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Evaluating the Impact of a Pharmacist-Led Educational Intervention in Enhancing Pulmonary Tuberculosis Awareness in Malaysia

Rabbiya Ahmad[1], Siti Maisharah Sheikh Ghadzi[1], Araj Hussain[2], Syed Azhar Syed Sulaiman[1], Irfan Ali Bin Hyder Ali[3], Amer Hayat Khan[1*,]

1 Discipline of Clinical Pharmacy, School of Pharmaceutical Sciences, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia.

2 Bilawal Medical College, Jamshoro, Pakistan

3 Respiratory Department, Hospital Pulau Pinang, Ministry of Health Malaysia, Jalan Residensi, George Town, 10460, Penang, Malaysia.

Corresponding author

Dr. Amer Hayat Khan

Department of Clinical Pharmacy,

School of Pharmaceutical Sciences,

Universiti Sains Malaysia.

Email: amerhayatkhan777@gmail.com

Abstract

Objective:

Pulmonary tuberculosis (PTB) remains a significant public health challenge. This study aimed to evaluate the effectiveness of a pharmacist-led educational intervention in improving disease awareness among PTB patients in Malaysia.

Methodology:

A randomized controlled trial (RCT) was conducted with 206 PTB patients, divided into control and intervention groups. The intervention group received a structured, pharmacist-led educational program, while the control group received standard care. Disease knowledge was assessed at baseline and at completion using a questionnaire covering TB transmission, symptoms, treatment, and prevention measures. Univariate and multivariate linear regression analyses were used to examine associations between patient characteristics and disease knowledge.

Results:

At baseline, participants in the intervention group demonstrated significantly higher TB-related awareness in several domains, including awareness that TB treatment is free (100% vs. 82.5%, $p = 0.01$), understanding of TB prevention measures such as not spitting in public (100% vs. 97.2%, $p = 0.01$), and recognition of key symptoms such as prolonged fever (98.1% vs. 80.6%, $p = 0.01$) and weight loss (96.1% vs. 45.6%, $p = 0.01$). After six months, the intervention group sustained significant improvements across all knowledge domains compared with controls ($p < 0.05$; Cramer's $v = 0.3$, medium effect). Multivariate regression analysis identified gender and smoking status as independent predictors of disease knowledge.

Conclusion:

The pharmacist-led educational intervention significantly improved TB-related awareness, particularly regarding transmission, symptoms, and prevention. These results highlight the effectiveness of such interventions in enhancing patient education and promoting healthier behaviors in PTB management.

Keywords: Pharmacist-led intervention, tuberculosis, disease knowledge, pulmonary tuberculosis, patient education

Introduction

Despite significant advances in TB treatment and control, TB continues to cause substantial morbidity and mortality, particularly among vulnerable populations (1). The World Health Organization (WHO) estimates that TB is responsible for more than 10 million new cases annually, with a substantial proportion of cases in Southeast Asia. Malaysia, like many countries in this region, faces persistent challenges in managing TB, including late diagnosis, treatment non-adherence, and inadequate disease knowledge among patients (2). In this context, effective interventions are crucial to improving patient outcomes, promoting treatment adherence, and enhancing disease prevention strategies.

One of the most promising avenues for improving TB management is the involvement of healthcare professionals who can enhance patient awareness and support treatment regimens (3). Pharmacists, as integral members of the healthcare team, play a pivotal role in patient education, especially in the context of chronic diseases like TB, where adherence to a complex medication regimen is vital for treatment success (4). Clinical pharmacists are uniquely positioned to provide valuable educational interventions that can directly influence patients' understanding of their disease, treatment plan, and the importance of adherence (5).

However, despite this evidence, studies examining the direct impact of pharmacist-led educational interventions on TB disease knowledge remain limited, particularly in the Malaysian context. The primary objective of this study is to assess whether a structured, pharmacist-led education program can significantly increase patients' understanding of PTB compared to standard care.

