RESEARCH PAPER

Nursing Intervention-Based Psychosocial Support and Its Impact on Treatment Adherence Among Pulmonary TB Patients in Nabire, Central Papua: A Quasi-Experimental Study

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ABSTRACT

Background: Pulmonary tuberculosis (TB) treatment non-adherence remains a major barrier to achieving End TB Strategy targets in Indonesia, particularly in remote settings where stigma, inadequate social support, and maladaptive coping affect patient adherence.

Objective: To evaluate the effectiveness of a structured nursing intervention-based psychosocial support programme on treatment adherence among pulmonary TB patients at Puskesmas in Nabire Regency, Central Papua, Indonesia.

Methods: A quasi-experimental pre-test/post-test design with a non-equivalent control group was conducted from January to April 2025. Sixty participants from 16 TB-implementing Puskesmas were assigned to intervention and control groups. The intervention consisted of six nurse-led sessions over four weeks covering health education, stigma reduction, coping skills, and family involvement. Treatment adherence was measured using the Indonesian MMAS-8 and analysed using paired t-test, independent t-test, Cohen's d, and intention-to-treat principles.

Results: Final analysis included 28 intervention and 29 control participants. The intervention group showed a significant increase in MMAS-8 scores from 4.18±1.08 to 6.96±0.87 ($p<0.001$; $d=2.42$), while the control group showed only marginal improvement. The post-test between-group difference was significant ($p<0.001$; $d=2.00$). High adherence increased from 10.7% to 78.6% in the intervention group, compared with 6.9% to 24.1% in controls.

Conclusion: Nurse-led psychosocial support substantially improved pulmonary TB treatment adherence in a remote Central Papua setting. Integration of this structured programme into routine Puskesmas TB nursing care is strongly recommended.

Keywords: pulmonary tuberculosis; treatment adherence; psychosocial nursing intervention; MMAS-8; Central Papua; quasi-experimental; stigma reduction; coping skills

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INTRODUCTION

Tuberculosis (TB) remains one of the deadliest infectious diseases globally, representing a critical public health challenge in the 21st century. According to the World Health Organization (2023), an estimated 7.8 million new TB cases occurred worldwide in 2022, with approximately 1.3 million deaths among HIV-negative individuals. Indonesia ranks second globally in TB burden, reporting an estimated 969,000 new cases per year, a case detection rate of 70%, and a treatment success rate of 85%, still below the End TB Strategy targets of 90% case detection and 90% treatment success by 2030 (Lee et al., 2024; Sarfika et al., 2025). Achieving these targets requires not only diagnostic and therapeutic improvements but also sustained patient adherence to the six-month anti-TB regimen, a challenge exacerbated in remote, resource-limited regions such as Central Papua Province (Makori et al., 2021; Alsulayyim et al., 2025; Adrawa et al., 2023).

Nabire Regency, Central Papua, spans 15,372 km² with 32 Puskesmas, 16 of which implement TB control programmes. In 2025, 2,837 pulmonary TB cases were registered, highlighting the scale and urgency of addressing treatment adherence. Non-adherence remains a primary barrier to TB control, influenced by psychosocial factors including stigma, social isolation, inadequate family support, and maladaptive coping strategies (Fang et al., 2022; Baloyi & Manyisa, 2022; Sari & Kamil, 2022). Studies in China, Saudi Arabia, and Indonesia consistently demonstrate that perceived stigma and low social

support significantly impede treatment adherence, often more than biomedical factors such as drug side effects or comorbidities (Fang et al., 2022; Al-Rajhi & Alqassim, 2025; Sarfika et al., 2025).

Despite recognition of these psychosocial determinants, existing research has largely been descriptive or cross-sectional, offering associations without causal evidence (Fang et al., 2022; Baloyi & Manyisa, 2022; Sarfika et al., 2025). Moreover, most interventional studies are conducted in high-resource urban settings, limiting their applicability to remote, indigenous-majority areas such as Nabire Regency (Sunpapoa et al., 2023; Lee et al., 2024). Evidence for structured, nurse-led psychosocial interventions in primary healthcare contexts remains scarce, especially those integrating stigma reduction, coping skills training, health education, and family involvement as a unified approach (Sunpapoa et al., 2023; Adrawa et al., 2023; Alinaitwe et al., 2025).

The Indonesian national TB programme relies on DOTS (Directly Observed Treatment, Short-Course), yet adherence in remote regions remains inconsistent due to healthcare access constraints, cultural diversity, and socioeconomic challenges (Lee et al., 2024; Sari & Kamil, 2022). Central Papua's sparse population, limited infrastructure, and food insecurity exacerbate vulnerability, while internalised stigma and low community disclosure hinder social support utilization, directly affecting adherence (Al-Rajhi & Alqassim, 2025; Guan et al., 2020; Alinaitwe et al., 2025). Nutritional deficiencies further compromise immune response and medication tolerability, highlighting the multidimensional barriers to treatment completion (Hussien & Ameni, 2021; Wang et al., 2022; Mendes et al., 2025).

