Effects of an Integrated Rehabilitation Program on Fatigue in Patients with Pulmonary Tuberculosis

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ABSTRACT

Objective: This study aimed to assess the effect of a six weeks integrated rehabilitation program on fatigue in pulmonary tuberculosis patients.

Materials and Methods: Sixty-eight participants were diagnosed with pulmonary tuberculosis receiving antituberculosis drugs treated for two weeks or more and have experienced fatigue. Participants were randomly selected into experimental and control groups with 34 participants each. The experimental group received usual care plus an integrated rehabilitation program that consisting of walking exercises (perform at least three times a week, light to moderate intensity and 20-30 min in duration), nutrition education and management of adverse reactions from antituberculosis drugs, and support from healthcare workers through the LINE application for a period of six weeks. The control group received the usual care with given the option to engage in activities to reduce their own fatigue for a period of six weeks. Fatigue symptoms were assessed with PFS-12 at baseline, at week 3 and week 6 and using the Repeated measure ANOVA for statistical analysis.

Results: The study found that the experimental group had a lower mean fatigue score at week 3 than at the baseline. At week 6, the mean fatigue score decreased significantly compared that at the baseline and compared to the control group with statistical significance ($F = 9.698$, $p < .001$), while no statistically significant differences were found in the control group ($F = 1.687$, $p = .200$)

Conclusion: The integrated rehabilitation program statistically and significantly reduced the levels of fatigue in pulmonary tuberculosis in 3-6 weeks.

Registration number: This study was registered at the Thai Clinical Trials Registry (TCTR20221202001).

Keywords: Pulmonary tuberculosis; integrated program; fatigue; line application (Siriraj Med J 2023; 75: 290-298)

INTRODUCTION

Fatigue is a symptom that can be found in patients with pulmonary tuberculosis at up to 88%.[1] This symptom is believed to be caused by chronic inflammatory processes and the functioning of the immune system,[2,3] including adverse reactions from the treatment received by the patient, which can also result in fatigue. Studies have shown that adverse reactions from antituberculosis drugs can directly and indirectly cause fatigue in 53 to 55% of patients.[4,5] Physical and mental factors that contribute to the occurrence of fatigue have also been found, including malnutrition, poor sleep quality, and depression.[1] In addition, studies have found that fatigue was a common symptom in 47% of post-tuberculosis patients.[6] This is caused by scarring of the lung tissue and can lead to limited lung expansion and obstructive

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Received 11 January 2023 Revised 23 February 2023 Accepted 1 March 2023
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https://doi.org/10.33192/smj.v75i4.260846

airway disorders may be observed, or a combination of both in some cases.[7,8] This results in inefficient gas exchange, causes patients to experience shortness of breath or difficulty breathing for a long period of time, thereby resulting in patient fatigue.

According to the review, Fatigue is a symptom that occurs continuously for months or years. This affects long-term lung rehabilitation and also significantly affects the patient's daily functioning and well-being. There are restrictions on activities, dependence on others, deteriorating health, discomfort, boredom, discouragement and hopelessness.[5] Patients might have to take time off work, lose income and feel a decrease in self-esteem. Moreover, if patients feel fatigue during the course of receiving antituberculosis drugs in combination with other adverse reactions, the result may be a decrease in cooperation with medication adherence.[9] Therefore, fatigue is considered an important problem that needs to be corrected before it affects the patient's body, mind, society, and economy. Encouraging patients to deal with their fatigue in the right way is, therefore, very essential for the care of patients with pulmonary tuberculosis.

Integrated rehabilitation programs combine physical and mental care rather than a single program, which covered the management of factors causing fatigue in pulmonary tuberculosis and the program also corresponded with the WHO's guidelines for patient care.[10,11] Based on a review of previous research, there have been no direct studies on the management of fatigue in patients with pulmonary tuberculosis at domestic or international. Thus, the researchers' interest is in studying the effects of an integrated rehabilitation program by applying Dodd's symptom management model,[12] which consists of three interrelated components: symptom experience, symptom management strategies, and symptom management outcomes. In the present study, the program included walking exercises, nutrition education and management of adverse reactions from antituberculosis drugs with support from health care provider and use of the LINE application to monitor patient care and keep up with the 4.0 technology era to achieve comprehensive care and to manage fatigue in patients with pulmonary tuberculosis effectively and sustainably in the long term. The present study aimed to study the effect of a six weeks integrated rehabilitation program on fatigue in pulmonary tuberculosis patients at the outpatient department, an advanced tertiary hospital in Bangkok, Thailand.