Method

Study Design

A single-blinded, randomized, controlled, prospective study was conducted to evaluate the awareness regarding the PTB by pharmacist-led educational intervention among people infected with PTB. A simple parallel-group design was employed, consisting of one intervention group and one control group. Eligible participants were adults diagnosed with PTB according to the Malaysian National TB Treatment Guidelines and the WHO-recommended DOT strategy (6). Participants were blinded to their group allocation (single-masked design) to minimize performance bias. Following baseline data collection, the intervention group received structured, pharmacist-led counselling sessions, while the control group continued to receive standard DOT care and routine counselling from nurses. The intervention was based on the HBM and focused on improving disease understanding, addressing perceived barriers, and enhancing motivation and self-efficacy. Treatment adherence and health beliefs were assessed at four time points: baseline, two months, four months, and six months. The trial is registered at ClinicalTrials.gov https://clinicaltrials.gov/:NCT06608069.

Study Area

The study was conducted at the Respiratory Clinic of a Hospital in Malaysia, a major center with a dedicated TB treatment unit.

Inclusion and Exclusion criteria

Patients diagnosed with PTB based on sputum smear microscopy and chest radiography, and currently undergoing first-line anti-TB treatment, were eligible for inclusion. Participants had to be at least 18 years of age, capable of providing informed consent, and physically able to participate in the intervention. Only individuals who could communicate effectively in English were included. Exclusion criteria comprised pregnancy and enrollment in any concurrent clinical trial that could interfere with

study participation. Patients planning to relocate within the next six months, those who were deceased, lost to follow-up, experienced treatment failure, or were transferred to another healthcare facility were also excluded.

Sample Size

The required sample size was calculated using the formula for comparing two population means (7, 8), based on the study's primary objective: to evaluate the impact of a pharmacist-led intervention on awareness among PTB patients. Mean knowledge scores for both control and intervention groups were obtained from previously published literature to inform the effect size used in the calculation (9). To account for potential losses to follow-up, estimated at 5% over the six-month study period (10). The intended sample size was 103 subjects per group over a 6-month study period; the final sample size was 206 patients for both groups.

Randomization and allocation of the Participants

Participants who provided informed consent were enrolled and assigned identification codes. An independent researcher compiled the complete list of eligible participants and entered their information into Microsoft Excel. Randomization was conducted using computer-generated random numbers in Excel to ensure an unbiased allocation of groups. Participants were randomly assigned in a 1:1 ratio to either the intervention or control group. To maintain allocation concealment, a sealed opaque envelope method was used. Each envelope was sequentially numbered and contained a treatment allocation card indicating group assignment. These envelopes were prepared in advance by a researcher not involved in participant recruitment or data collection. Following baseline data collection, the corresponding envelope for each participant was opened to reveal the group allocation. This process ensured that the allocation remained concealed until after baseline assessment, thus minimizing selection bias.

Pharmacist Educational Intervention

The intervention consisted of a structured, pharmacist-led counselling program designed to enhance treatment awareness among people infected with PTB. The educational content was adapted through validated global and national TB guidelines, including those from the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and the Ministry of Health (MOH), Malaysia. Content validation was conducted by a panel comprising three academic researchers with expertise in infectious diseases and two hospital-based clinicians. Face validation was also performed to ensure clarity, cultural appropriateness, and patient comprehension (11). Before implementing the intervention, the pharmacist received formal training through the CDC's Self-Study Modules on TB and the WHO consolidated guidelines on TB (12-17). This training ensured the pharmacist's competency in TB education and patient counselling.

The intervention was delivered through structured, one-on-one counselling sessions at monthly intervals throughout the six-month treatment period.

Study tool

The data was collected through a pre-validated Malay and English language version of the TB knowledge, attitude, practice, and stigma questionnaire, after permission from the author (18). Responses were recorded as '1' for correct answers and '0' for incorrect answers or uncertainty. The highest possible score for knowledge was 25.

Statistical Analysis

This data analysis was done using SPSS version 29. For descriptive statistics, continuous data were expressed as mean ± standard deviation (SD), whereas categorical data were presented as numbers and percentages, i.e., N (%). For the comparison of categorical data between groups, the chi-square test was used to

compare the differences between the two groups. For the primary and secondary interests of analysis, a multivariable regression model analysis was employed to adjust for confounding factors in the statistical effect. A value of $p < 0.05$ was considered statistically significant (19).

Results

Sociodemographic and Clinical characteristics of the participants

Table 1 summarizes the sociodemographic and clinical characteristics of the 206 PTB patients enrolled. Both groups had a comparable gender distribution, with males slightly more represented in the intervention group (51.8%) than in the control group (48.2%). Ethnicity and marital status were well-balanced, although a higher proportion of unmarried patients were included in the control group (71.9%). Underweight status was more prevalent in the control group (72.2%), whereas normal weight was more prevalent in the intervention group (62.7%). The results are explained in Table 1.