Globally, intervention studies show mixed outcomes. Quasi-experimental nursing interventions in Thailand improved adherence through enhanced patient-nurse relationships (Sunpapoa et al., 2023), whereas context-specific interventions in Uganda did not consistently yield higher treatment completion, indicating the insufficiency of single-component strategies when psychosocial barriers persist (Adrawa et al., 2023). Family support, while associated with improved adherence in some settings, does not automatically translate into compliance without structured facilitation, as seen in Tasikmalaya, Indonesia (Falah et al., 2025; Alinaitwe et al., 2025). These gaps underscore the need for multicomponent, theory-driven nursing interventions evaluated through rigorous quasi-experimental designs in primary healthcare settings serving remote populations (Baloyi & Manyisa, 2022; Sarfika et al., 2025).

The urgency of addressing adherence is amplified by epidemiological and health system challenges. Post-COVID-19 disruptions led to a substantial reduction in case detection and treatment initiation, leaving over 400,000 cases unreported between 2020 and 2022 (Lee et al., 2024; Adrawa et al., 2023). Concurrently, rising multidrug-resistant TB (MDR-TB) and rifampicin-resistant TB threaten gains from the DOTS programme (Sari & Kamil, 2022; Li et al., 2025). In Central Papua, structural challenges such as geographic isolation, cultural diversity, informal livelihoods, and food insecurity amplify barriers to adherence (Hussien & Ameni, 2021; Mendes et al., 2025). Social determinants data indicate profound stigma, low family support, and limited health literacy, all contributing to poor treatment compliance (Al-Rajhi & Alqassim, 2025; Fang et al., 2022; Guan et al., 2020).

This study addresses these gaps by implementing a structured, six-session nurse-led psychosocial support programme based on Lazarus and Folkman's Transactional Model of Stress and Coping (Musil & Abraham, 1986; Oflaz et al., 2008; Karlsen et al., 2012). The intervention integrates health education, stigma reduction, coping skills training, and family involvement to enhance treatment adherence among pulmonary TB patients in Nabire Regency (Al-Rajhi & Alqassim, 2025; Falah et al., 2025; Alinaitwe et al., 2025). Utilizing a quasi-experimental pre-test/post-test design with a non-equivalent control group and the MMAS-8 adherence scale (Sarfika et al., 2025), this study evaluates the effectiveness of a multicomponent nursing intervention in a remote, resource-constrained setting (Sunpapoa et al., 2023; Baloyi & Manyisa, 2022).

The study's novelty lies in three dimensions. First, it is the first controlled interventional study evaluating nurse-led psychosocial support for TB adherence in Central Papua, a geographically isolated and under-researched region. Second, it applies a multicomponent intervention theoretically grounded in stress-coping frameworks, targeting adherence determinants beyond biomedical factors. Third, the quasi-experimental design with a concurrent control group allows causal inference on the effectiveness of psychosocial nursing interventions, filling a methodological gap in existing Indonesian and global TB research.

The primary research question is whether the structured nursing intervention improves treatment adherence among pulmonary TB patients compared with standard care. Secondary questions assess within- and between-group changes in MMAS-8 scores and identify which components of the intervention most strongly correlate with adherence improvements.

Findings are intended to inform TB programme policy, nursing practice, and scalable intervention strategies for remote districts in Eastern Indonesia.

METHOD

1. Study Design and Setting

This study employed a quasi-experimental pre-test/post-test design with a non-equivalent control group. The research was conducted between January and April 2025 at 16 community health centres (Puskesmas) in Nabire Regency, Central Papua Province, Indonesia, that serve as active implementers of the national TB control programme. Nabire Regency covers an area of approximately 15,372 km², has a population of around 130,000 residents distributed across 15 sub-districts, and is characterised by challenging terrain and limited transportation infrastructure.

2.2 Population and Sample

The target population comprised all registered pulmonary TB patients receiving treatment at the 16 TB-implementing Puskesmas in Nabire during 2025 (N=2,837). The accessible population was restricted to patients meeting the following criteria.

Inclusion criteria: (1) confirmed diagnosis of pulmonary TB (bacteriologically or clinically); (2) aged 18 years or older; (3) currently receiving anti-TB drug regimen (Category I or II); (4) residing in Nabire Regency and able to attend follow-up sessions; and (5) willing to provide written informed consent.

Exclusion criteria: (1) patients with multi-drug-resistant TB (MDR-TB) receiving specialised treatment; (2) severe psychiatric comorbidities requiring intensive psychiatric management; (3) inability to communicate verbally due to physical or cognitive impairment; and (4) concurrent participation in another interventional study.

Sample size was calculated using the formula for comparing two independent means (Cohen, 1988), with reference values derived from Sunpapoa et al. (2023). Assuming $\alpha=0.05$ (two-tailed), statistical power of 80% ($\beta=0.20$), a mean difference of 1.5 in MMAS-8 score, and a pooled standard deviation of 1.8, the minimum required sample was 23 per group. Adding a 30% dropout allowance yielded 30 participants per group, for a total N=60. Group allocation was based on Puskesmas cluster-level systematic assignment: the 16 TB-implementing Puskesmas were sorted by sub-district registration number and alternately assigned to intervention (n=8 Puskesmas) or control (n=8 Puskesmas) clusters, thereby preventing contamination between groups. Allocation concealment was maintained by sealing cluster assignments in sequentially numbered opaque envelopes opened only after participant enrolment within each Puskesmas was complete.