MATERIALS AND METHODS

Study design and participants

This study was a single-blind randomized controlled trial. The Study population consist of both male and female patients with pulmonary tuberculosis. Eligible participants were (a) aged at least 18 years old, (b) Who have been treated with anti-TB drugs for 2 weeks or more, (c) And have experienced fatigue (Use the method of asking about the experience of fatigue, For example: feeling tired, lethargic, sluggish, uncomfortable, sleepy all the time, lack of energy, exhaustion, lack of motivation, decreased activity etc.), (d) With ability to continue daily routines for at least 6 minutes without getting tired, (e) Have no restrictions on walking and exercising, (f) And have no cognitive impairment, (g) And are able to use the LINE application, and (h) Are also able to read and write in Thai. The exclusion criteria applied to patients with comorbidities causing simple fatigue, such as Acquired Immune Deficiency Syndrome, Chronic obstructive pulmonary disease, Asthma, Congestive heart failure, Cancer with chemotherapy or radiotherapy, a history of coronavirus disease 2019, and obstructive sleep apnea.

The sample size was calculated using power analysis. The required sample size calculation for repeated measures analysis of variance (ANOVA) test indicated a sample of 68 participants (34 per group), with a power (p) of 0.80, significance level (α) of 0.05, medium effect size (f) of 0.25, and attrition rate of 20%. The researcher prepares for the sampling process by the research assistant who is not involved in this research project is responsible for preparing numbers 1-68 that use a computer program to randomize by specifying which number is group one or group two and packed in a sealed brown envelope prepared, with group one being the control group and group two being the experimental group. After that, the researcher had the sample randomly select an envelope and the researcher opens a sealed brown envelope containing the number and grouped the samples into the control group and the experimental group according to the number inside the envelope. (Fig 1).

Intervention

Both groups received usual care for patients with pulmonary tuberculosis attending the Outpatient. The experimental group received an integrated rehabilitation program created by the researchers based on the application of the pulmonary rehabilitation program and the use of the symptom management model of Dodd. The integrated rehabilitation program has been reviewed for content accuracy, format and language used from five experts. The program consisted of walking exercise, nutrition education and management of adverse reactions from antituberculosis drugs with reinforcement of support from health care provider via the LINE application for