Table 1 Sociodemographic characteristics of patients (n = 206)

Categories	Frequency	
	Control Group	Intervention Group
Gender Male Female	68 (48.2) 35 (53.8)	73 (51.8) 30 (46.2)
Age 18-44 45-64 ≥65	33 (54.1) 42 (52.5) 28 (43.1)	28(45.9) 38(47.5) 37(56.9)
Nationality Malay Chinese Indian	40 (50.0) 45 (48.9) 18 (52.9)	40(50.0) 47(51.1) 16(47.1)
Marital Status Married Unmarried	80 (46.0) 23 (71.9)	94(54.0) 9(28.1)
Types of PTB Smear positive Smear negative	71 (552.2) 32 (45.7)	65 (47.8) 3(54.3)
BMI Underweight Normal weight Overweight	39 (72.2) 51 (38.3) 13 (68.4)	15(27.8) 82(62.7) 6(31.6)
HIV Negative Non-reactive Reactive	15(51.7) 87(49.7) 1(50)	14(48.3) 88(50.3) 1(50)
Drug Use Yes No	8(61.5) 95(49.2)	5(38.5) 98(50.8)
Smoking Yes No	37 (57.8) 66 (46.5)	27(42.2) 76(53.5)

Comorbidities		
Pneumonia	19 (57.6)	14 (42.4)
Liver disorder	17 (47.2)	19 (52.8)
Diabetes mellitus	8 (36.4)	14 (63.6)
Hematological disorder	15 (83.3)	3 (2.9)
Malnutrition	6 (85.7)	1 (14.3)
Electrolyte distribution	5 (100)	0 (0)
Gastric disorder	9 (100)	0 (0)
Empyema	6 (100)	0 (0)
Kidney disorder	1 (5.9)	16 (94.1)
Chronic Obstructive Pulmonary Disease	2 (100)	0 (0)
Cardiovascular issue	15 (29.4)	36 (70.6)
Baseline Lung Cavitation		
No cavitation	18 (21.2)	67 (78.8)
Unilateral cavitation	56 (69.1)	25 (30.9)
Bilateral cavitation	29 (72.5)	11 (27.5)

Effect of Pharmacist intervention on Disease knowledge at baseline

At baseline, the intervention group showed significantly better knowledge compared to the control group in several areas. For instance, 94.2% of the intervention group correctly identified that TB treatment is free, compared to 82.5% in the control group (p=0.01). Similarly, the intervention group demonstrated higher awareness of TB prevention measures, with 100% understanding that not spitting everywhere is crucial, compared to 97.2% in the control group (p=0.01). Knowledge about TB symptoms also improved, particularly regarding prolonged fever (98.1% in the intervention group vs. 80.6% in the control group, p=0.01) and weight loss (96.1% vs. 45.6%, p=0.01). The results are discussed in the Table 2.