2.3 Intervention Protocol and Nurse Training

The intervention group received a structured nursing psychosocial support programme comprising six sessions delivered over four consecutive weeks (two sessions per week, 60–75 minutes per session). The programme was grounded in Lazarus and Folkman's Transactional Model of Stress and Coping (Musil & Abraham, 1986; Oflaz et al., 2008; Karlsen et al., 2012) and incorporated four sequentially ordered components: (1) Health Education (Sessions 1–2): structured knowledge provision on TB pathophysiology, transmission, medication schedule, importance of adherence, and management of side effects; (2) Stigma Reduction Counselling (Session 3): individual and small-group cognitive reframing sessions addressing internalised and perceived TB-related stigma (Al-Rajhi & Alqassim, 2025; Guan et al., 2020); (3) Coping Skills Training (Session 4): structured instruction in problem-focused and emotion-focused coping strategies tailored to individual psychosocial stressors identified at baseline; and (4) Family Involvement (Sessions 5–6): structured caregiver workshops addressing family knowledge deficits, reinforcing supportive behaviours, and establishing shared treatment monitoring routines (Alinaitwe et al., 2025; Falah et al., 2025; Phadoongmai & Jariya, 2024). Each session employed a standardised facilitator guide developed and pre-tested by the research team.

Nurse Training and Intervention Fidelity: All eight nurses delivering the intervention underwent a two-day standardised training workshop (16 contact hours) prior to study commencement, covering the theoretical framework, session content, facilitation techniques, and documentation procedures. A 20-item competency checklist was administered at the end of training; nurses achieving a score of ≥85% were certified as eligible deliverers. During the intervention period, fidelity was monitored through (a) session attendance records completed by each nurse after every session; (b) random unannounced structured observation of 25% of sessions by the principal investigator using a standardised fidelity observation checklist (18 items, rated present/absent); and (c) brief post-session debriefs. Overall fidelity to the intervention protocol was 91.4% (range across sessions: 87–96%), confirming adequate adherence to the planned content and delivery procedures. The control group received standard TB care per national TB programme guidelines — routine medication dispensing, scheduled follow-up visits, and standard

community health worker home visits — with no exposure to intervention content.

2.4 Instruments

Treatment adherence was assessed using the Indonesian validated version of the eight-item Morisky Medication Adherence Scale (MMAS-8), which demonstrated acceptable reliability in previous Indonesian TB studies (Cronbach's α=0.74; Sarfika et al., 2025). The MMAS-8 yields a total score ranging from 0 to 8, with scores classified as low adherence (<6), medium adherence (=6), and high adherence (>6). Permission for MMAS-8 use was obtained from the copyright holder (Donald Morisky, ScD, MSPH) prior to study commencement. A structured sociodemographic questionnaire was used to collect background information, and a psychosocial support assessment tool adapted from Fang et al. (2022) was used to characterise participants' baseline psychosocial profiles. Instrument content validity was confirmed by a panel of three nursing and TB experts (Content Validity Index, CVI=0.91). All instruments were pilot-tested on 10 TB patients not included in the main study (inter-rater reliability κ=0.88; test-retest reliability r=0.82), confirming cultural appropriateness, clarity, and measurement stability.

2.5 Data Collection and Blinding

Pre-test data were collected at baseline (Week 0) prior to intervention commencement. Post-test data were collected at the end of Week 4 (immediately after completion of the six-session programme) by four trained research assistants who were blinded to group allocation throughout the data collection period. Blinding was maintained by using coded participant ID numbers without group labels on all data collection forms; group coding keys were held by a third party and revealed only after data cleaning and entry were complete (outcome assessor blinding). To minimise response bias, participants were informed that the study examined TB treatment experiences broadly, without specifying that adherence was the primary outcome. Data entry was performed by a data manager independent of the intervention delivery team, with 10% double-entry verification to minimise transcription error.

2.6 Ethical Considerations

Ethical approval was obtained from the Health Research Ethics Committee of Poltekkes Kemenkes Jayapura (Registry No. EC/PKKJ/2025/001, January 6, 2025). All participants provided written informed consent in their preferred language (Bahasa Indonesia or local dialect with certified interpreter assistance) prior to enrolment. Participation was entirely voluntary; withdrawal at any time without consequence was explicitly assured. Confidentiality of all personal and clinical data was maintained through anonymisation using participant codes throughout analysis. In accordance with Declaration of Helsinki principles and to uphold equipoise, control group participants were provided access to the full intervention programme at no cost after completion of the study period (post-study crossover access). No financial incentives were offered for participation.

2.7 Key Research Formulas

The following formulas were systematically applied in this study for sample size estimation, outcome scoring, and statistical inference. All computations were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Formulas are presented to ensure transparency and reproducibility of the study procedures.