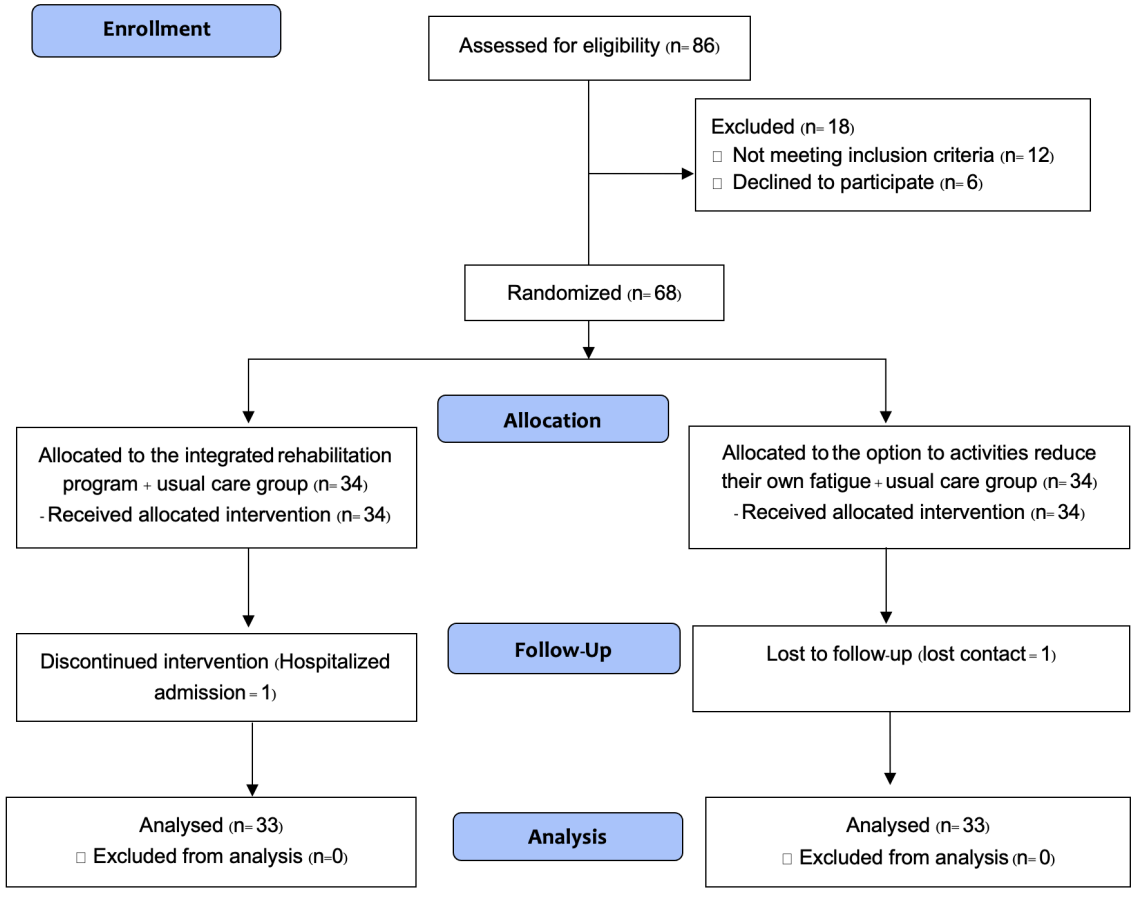

Fig 1. Flow diagram of participant eligibility and randomization process

a period of six weeks. The researchers described fatigue reduction programs and added participants to the TB care LINE account, which includes animated knowledge clips and exercise video clips for participants to study and for training researchers in skills for assessing the intensity of exercise by estimating the percentage of the highest heart rate. Participants were advised to check their pulse rates during the most exhausting periods of exercise, optimal pulse rates were calculated for each patient, and the participants were allowed to practice checking their own pulse rates until they had the confidence to return to practice at home. Furthermore, appropriate exercise goals were set for the participants with a frequency of at least three times a week, light to moderate intensity and a duration of 20-30 minutes. The participants were then given walking diaries. When walking at home as recommended, the participants were instructed to record their walking exercise. At the end of each week, the participants were instructed to send the record of their workout data to the researchers via the TB care LINE account to monitor and assess their walking exercise trends to determine whether or not set goals had been met. After the researchers obtained recorded exercise data from the participants, they sent the messages and stickers of encouragement to the participants. Next, the researchers called to follow up with the participants via the LINE application to inquire about problems. During the week, the participants received infographic knowledge through the TB care LINE account, three times a week, on Monday, Wednesday and Friday at 10 am, to encourage participants to perform their activities and review their knowledge any time.

The control group received a manual "Learning and Understanding Tuberculosis" of the Department of Disease Control. And were given a diary to record the activities they selected to reduce the occurrence of fatigue over a 6-week period.

Outcome measurement

The study outcomes included fatigue (using the Piper Fatigue Scale-12 [PFS-12][13] and the Thai-translated versions).[14] A total of 12 questions were answered via Google FORM via the LINE application for the baseline (T1) and evaluated at Week 3 (T2) and at Week 6 (T3) at the end of the study and demographic characteristics, history of illness and treatment (using the questionnaire developed by the researchers and patient's medical records) Furthermore, to monitor walking exercise adherence

to program (perform at least 3 times a week, light to moderate intensity and 20-30 min in duration), including problems and obstacles in participating in the program.