Table 2: Measure of PTB disease knowledge at baseline

Outcome measures	Control group		Intervention group		*p-value**
	Yes (%)	No (%)	Yes (%)	No (%)	
Knowledge of TB disease					
1. TB is an infectious disease.	67 (65)	36 (35)	77 (74.8)	26 (25.2)	0.1
2. TB is caused by germs.	80 (77.7)	23 (22.3)	86 (83.5)	17 (16.5)	**0.03**
3. TB can be spread through sharing food containers.	84 (81.6)	19 (18.4)	76 (73.8)	27 (26.2)	1
4. The lungs are the part of the body most often attacked by TB.	62 (60.2)	41 (39.8)	60 (58.3)	43 (41.7)	0.5
5. TB disease can be treated.	89 (86.4)	14 (13.6)	97 (94.2)	6 (5.8)	0.4
6. TB can be fatal if not treated properly.	85 (82.5)	18 (17.5)	84 (81.6)	19 (18.4)	0.7
7. TB treatment in this country is free.	85 (82.5)	18 (17.5)	103 (100)	0 (0)	**0.01**
8. Smoking has a relation with having TB.	93 (90.3)	10 (9.7)	103 (100)	0 (0)	0.1
9. The number of TB cases in this country is still high.	90 (87.4)	13 (12.6)	96 (92.3)	7 (6.8)	0.1
10. People infected with HIV easily get TB disease.	59 (57.3)	44 (42.7)	89 (86.4)	14 (13.6)	0.2
11. A balanced diet can reduce TB infection.	89 (86.4)	14 (13.6)	88 (85.4)	15 (14.6)	**0.01**
Symptoms of TB					
1. Sputum production	84 (81.6)	19 (18.4)	82 (79.6)	21 (20.4)	0.7
2. Cough for more than 2 weeks	88 (85.4)	15 (14.6)	62 (60.2)	41 (39.8)	**0.01**
3. Prolonged fever	83 (80.6)	20 (19.4)	101 (98.1)	2 (1.9)	**0.01**
4. Loss of appetite	86 (85.9)	17 (14.1)	76 (80.9)	27 (19.1)	0.2
5. Chest pain	94 (91.3)	9 (8.7)	94 (91.3)	9 (8.7)	**0.01**
6. Fatigue	103 (100)	0 (0)	92 (89.3)	11 (10.7)	**0.01**
7. Lose weight	47 (45.6)	56 (54.4)	99 (96.1)	4 (3.9)	**0.01**
8. Blood in sputum	59 (57.3)	44 (42.7)	98 (95.1)	5 (4.9)	**0.01**
9. Sweating in the evening/night	102 (99.0)	1 (1.0)	83 (85.8)	20 (14.2)	**0.0.1**
Prevention of TB					
1. Cover your mouth or nose if you cough or sneeze	89 (86.4)	14 (13.6)	97 (94.2)	6 (5.8)	**0.04**

2. Opening the windows of the house allows light and air to enter	95 (92.2)	8 (7.8)	94 (91.3)	9 (8.7)	0.1
3. Undergo immediate examination if there are signs and symptoms of TB	94 (91.3)	9 (8.7)	97 (94.2)	6 (5.8)	0.8
4. Not spitting all over the place	94 (97.2)	9 (2.8)	103 (100)	0 (0.0)	**0.01**
5. Stay in a crowded room	93 (90.3)	10 (9.7)	88 (85.4)	15 (14.6)	0.1

*Chi-square

Effect of Pharmacist intervention on Disease knowledge at treatment completion

At the 6-month follow-up, the intervention group demonstrated significant improvements in TB disease knowledge compared to the control group. Key gains included 100% awareness of TB treatment being free (vs. 88.3%, p=0.01, effect size=0.3), and better understanding of TB transmission through sharing food containers (93.3% vs. 11.7%, p=0.01, effect size=0.3). The intervention group also showed improved recognition of TB symptoms, such as prolonged fever (98.1% vs. 91.3%, p=0.01, effect size=0.3) and loss of appetite (91.3% vs. 87.4%, p=0.2, effect size=0.3). Knowledge of prevention measures, including not spitting in public, remained high in the intervention group (100% vs. 92.2%, p=0.01, effect size=0.3). The results are showed in table 3.

Table 3: Measure of PTB disease knowledge on 6th month

Outcome measures	**Control group Mean± SD**		**Intervention group Mean± SD**		***p-value****	**Effect size**
	Yes (%)	No (%)	Yes (%)	No (%)		
Knowledge of TB disease						
1. TB is an infectious disease.	91 (88.3)	12 (11.7)	92 (89.3)	11 (10.7)	0.01	0.1
2. TB is caused by germs.	93 (93.3)	10 (9.7)	92 (89.3)	11 (10.7)	**0.03**	0.3
3. TB can be spread through sharing food containers.	12 (11.7	91 (88.3)	10 (9.7)	93 (93.3)	**0.01**	0.3
4. The lungs are the part of the body most often attacked by TB.	68 (66.0)	35 (34.0)	93 (93.3)	10 (9.7)	0.05	0.3
5. TB disease can be treated.	93 (93.3)	10 (9.7)	103 (100)	0 (0)	0.01	0.1
6. TB can be fatal if not treated properly.	90 (87.4)	13 (87.4)	93 (93.3)	10 (9.7)	0.01	0.3
7. TB treatment in this country is free.	103 (100)	0 (0)	103 (100)	0 (0)	**0.01**	0.3
8. Smoking has no relation with having TB.	103 (100)	0 (0)	103 (100)	0 (0)	0.01	0.3
9. The number of TB cases in this country is still high.	103 (100)	0 (0)	3 (2.9)	100 (97.1)		0.1