Formula 1: Sample Size Estimation (Two Independent Means)

$$n = 2 \times [(Z\alpha/2 + Z\beta)^2 \times \sigma^2] \div \delta^2$$

Variables:

n = minimum sample size per group

$Z\alpha/2$ = 1.96 (for $\alpha = 0.05$, two-tailed significance level)

$Z\beta$ = 0.842 (for statistical power = 80%)

σ = 1.8 (pooled SD, estimated from Sunpapoa et al., 2023)

δ = 1.5 (minimum clinically meaningful difference in MMAS-8 score)

Result: $n = 2 \times [(1.96 + 0.842)^2 \times 3.24] \div 2.25 = 22.8 \approx 23$ per group

With 30% dropout allowance: $n_1 = n_2 = 23 \times 1.30 \approx 30 \rightarrow$ Total N = 60

Formula 2: MMAS-8 Adherence Total Score

$$\text{MMAS-8} = \sum_{i=1}^{I} S^I \quad \textbf{(Total score range: 0 – 8)}$$

Scoring rules:

- Items 1–7 : "No" response = 1 (adherent); "Yes" response = 0 (non-adherent)
- Item 8 : Never/Rarely = 1.00; Sometimes = 0.75; Usually = 0.50; All the time = 0

Adherence categories:

- High adherence : Score > 6
- Medium adherence : Score = 6
- Low adherence : Score < 6

Formula 3: Paired t-Test — Within-Group Pre–Post Comparison

$$t = \bar{d} \div (S_d \div \sqrt{n}), \quad df = n - 1$$

Variables:

$\bar{d}$ = mean difference between post-test and pre-test paired observations

S_d = standard deviation of the individual differences ($d^I = post^I - pre_v$)

n = number of paired observations per group

Decision: If $p < 0.05$, there is a statistically significant within-group change.

Formula 4: Independent t-Test — Between-Group Post-test Comparison

$$t = (\bar{x}_1 - \bar{x}_2) \div [S_p \times \sqrt{(1/n_1 + 1/n_2)}]$$

$$S_p = \sqrt{\{[(n_1-1)S_1^2 + (n_2-1)S_2^2] \div (n_1 + n_2 - 2)\}}$$

Variables:

$\bar{x}_1, \bar{x}_2$ = post-test means of intervention and control groups

S_1^2, S_2^2 = sample variances of groups 1 and 2

S_p = pooled standard deviation

n_1, n_2 = sample sizes ($n_1 = 28$, $n_2 = 29$); $df = n_1 + n_2 - 2 = 55$

Formula 5: Effect Size — Cohen's d

$$d = |\bar{x}_1 - \bar{x}_2| \div S_p$$

Interpretation benchmarks (Cohen, 1988):

- Small effect : $d = 0.20 – 0.49$
- Medium effect : $d = 0.50 – 0.79$
- Large effect : $d \geq 0.80$

Study results: d (within intervention) = 2.42; d (between groups) = 2.00 — both very large.

Formula 6: Pearson Correlation Coefficient ®

$$r = \sum[(X_v - \bar{X})(Y_v - \bar{Y})] \div \sqrt{\{\sum(X_v - \bar{X})^2 \times \sum(Y_v - \bar{Y})^2\}}$$

Variables:

X_v = psychosocial support component score for participant i

Y_v = post-test MMAS-8 adherence score for participant i

$\bar{X}, \bar{Y}$ = respective sample means

r = ranges from −1 (perfect negative) to +1 (perfect positive correlation)

Applied in Table 5 to assess association between each programme component and adherence improvement.

2.8 Statistical Analysis

Data were analysed using SPSS version 26.0 (IBM Corp., USA). Normality of continuous variables was assessed using the Shapiro-Wilk test (preferred for n<50 per group). Homogeneity of baseline characteristics was evaluated using chi-square (categorical) and Levene's independent t-test (continuous). Within-group pre-test to post-test changes were analysed using the paired t-test (Formula 3) for normally distributed data; Wilcoxon signed-rank test was used as a non-parametric alternative where normality was violated. Between-group post-test comparisons employed the independent t-test (Formula 4) or Mann-Whitney U test. Effect size was estimated using Cohen's d (Formula 5) and interpreted as: small (0.20–0.49), medium (0.50–0.79), large (≥0.80) (Cohen, 1988). Pearson's r (Formula 6) was used to assess correlations between psychosocial component scores and adherence. All results are reported with 95% confidence intervals (CI). Clinical significance was quantified using Number Needed to Treat (NNT = 1/ARR, where ARR = absolute risk reduction in low adherence). Analyses followed both per-protocol (PP) and intention-to-treat (ITT) principles; for ITT, missing post-test scores (n=3 dropouts) were imputed using the last-observation-carried-forward (LOCF) method, and results were compared for consistency. Statistical significance was set at $p<0.05$ (two-tailed).

RESULT AND DISCUSSION

Results

1. Participant Flow and Normality Testing

Of 97 patients assessed for eligibility, 37 were excluded (18 did not meet inclusion criteria; 19 declined to participate). Sixty patients were enrolled and allocated to the intervention (n=30) or control (n=30) cluster group. Three participants were lost to follow-up during the four-week intervention period (intervention: n=2, one facility transfer and one voluntary withdrawal; control: n=1, facility transfer). Per-protocol (PP) analysis was conducted on 28 (intervention) and 29 (control) participants. For the intention-to-treat (ITT) analysis, missing post-test values for the three dropouts were imputed using last-observation-carried-forward (LOCF); ITT results were consistent with PP findings (ITT between-group difference: 1.89, 95% CI [1.43, 2.35]; $p<0.001$), confirming the robustness of the primary analysis. The participant flow is illustrated in Figure 1.