The PFS-12 tool was tried in 30 patients with similar characteristics to the participants in the present study by using Cronbach's alpha coefficient formula. The reliability value was .90 and the reliability value in the 68 participants in this study was .90.

Statistical analysis

All data analyses were performed using SPSS v.25. Descriptive statistics were used to analyze demographic characteristics and history of illness and treatment, followed by comparison of the differences between the experimental and control groups at baseline by using Chi-square testing or fisher's exact test and independent t-test. Analysis of the differences in mean fatigue scores at baseline, week 3 and week 6 between the experimental and control groups by using repeated measures ANOVA.

RESULTS

Demographic characteristics and history of illness and treatment

Overall, 68 participants completed the baseline. Of these, 1 and 1 from the intervention and control groups withdrew from the study, respectively. In contrast, 66 participants completed at the end of the study (33 and 33 from the experimental and control groups, respectively). Furthermore, there was no difference between the two groups at baseline (Tables 1 & 2).

Comparison of mean fatigue scores of patients with pulmonary tuberculosis at baseline, week 3 and week 6 within groups and between groups

When comparing the differences in mean fatigue scores over time in the experimental group and control groups (within group) at (baseline, week 3 and week 6), the mean fatigue score in the control group had no statistically significant difference when compared over time ($F = 1.687$, $p = .200$). In the experimental group, the mean fatigue scores had statistically significant differences ($F = 29.866$, $p < .001$) when comparing pairwise differences over time in the experimental group, the mean fatigue scores were found to vary in three pairs: The mean fatigue score at week 3 was lower than at baseline (difference of 0.90 points), and the mean fatigue score at week 6 was lower than week 3 (difference of 1.04 points) and the mean fatigue score at week 6 was statistically and significantly lower than baseline (difference of 1.95 points) ($p < .001$) over time, while no such difference was found in the control group .

When comparing the differences in mean fatigue scores between the experimental and control groups over time (between groups) at (baseline, week 3 and week 6), it was found that the time effect changed from T1 (baseline) to T3 (week 6). In addition, the interaction between time and group variables (time * group interactions) were statistically significantly different ($F = 9.698$, $p < .001$) While the control group had a relatively stable mean fatigue score. In the experimental group, the mean fatigue score continued to decrease. (Fig 2).

TABLE 1. Demographic characteristics of the experimental and control groups at baseline.

Demographic characteristics	Experimental Group (n=34) n (%) or mean ± SD	Control Group (n= 34) n (%) or mean ± SD	P - value
Gender (male)	15 (44.1)	17 (50)	0.627[a]
Age (years)	57.21 ± 17.30	52.88 ± 18.22	0.319[c]
Body Mass Index (kg/m^2)	20.57 ± 3.04	19.95 ± 3.88	0.464[c]
Marital Status (Married)	20 (58.8)	22 (64.7)	0.618[a]
Education (Primary school)	21 (61.8)	13 (38.2)	0.104[a]
Occupation (Hired Labor)	7 (20.6)	10 (29.4)	0.302[a]
Income (baht/month)	12,058.82 ±16,118.08	13,057.06 ±10,725.92	0.765[c]
Healthcare Scheme (Universal Coverage)	19 (55.9)	16 (47.1)	0.482[b]
Have a Caregiver	34 (100)	33 (97.1)	1.000[b]
Never Exercise	14 (41.2)	20 (58.8)	0.146[a]

[a]Chi-square test, [b]Fisher's exact test, [c]Independent *t* test.

TABLE 2. History of illness and treatment of the experimental and control groups at baseline.

