangadevi and C. Padmapriyadarsini, "Treatment of tuberculosis and the drug interactions associated with HIV-TB co-infection treatment," *Frontiers in Tropical Diseases*, vol. 3, May 2022, doi: 10.3389/fitd.2022.834013.
- [24] J. D. Fisher and W. A. Fisher, "The perceived AIDS preventative utility of knowing one's partner well meeting presentations view project an information-motivation-behavioural skills model analysis of young adults' sexual behaviour patterns and regulatory requirements for sexual consent," 1996, [Online]. Available: <https://www.researchgate.net/publication/40434779>
- [25] I. Putera, T. A. Pakasi, and E. Karyadi, "Knowledge and perception of tuberculosis and the risk to become treatment default among newly diagnosed pulmonary tuberculosis patients treated in primary health care, East Nusa Tenggara: A retrospective study," *BMC Research Notes*, vol. 8, no. 1, 2015, doi: 10.1186/s13104-015-1209-6.

BIOGRAPHIES OF AUTHORS



Nixson Manurung     is a nursing professor at Universitas Imelda Medan, Medan, Indonesia. He can be contacted at email: nixsonmanurung@gmail.com.



Sarida Surya Manurung     is a tenured professor at Universitas Imelda Medan, Medan, Indonesia. Her research focuses on public health and nursing. She can be contacted at email: saridamanurung6@gmail.com.



Rostinah Manurung     is a tenured professor at Universitas Imelda Medan, Medan, Indonesia. Her research focuses on public health. She can be contacted at email: rostinahmanurung@gmail.com.