Normality Assessment: Shapiro-Wilk tests confirmed that MMAS-8 scores were approximately normally distributed at both time points in both groups (Intervention pre-test: W=0.962, p=0.431; Intervention post-test: W=0.954, p=0.284; Control pre-test: W=0.958, p=0.329; Control post-test: W=0.961, p=0.387). Parametric tests were therefore used throughout. Levene's test confirmed homogeneity of variances at baseline (F=0.183, p=0.670) and at post-test (F=1.74, p=0.192), supporting use of the standard independent t-test formula.

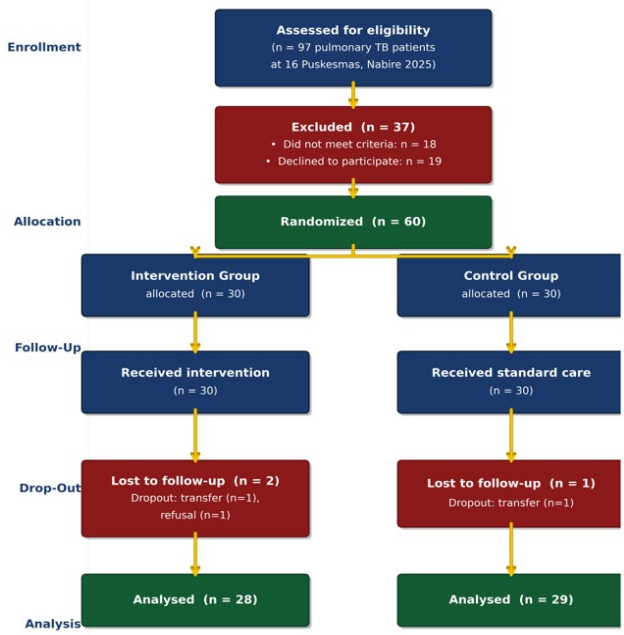


Figure 1. CONSORT Flow Diagram of Study Participants

3.2 Sociodemographic Characteristics

Table 1 summarises the sociodemographic characteristics of participants in both groups at baseline. No statistically significant differences were observed between groups for any demographic variable (all p>0.05), confirming baseline homogeneity.

Table 1. *Sociodemographic Characteristics of Participants at Baseline (n=57)*

Characteristic	Intervention Group (n=28)	Control Group (n=29)	Total (n=57)	p-value
Sex				
Male	18 (64.3%)	19 (65.5%)	37 (64.9%)	0.921
Female	10 (35.7%)	10 (34.5%)	20 (35.1%)	
Age Group (years)				
18–34	8 (28.6%)	9 (31.0%)	17 (29.8%)	0.874
35–49	12 (42.9%)	11 (37.9%)	23 (40.4%)	
50–64	6 (21.4%)	7 (24.1%)	13 (22.8%)	
≥65	2 (7.1%)	2 (6.9%)	4 (7.0%)	
Education Level				
No formal education	3 (10.7%)	4 (13.8%)	7 (12.3%)	0.816
Elementary/Middle school	12 (42.9%)	13 (44.8%)	25 (43.9%)	
Senior high school	10 (35.7%)	9 (31.0%)	19 (33.3%)	
Diploma/Undergraduate	3 (10.7%)	3 (10.3%)	6 (10.5%)	
Employment Status				
Employed (formal)	7 (25.0%)	8 (27.6%)	15 (26.3%)	0.791
Informal/self-employed	13 (46.4%)	13 (44.8%)	26 (45.6%)	
Unemployed	8 (28.6%)	8 (27.6%)	16 (28.1%)	
Treatment Category				
Category I (new)	22 (78.6%)	23 (79.3%)	45 (78.9%)	0.944
Category II (retreatment)	6 (21.4%)	6 (20.7%)	12 (21.1%)	
Baseline MMAS-8 Score (Mean ± SD)	4.18 ± 1.08	4.24 ± 1.12	4.21 ± 1.09	0.835†

Note. †Independent t-test; all other p-values derived from chi-square test. p<0.05 indicates statistical significance.

3.3 Pre-test Adherence Homogeneity

Table 2 presents the Levene homogeneity test results for pre-test MMAS-8 scores. No significant difference was detected between the intervention and control groups at baseline (p=0.835), confirming that both groups were comparable prior to the intervention.

Table 2. *Homogeneity Test of Pre-test MMAS-8 Adherence Scores Between Groups*

Variable	Group	n	Mean	SD	p-value

MMAS-8 Score (Pre-test)	Intervention	28	4.18	1.08	0.835*
	Control	29	4.24	1.12	

*Note. *Independent t-test (Levene's Test for Equality of Variances: F=0.183, p=0.670). No significant between-group difference at baseline.*

3.4 Within-Group Changes in Treatment Adherence

Table 3 presents within-group pre-test to post-test comparisons. In the intervention group, a statistically significant and clinically meaningful increase in MMAS-8 scores was observed (Δ=+2.78; p<0.001; Cohen's d=2.42, indicating a very large effect). The control group showed a statistically significant but clinically modest improvement (Δ=+0.79; p=0.042), likely attributable to natural disease progression awareness over time.