History of Illness & Treatment	Experimental Group (n=34) n (%) or mean ± SD	Control Group (n= 34) n (%) or mean ± SD	P - value
Tuberculosis Patient (New Case)	32 (94.1)	27 (79.4)	0.150[b]
Extrapulmonary Tuberculosis (No)	31 (91.2)	30 (88.2)	1.000[b]
Duration of tuberculosis illness (months)	4.47 ± 3.71	5.63 ± 4.36	0.241[c]
Duration of taking anti-tuberculosis drugs (months)	4.31± 3.83	5.46 ± 4.42	0.256[c]
Chronic Disease/Comorbidities*			
Diabetes Mellitus	6 (17.6)	10 (29.4)	0.253[a]
Dyslipidemia	10 (29.4)	8 (23.5)	0.582[a]
Hypertension	10 (29.4)	12 (35.3)	0.604[a]
Antituberculosis Drug Regimen (2HRZE/4-7HR)	21 (61.8)	20 (58.8)	0.812[b]

[a] Chi-square test, [b] Fisher's exact test, [c] Independent *t* test. *Top three most common comorbidities (more than 1 answer possible).

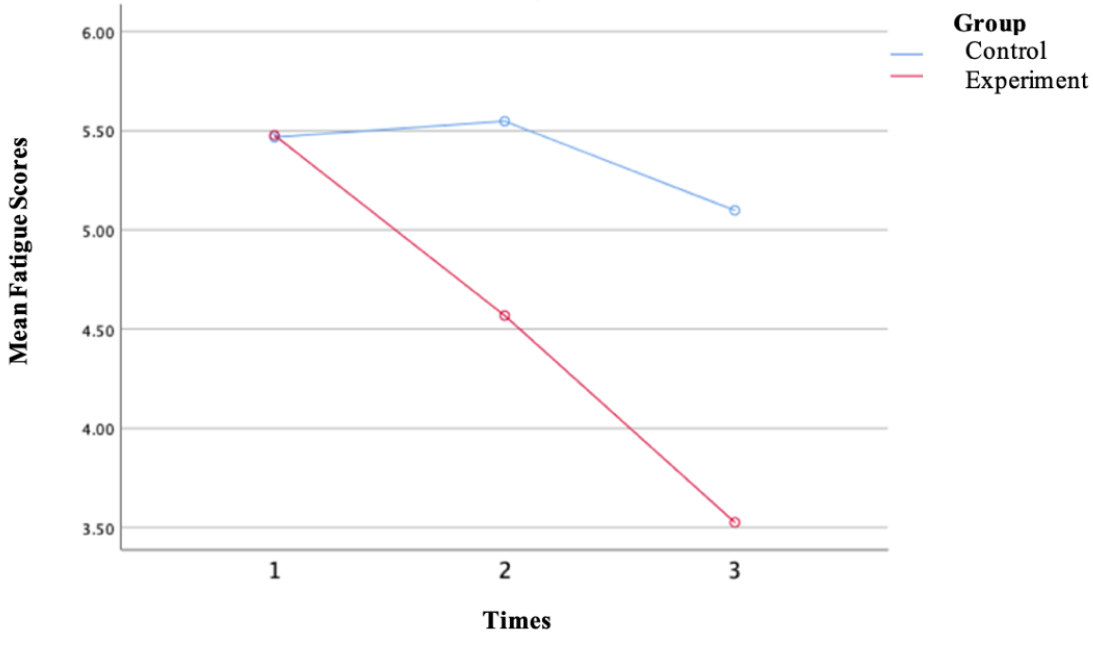

Fig 2. The graph shows the changes in mean fatigue scores at baseline (Time 1) week 3 (Time 2) and week 6 (Time 3) between the experimental and control groups.

Walking exercise adherence to program

Overall, 34 participants received the intervention (Integrated rehabilitation program); of these, 33 (97.05%) completed the study, and 1 (2.9%) did not complete the planned follow-up because of hospitalized admission. In the intervention group, 28 (84.84%) of the participants were able to engage in walking exercise for the number of days meeting the set goal (Perform at least 3 times/week). Otherwise, the participants were able to exercise more than or equal to 18 days in a 6-week period and exercising on average 6 days per week. Designating light to moderate walking intensity (57-76% of maximum heart rate), 30 (90.90%) of the participants were able to perform walking exercise at the designated intensity. And the recommended goal is 20 - 30 minutes at a time. A total of 19 participants, or 57.58 %, were able to exercise for a

specified duration (20-30 minutes/session). The study also found the participants to exercise for an average in the range of 11 to 56 minutes per time. In addition, Problems & obstacles to participating the program include: Some weeks, the participants are inconvenient, not having time from work that must travel, etc. Some elderly people feeling very tired when exercising towards a specific goal or after increasing the intensity and duration of walking exercise. The participants were slightly tired, slightly swollen legs when resting, the symptoms improved and no adverse events were found in this study, such as arrhythmia, dyspnea, rapid and shallow breathing, and severe muscle pain, etc.