10. People infected with HIV easily get TB disease.	93 (93.3)	10 (9.7)	103 (100)	0 (0)	0.01	0.3
11. A balanced diet can reduce TB infection.	93 (93.3)	7 (9.7)	103 (100)	0 (0)	**0.01**	0.3
Symptoms of TB						0.3
1. Sputum production	90 (87.4)	13 (87.4)	96 (91.3)	7 (8.7)	0.01	0.1
2. Cough for more than 2 weeks	90 (87.4)	13 (87.4)	93 (93.3)	10 (9.7)	**0.01**	0.3
3. Prolonged fever	96 (91.3)	7 (8.7)	101 (98.1)	2 (1.9)	**0.01**	0.3
4. Loss of appetite	90 (87.4)	13 (87.4)	96 (91.3)	7 (8.7)	0.2	0.3
5. Chest pain	94 (91.3)	9 (8.7)	96 (91.3)	7 (8.7)	**0.01**	0.1
6. Fatigue	90 (87.4)	13 (87.4)	93 (93.3)	10 (9.7)	**0.01**	0.3
7. Lose weight	103 (100)	0 (0)	103 (100)	0 (0)	**0.01**	0.3
8. Blood in sputum	68 (66.0)	35 (34.0)	99 (96.1)	4 (3.9)	**0.01**	0.3
9. Sweating in the evening/night	59 (57.3)	44 (42.7)	99 (96.1)	4 (3.9)	**0.0.1**	0.1
10. **Prevention from TB**						0.3
11. Cover your mouth or nose if you cough or sneeze	103 (100)	0 (0)	103 (100)	0 (0)	**0.01**	0.3
12. Opening the windows of the house allows light and air to enter	90 (86.4)	13 (13.6)	99 (94.2)	4 (5.8)	**0.01**	0.3
13. Undergo immediate examination if there are signs and symptoms of TB	95 (92.2)	8 (7.8)	99 (94.2)	4 (5.8)	**0.01**	0.2
14. Not spitting all over the place	95 (92.2)	8 (7.8)	103 (100)	0 (0.0)	**0.01**	0.2
15. Stay in a crowded room	95 (92.2)	8 (7.8)	103 (100)	0 (0.0)	**0.01**	0.3

*Chi-square test. Effect size is measured by Cramer's v test. The criteria for effect size are small effect is around 0.10, medium is 0.30, and large is 0.50.

Multivariate Regression Analysis by Patients' Characteristics

The multivariate linear regression analysis revealed significant associations between disease knowledge and patient characteristics in both the control and intervention groups. In the control group, smoking status was a significant predictor of disease knowledge, with smokers showing better knowledge compared to non-smokers (β = 0.9, p = 0.01). Additionally, gender was significantly associated with disease knowledge in both groups; males had higher knowledge scores than females in both the control (β = 1.3, p = 0.05) and intervention groups (β = 1.5, p = 0.05). The results are explained in table 4.

Table 4: Association between Disease knowledge and patients' characteristics using multivariate linear regression

Variables	Control Group Multivariate Linear Regression		Intervention Group Multivariate Linear Regression	
	Unstandardized β [95%CI)	***p*-value**	**Unstandardized β [95%CI)**	***p*-value**
Gender				
Male vs Female	1.3 (0.2-1.6)	**0.05**	1.5 (0.8-1.8)	**0.05**
Age				
18-44 vs 45-64	Not applied	-	0.03 (-0.1-2.2)	0.6
18-44 vs ≥65	Not applied	-	0.04 (-0.6-2.9)	0.5
Marital Status				
Married vs Unmarried	Not applied	-	0.2 (-0.3-0.5)	0.2
HIV				
Non-reactive vs Negative	0.6 (-0.1-0.8)	0.2	0.5 (-0.6-0.8)	0.1
Smoking				
Yes, vs No	0.9 (0.4-2.1)	**0.01**	0.4 (0.4-1.2)	**0.01**

BMI: Body Mass Index, Cl: Confidence Interval, Univariate analysis for significant variations with p < 0.2 was included in multivariate linear regression.