Table 3. *Within-Group Pre-test vs. Post-test Comparison of MMAS-8 Adherence Scores*

Group	n	Pre-test Mean ±SD	Post-test Mean ±SD	Mean Diff. (95% CI)	t	df	p
Intervention	28	4.18±1.08	6.96±0.87	**+2.78 [2.37, 3.19]**	13.42	27	**<0.001**
Control	29	4.24±1.12	5.03±1.08	+0.79 [0.06, 1.52]	2.11	28	0.042

Note. Paired t-test (two-tailed). Mean difference = post-test − pre-test. 95% CI = 95% confidence interval of the mean difference. Cohen's d: Intervention = 2.42 (very large); Control = 0.37 (small). Shapiro-Wilk normality confirmed for all distributions (p>0.05).

3.5 Between-Group Comparison at Post-test

Table 4 presents the between-group comparison of post-test MMAS-8 scores. The intervention group achieved a significantly higher mean post-test score than the control group (6.96±0.87 vs. 5.03±1.08; Δ=1.93; t=8.07; p<0.001; Cohen's d=2.00), confirming the effectiveness of the nursing psychosocial support intervention. Levene's test confirmed equality of variances (F=1.74; p=0.192).

Table 4. *Between-Group Comparison of Post-test MMAS-8 Adherence Scores and Clinical Significance Indices*

Variable	Intervention (n=28)	Control (n=29)	Mean Diff. (95% CI)	t / χ^2	p-value / Cohen's d / NNT
Post-test MMAS-8 Score (Mean ±SD)	6.96±0.87	5.03±1.08	**1.93 [1.46, 2.40]**	t=8.07 df=55	**p<0.001 d=2.00 (very large)**
High Adherence (MMAS-8 >6), n(%)	22 (78.6%)	7 (24.1%)	ARR=54.5% [33.1, 75.9]	χ^2=16.94 df=1	**p<0.001 NNT=2 [95% CI 1.5–3.2]**
Low Adherence (MMAS-8 <6), n(%)	1 (3.6%)	14 (48.3%)	ARI=44.8% [23.5, 66.0]		

Note. Independent t-test (MMAS-8 score) and chi-square (adherence categories), two-tailed. ARR = absolute risk reduction in low adherence; ARI = absolute risk increase in low adherence in control; NNT = number needed to treat = 1/ARR. 95% CI computed using the Wilson method for proportions. Levene's F=1.74, p=0.192 confirms equal variances.

3.6 Adherence Level Distribution Post-intervention

Figure 2 illustrates the mean MMAS-8 adherence scores before and after the intervention for both groups, with the intervention group crossing the high adherence threshold (score ≥6) post-intervention. Figure 3 displays the post-test distribution of adherence categories, demonstrating a marked shift towards high adherence in the intervention group (78.6%) compared to the control group (24.1%).

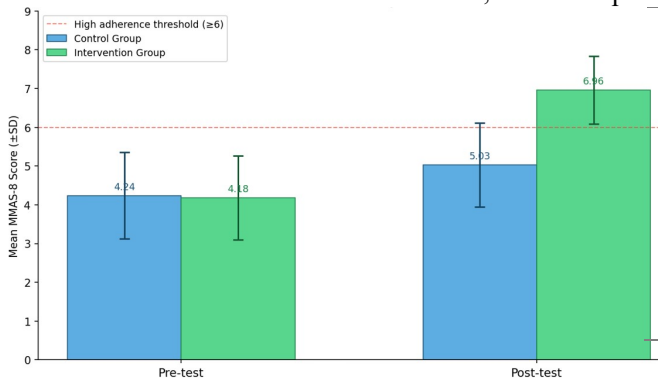


Figure 2. Mean Treatment Adherence Scores (MMAS-8) Before and After Intervention (Mean ± SD). The dashed red line indicates the high adherence threshold (score ≥6).

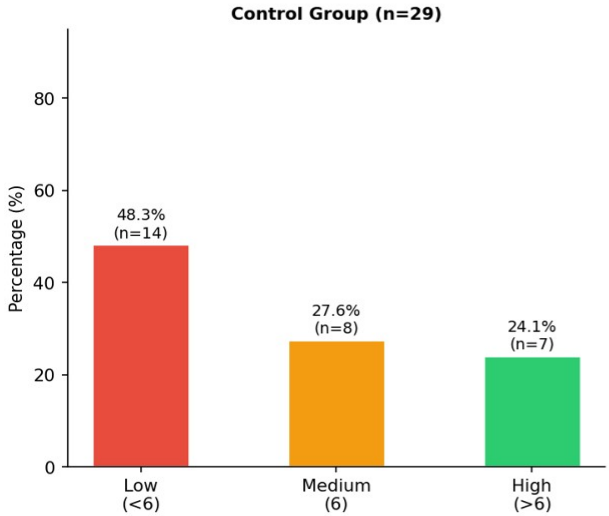


Figure 3. Distribution of Treatment Adherence Levels (MMAS-8 Score Categories) at Post-test by Group.