DISCUSSION

The results of this study, finding that patients with pulmonary tuberculosis had statistically significant decreases in fatigue after receiving the integrated rehabilitation program and the decreases were substantial when compared to the control group and with statistical significance ($p < .001$). That the integrated rehabilitation program can reduce fatigue in patients with pulmonary tuberculosis is the result of the three components in the program, which included the following: walking exercise, nutrition education and management of adverse reactions from antituberculosis drugs, support from health care provider together with the use of the LINE application in health care monitoring that covers physical and mental care rather than a single program format. Thus, the program covers the main causes or contributing factors involved fatigue in pulmonary tuberculosis. The program style in this study is consistent with a study by Xu et al.[15] of a holistic nursing model combined with breathing exercises. As a result, tuberculosis patients can take better care of themselves and improve lung function and the quality of life improved statistically and also consistent with previous studies on pulmonary rehabilitation programs in patients with pulmonary tuberculosis that require components a variety of programs, including exercise, breathing exercises, education, nutrition support, and psychological support.[16] Thus, fatigue can be managed effectively and is beneficial in reducing residual pulmonary impairment.[17,18]

The present study was based on the Symptom Management Model of Dodd[12] consisting of three main dynamic components applied in the integrated rehabilitation program, which can be described as follows: Experiencing fatigue among patients with pulmonary tuberculosis is an individual differently perception. It is therefore necessary to create a common understanding that fatigue is a manageable condition. Understanding these elements was the starting point for raising awareness and building confidence for participants to manage symptoms, thereby leading to effective management of fatigue. Managing symptoms well requires a health care team that can develop appropriate symptom management strategies for patients. In the present study, For the control group, even though they were not given the integrated rehabilitation program, they were given the option to engage in activities to reduce their own fatigue. This study found that most of the participants in the control group chose to use the method of rest and relaxation when fatigued and others engaged in prayer, meditation, and exercise sometimes, etc. This finding corresponded with previous studies found that sleep was the most frequently chosen symptom management method for the managing fatigue.[19] The outcome was that this method was able to help alleviate some of the symptoms but might not have been sufficiently effective due to the fact that the fatigue in patients with pulmonary tuberculosis is caused by a variety of reasons. In addition, the fatigue in patients with pulmonary tuberculosis is classified as chronic fatigue in which sleep and relaxation may not yield optimal outcomes.[2] The experimental group implemented an integrated rehabilitation program to reduce fatigue and affecting the perceived experience of reduced fatigue symptoms. The experimental group therefore continued to use strategies to manage fatigue symptoms to help control symptoms from recurring. This is in line with the symptom management concept of Dodd[12], which is a dynamic process. As a result, the integrated rehabilitation program can statistically significant reduce fatigue in pulmonary tuberculosis patients.

When describing each component of an integrated rehabilitation program that can reduce fatigue in pulmonary tuberculosis patients, it can be described as follows: People who exercise regularly will help stimulates immune function, strengthens the body, reducing dyspnea, fatigue and improving the physical performance.[18,20] and causes the body to level up the neurotransmitter monoamine, leading to the balancing of the nervous and limbic systems associated with emotions and sensations. It also improves mood, relieves depression, reduces anxiety, and promotes better sleep quality.[21] Furthermore, educating patients about nutrition and the management of adverse reactions from antituberculosis drugs in an easy-to-understand format can be described through videos, illustrated manuals, and the knowledge sent in an infographic format to the participants in order to remind the participants to review their knowledge. This is consistent with the study that the use of multimedia to inform TB patients

results in knowledge skills and behavior modification can take better care of themselves.[22] It also gives them understanding about choices of food intake and helps them recognize the benefits of proper dietary intake, which will help encourage patients to have better nutrition or maintain good nutrition[23,24] that it plays an important role in reducing fatigue and strengthens the body's immune system, helping to promote recovery from illness with tuberculosis[24,25] Including the knowledge of adverse reaction management strategies from antituberculosis drugs will help patients apply the knowledge gained in the event of an adverse reaction and help adherence to treatment include make patient feel truly comprehensive care[26,27] and educating is also another form of social support in the field of information. It is very important and necessary to take care of tuberculosis patients.[28]