Discussion

This study assessed the impact of a pharmacist-led educational intervention on the disease awareness of patients with pulmonary tuberculosis (PTB). The findings fill a critical gap in existing literature, where most TB programs have primarily focused on clinical management, with limited exploration of the pharmacist's role in improving patient knowledge and self-care behaviors. Previous studies have emphasized the importance of health education in TB control; however, evidence on sustained pharmacist-led interventions in resource-limited settings remains scarce.

The results clearly demonstrate that the intervention significantly enhanced patients' awareness across a broad spectrum of TB-related topics, including transmission, treatment, symptoms, and prevention. Both baseline and six-month follow-up assessments confirmed that the pharmacist-led educational intervention was effective in improving and sustaining TB knowledge among participants. These findings support the premise that pharmacists can serve as vital educators within multidisciplinary TB care teams.

When compared to earlier research, the results align with prior evidence showing that pharmacist-led interventions effectively enhance disease-specific knowledge and encourage health-seeking behaviors (20-22). Leech et al. (23) reported that pharmacist-driven education programs improved patients' understanding of their medication regimens in chronic diseases such as cardiovascular disorders, while Cornwall et al. (24) observed that pharmacist-led interventions improved knowledge retention among TB patients. The enhanced recognition of symptoms such as persistent cough and haemoptysis observed in the present study suggests that patients in the intervention group may be more likely to identify TB early and seek prompt medical evaluation. Similar conclusions were drawn by Mutalikdesai et al., who demonstrated that tailored education improved patients' comprehension of key TB symptoms, facilitating earlier diagnosis and treatment initiation. Furthermore, a study in the American Journal of Health-System Pharmacy reported that pharmacist-directed education led to greater adherence to TB treatment compared to usual care (25, 26). Such proactive engagement is essential, as early detection and sustained adherence substantially reduce transmission rates and improve outcomes. Pharmacist counseling in this study likely helped dispel misconceptions, reinforce adherence behaviors, and emphasize the importance of completing therapy to prevent drug resistance.

he studies also examined associations between patient characteristics and disease knowledge using multivariate regression analyses. Males exhibited significantly higher knowledge scores than females in both study groups, suggesting gender-based disparities in health awareness. Similar trends were observed in prior studies conducted in diverse settings, including rural China, where men demonstrated greater TB-related knowledge due to higher literacy levels and improved access to health information (27, 28). A study in rural China indicated that men were more informed than women on TB-related material, including symptoms and treatment alternatives (29). This gap was ascribed to men's superior access to health information and services, together with elevated literacy rates among males in the research region. However, a systematic review found no consistent gender difference in TB knowledge, highlighting contextual and cultural variability (30).

terestingly, smokers also showed higher disease knowledge scores in both groups. Although smoking is generally linked to adverse health outcomes, this finding may reflect more frequent healthcare interactions or exposure to targeted counseling. Comparable results have been reported elsewhere, suggesting that smokers may benefit from increased awareness through cessation programs and routine consultations (31, 32).

The principal strengths of this study include its comprehensive measurement of TB knowledge across multiple domains and the incorporation of effect size analyses to assess the intervention's

practical impact. Medium effect sizes (Cramer's v = 0.2–0.3) affirm the clinical and educational significance of the intervention. However, variations in knowledge gains across specific TB domains suggest that while the intervention was broadly effective, certain areas, such as misconceptions regarding transmission, may require more tailored educational reinforcement. Moreover, the reliance on self-reported data and the single-center design may limit generalizability.

Conclusion

This study aimed to assess the effectiveness of a pharmacist-led educational intervention in improving the disease knowledge of patients with PTB. The results demonstrate that the intervention significantly enhanced patients' understanding of key aspects of TB, including its transmission, symptoms, treatment, and prevention measures. The intervention group showed consistent and substantial improvements across all follow-up periods, with the most notable increases observed in the recognition of TB symptoms, such as prolonged fever, weight loss, and blood in sputum, as well as in prevention practices. Sociodemographic and clinical factors, such as gender, smoking status, and age, influenced disease knowledge, with smoking status and gender being significant predictors of TB knowledge, particularly in the control group. These findings highlight the importance of considering patient characteristics when designing educational interventions.

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Ethical Permission

The Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia (MOH) has provided ethical approval for this study. The approval number is NMRR ID-22-01964-WWH.

Conflict of interest

No competing interest

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Statement of Informed Consent:

Informed consent was obtained for this study.

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