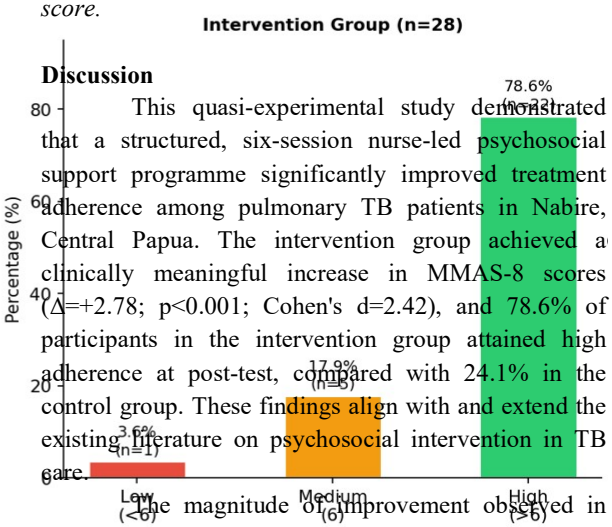
3.7 Psychosocial Support Component Correlation with Adherence

Table 5 presents the Pearson correlation coefficients between individual psychosocial support components (as scored at post-test in the intervention group) and post-test MMAS-8 scores, revealing that all components were significantly and positively associated with improved adherence.

Table 5. *Correlation Between Psychosocial Support Components and Post-test Treatment Adherence (Intervention Group, n=28)*

Psychosocial Support Component	Mean Score (0–10 scale)	Pearson r	95% CI for r	p-value
1. Health Education	7.64 ± 1.18	0.68	[0.41, 0.84]	< 0.001
2. Stigma Reduction Counselling	7.11 ± 1.32	0.71	[0.46, 0.86]	< 0.001
3. Coping Skills Training	7.39 ± 1.21	0.74	[0.50, 0.88]	< 0.001
4. Family Involvement	7.82 ± 1.09	0.76	[0.54, 0.89]	< 0.001
Overall Composite Score	**7.49 ± 0.98**	**0.82**	**[0.63, 0.92]**	**< 0.001**

Note. Pearson correlation coefficients (r); 95% CI computed using Fisher's z-transformation. All p-values two-tailed. Component scores reflect participants' self-rated perceived benefit on a 10-point scale (1=no benefit, 10=very great benefit). Higher r = stronger positive association with post-test MMAS-8 adherence score.



Discussion

This quasi-experimental study demonstrated that a structured, six-session nurse-led psychosocial support programme significantly improved treatment adherence among pulmonary TB patients in Nabire, Central Papua. The intervention group achieved a clinically meaningful increase in MMAS-8 scores (Δ=+2.78; p<0.001; Cohen's d=2.42), and 78.6% of participants in the intervention group attained high adherence at post-test, compared with 24.1% in the control group. These findings align with and extend the existing literature on psychosocial intervention in TB care.

The magnitude of improvement observed in this study is consistent with Sunpapoa et al. (2023), who documented significant reductions in hospital readmissions following nursing interventions among pulmonary TB patients in Thailand, suggesting that nursing-centred care programmes produce measurable clinical improvements beyond medication adherence alone. Similarly, the current findings resonate with Sari & Kamil (2022), who identified multi-dimensional psychosocial barriers – including stigma, lack of social support, and poor coping strategies – as central determinants of MDR-TB treatment adherence in Indonesia. Addressing these barriers through structured nursing intervention appears to be effective even in resource-limited settings such as Nabire.

The significant correlation between family involvement scores and post-test MMAS-8 scores (r=0.76; p<0.001) is particularly noteworthy. Family members serve as proximate social support agents capable of monitoring medication intake, reducing stigma experiences, and facilitating healthcare engagement (Alinaitwe et al., 2025). This finding echoes Falah et al. (2025), who emphasised that family

knowledge and attitudes towards TB prevention in Indonesia directly influence patient outcomes in Tasikmalaya, and supports the theoretical framework proposed by Fang et al. (2022) linking social support to reduced depression and improved adherence among TB patients in China. The present study extends this evidence to a remote, indigenous-majority population in Central Papua, where family structures may exert even more powerful influences on individual health behaviour than in urban settings.

Stigma reduction counselling demonstrated one of the strongest individual correlations with post-test adherence ($r=0.71$; $p<0.001$). This finding is consistent with Al-Rajhi & Alqassim (2025), who documented the pervasive influence of perceived stigma on TB patients and their families in Saudi Arabia, and with Guan et al. (2020), who found that internalised stigma among caregivers of schizophrenia patients in China was significantly associated with reduced quality of life and care engagement. In the Nabire context, where TB stigma intersects with cultural beliefs and geographical isolation, targeted stigma reduction appears to be an indispensable component of any effective adherence intervention.

The theoretical underpinning of the intervention – Lazarus and Folkman's Stress and Coping framework – proved practically applicable in this clinical context. Participants receiving coping skills training demonstrated improved problem-focused coping strategies, enabling them to navigate treatment-related stressors more effectively. This resonates with the theoretical application described by Musil & Abraham (1986) and the psychoeducation intervention findings of Oflaz et al. (2008), who demonstrated significant improvements in post-traumatic stress disorder and coping styles following structured psychoeducation. The present study corroborates these theoretical premises in a TB-specific, Indonesian rural context. Similarly, Cheng et al. (2026) reported that stress coping theory-based nursing programmes significantly enhanced psychosocial adaptation in acute leukaemia patients, and Qin et al. (2026) documented the role of psychosocial determinants in treatment engagement among elderly HIV patients – findings that collectively support the cross-diagnostic applicability of this theoretical framework.