Reinforcing support from health care provider through the use of LINE applications to monitor, assess activity performance, communication and is a channel for transmitting information about multimedia knowledge.[29] It is the nurse's role in social support for evaluation by providing feedback in the form of sending messages and stickers of appreciation and encouragement. Which tells the participants about the results of the exercise after the participants saw the results of their own performance. It will help motivate and encourage the participants to continue to exercise continuously. Including emotional support and information for tuberculosis patients with encouragement show empathy, concern and empathy as a caregiver for tuberculosis patients.[28] Consistent with the study found this support would make tuberculosis patients under stress, anxiety during treatment feel warm and comfortable in being closely cared for and make patients feel self-worth encourage patients to be more aware of self-care.[30]

The results of this study, finding that participation adherence to program was as high as 97.05%, as a result of a follow-up calls via LINE application were made once a week throughout the research period to inquire about problems and obstacles in exercising including general symptoms of the participants. Makes it possible to track and evaluate the trend of exercise whether it meets the goals set or not and can plan together each week and can help manage and modify exercises flexibly according to individual suitability. It is similar to many previous studies in the use of the telephone follow-up method. It was found that phone calls follow up on activities and give advice periodically contributing to the participants group's cooperation and persistence in the program.[31,32] It is therefore a part that helps to make the integrated rehabilitation program more effective.

This study has some limitations. The integrated rehabilitation program conducted through the LINE application was available only to participants with smartphones who were able access the program. This study collected data at advanced tertiary care hospital in a single urban area. There may be limitations to the use of research results in generalize to the entire tuberculosis patient population.

CONCLUSION

The integrated rehabilitation program statistically and significantly reduced the levels of fatigue in pulmonary tuberculosis in 3-6 weeks.

Recommendations and implications

1. Nurses and health care teams can implement the integrated rehabilitation program to care for patients with pulmonary tuberculosis such as nutrition education, managing adverse reactions to antituberculosis drugs and promoting exercise together with Dodd's symptom management concept. The patient's fatigue was assessed, and sufficient information is provided to patients and there should be a plan for periodic follow-up visits and encourages patients to manage fatigue appropriately.

2. Studies should be conducted on the effects of the integrated rehabilitation program on fatigue in patients with pulmonary tuberculosis in different locations and contexts from this study. Furthermore, longitudinal studies (e.g., 3 months, 6 months, or 1 year) can be generalized extensively in the care of patients with pulmonary tuberculosis.

3. Clinical outcomes, such as pulmonary function, respiratory and skeletal muscle strength, subjective perception exertion, and dyspnea, body weight, serum albumin level or quality of life should be measured in patients with pulmonary tuberculosis to further monitor the effectiveness of such programs.

Supplementary material: The online version contains supplementary material available at.... (According to the attached supplementary file).

Author contribution: All author contributed to the study conception and design. Material preparation and data collection were performed by Sunisa Nguantad. Data analysis, interpretation of data and the first draft of the manuscript were performed by Sunisa Nguantad, Wimolrat Puwarawuttipanit, and Pichitra Lekdamrongkul and all authors commented on previous version of the manuscript. All authors read and approved the final manuscript.

Funding: No funding

Informed consent: Informed consent was obtained from all individual participants included in the study.

Data availability statement: Available for review upon reasonable request

Conflict of interest: All authors declare that they have no personal or professional conflict of interest.

ACKNOWLEDGMENTS

We thank the pulmonary tuberculosis patients for their participation and all the staff in this research.

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