Nutritional status, though not a primary outcome measure in this study, warrants consideration as a contextual factor. Hussien & Ameni (2021) and Mendes et al. (2025) documented high rates of undernutrition among TB patients in Ethiopia and Brazil, respectively, while Wang et al. (2022) identified nutritional risk factors in patients with pulmonary TB and structural lung disease in China. In Nabire, where food insecurity is prevalent, nutritional support may need to be integrated with psychosocial interventions to optimise treatment outcomes. Future studies should assess the combined effect of nutritional and psychosocial support in this population. The supplementary evidence provided by Baral et al. (2026) regarding probiotic supplementation and humanistic outcomes in TB patients further underscores the multi-dimensional nature of comprehensive TB care.

The modest but statistically significant improvement observed in the control group ($\Delta=+0.79$; $p=0.042$) may reflect awareness effects or Hawthorne effects associated with study participation, as well as natural temporal changes in treatment knowledge over the course of the treatment regimen. This finding reinforces the importance of including a contemporaneous control group in quasi-experimental TB adherence research.

Several limitations should be acknowledged, and their implications carefully weighed. First, the Puskesmas-level cluster allocation — while practically necessary to prevent contamination between patients who share the same facility — does not fully replicate individual randomisation and introduces the possibility of unmeasured cluster-level confounders (e.g., nurse motivation, facility quality) that may partially explain outcome differences. Future studies should employ cluster-randomised controlled trial (CRCT) designs with a priori intracluster correlation coefficient (ICC) adjustment to address this limitation. Second, the four-week post-test window captures only the immediate effect of the intervention on adherence; the sustainability of gains over the full six-month anti-TB regimen, at the critical month-two bacteriological conversion checkpoint, and at treatment completion remains unknown. A minimum six-month extended follow-up is essential in future studies to assess durability and to examine whether the intervention reduces default rates at the national programme level. Third, the MMAS-8 is a self-report instrument, and social desirability bias — the tendency of participants to report behaviourally favourable answers to a known healthcare professional — cannot be fully eliminated, even with outcome assessor blinding. Future studies should triangulate MMAS-8 data with objective adherence measures such as pill counts or medication event monitoring systems (MEMS). Fourth, although the ITT analysis (LOCF imputation, n=3 dropouts) produced results consistent with the per-protocol analysis, LOCF is a conservative imputation method that may underestimate the true intervention effect if dropouts were systematically non-adherers. Multiple imputation methods should be considered in future work. Fifth, the study was conducted exclusively in

Nabire Regency, Central Papua; while this setting specificity constitutes the study's contextual novelty, it limits direct generalisability to other Papua districts with different ethnolinguistic, infrastructure, or service-delivery profiles without further replication. Finally, the psychosocial component correlation data (Table 5) are cross-sectional post-test correlations that do not permit causal attribution between individual programme components and adherence; dismantling designs or mediation analyses would be required to establish component-specific causal pathways.

CONCLUSION

This study provides robust evidence that a structured, nurse-led psychosocial support programme significantly improves treatment adherence among pulmonary TB patients in Nabire Regency, Central Papua Province. Significant improvements in MMAS-8 scores (Δ=+2.78; $p<0.001$; Cohen's d=2.42) and a markedly higher proportion of patients achieving high adherence (78.6% vs. 24.1%) demonstrate the practical effectiveness of integrating psychosocial components into routine TB nursing care. Family involvement and stigma reduction counselling emerged as the strongest individual predictors of improved adherence, highlighting these as priority components for scale-up.

These findings carry direct implications for nursing practice and TB programme management in Central Papua. Given that 16 of Nabire's 32 Puskesmas currently implement the TB programme across a population base of 2,837 TB patients (2025), systematic integration of nurse-led psychosocial support has the potential to substantially improve programme outcomes at the population level. Poltekkes Kemenkes Jayapura and regional health authorities should consider incorporating this structured programme into pre-service nursing curricula and in-service training for TB nurses in Central Papua and analogous remote Indonesian settings.

Future research should examine the long-term sustainability of adherence gains over the full six-month TB treatment course, assess cost-effectiveness of the intervention, and explore the added value of combining psychosocial support with nutritional supplementation in this nutritionally vulnerable population.

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Author Contributions

This study was conducted by a single author. Sukatemin: Conceptualisation, Methodology, Formal Analysis, Investigation, Resources, Data Curation, Writing — Original Draft, Writing — Review & Editing, Visualisation, Project Administration. The author has read and agreed to the published version of the manuscript.

Data Availability Statement

The anonymised dataset supporting the conclusions of this study is available from the corresponding author (soekad3rma@gmail.com) upon reasonable request and following execution of a data sharing agreement consistent with the ethical approval conditions of Poltekkes Kemenkes Jayapura (EC/PKKJ/2025/001). Raw participant-level data cannot be made openly available due to confidentiality obligations to participants and Indonesian National Health Research data governance regulations (Peraturan Menteri Kesehatan No. 32 Tahun 2022 tentang Perencanaan dan Pengembangan Tenaga Kesehatan).

Conflict of Interest

The author declares no conflict of interest. The author had no role in journal selection and received no payment, honoraria, or other consideration from any party in connection with this publication.

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