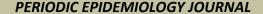**J u r n a l   B e r k a l a**
EPIDEMIOLOGI
PERIODIC EPIDEMIOLOGY JOURNAL

ORIGINAL ARTICLE

FACTORS ASSOCIATED WITH TUBERCULOSIS-DIABETES MELLITUS COMORBIDITY

Faktor-faktor yang Berhubungan dengan Komorbiditas Tuberkulosis-Diabetes Mellitus

Dyan Kunthi Nugrahaeni[1] , **Ika Kusumasari[2]** , **Teguh Akbar Budiana[3]** , **Novie Elvinawaty Mauliku[4]**
[1]Master of Public Health Study Program, Faculty of Health Science and Technology, Jenderal Achmad Yani University, Cimahi, West Java, Indonesia, 40531, dyankunthi@yahoo.co.id
[2]Public Health Study Program, Faculty of Health Science and Technology, Jenderal Achmad Yani University, Cimahi, West Java, Indonesia, 40531, ikakusumasari33@gmail.com
[3]Public Health Study Program, Faculty of Health Science and Technology, Jenderal Achmad Yani University, Cimahi, West Java, Indonesia, 40531, budianateguh@yahoo.co.id
[4]Master of Public Health Study Program, Faculty of Health Science and Technology, Jenderal Achmad Yani University, Cimahi, West Java, Indonesia, 40531, nmauliku@gmail.com
Corresponding Author: Dyan Kunthi Nugrahaeni, dyankunthi@yahoo.co.id, Master of Public Health Study Program, Faculty of Health Science and Technology, Jenderal Achmad Yani University, Cimahi, West Java, 40531, Indonesia

ARTICLE INFO

ABSTRACT

Background: The double burden disease refers to the increase of communicable and non-communicable disease, such as comorbidity tuberculosis (TB) with diabetes mellitus (DM). If not treated properly and managed, tuberculosis can lead to comorbidity with diabetes mellitus. **Purpose:** This research aims to determine factors associated with tuberculosis-diabetes mellitus comorbidity. **Methods:** Research design used case-control study, sample cases are TB patients with DM as many as 15 people, while sample control is TB patient without DM as many as 30 people. Independent variables include age, education, occupation, TB severity, body mass index, and quality of life, while the dependent variable is comorbidity TB-DM. The instrument used the World Health Organization's Quality of Life Brief Version (WHOQOL-BREF). Data analysis was performed utilizing the Chi-Square test and Independent T-test. **Results:** This study's findings indicated that the variable age (p= 0.011; OR= 6; 95% CI= 1.39-25.85), education (p=0.03; OR= 4.12; 95% CI= 1.06-16.03), TB severity (p= 0.02; OR= 4.57; 95% CI= 1.18-17.67), and quality of life domains were significantly related to TB-DM with comorbidity: physical (p=0.00; OR=42.25; 95%CI=6.82-261.61), psychological (p=0.03; OR=4; 95% CI=1.07-14.89) and environmental domain (p=0.01; OR=10.54; 95% CI=1.06-105.03). **Conclusion:** Factors influencing comorbidity between TB-DM include age, education level, TB severity and quality of life. Enhancing immunity in TB patients is essential to reduce the severity of TB and comorbidity of TB-DM, with recommendations for support from family,

parents, children, and friends to improve the quality of life for those with TB-DM.

ABSTRAK

Latar Belakang: *Penyakit beban ganda (double burden disease) adalah meningkatnya penyakit menular dan tidak menular, seperti komorbiditas tuberkulosis (TB) dengan diabetes melitus (DM). Bila tidak diobati dan ditatalaksana dengan baik, tuberkulosis dapat menimbulkan komorbiditas dengan diabetes melitus.* ***Tujuan:*** *Penelitian ini bertujuan untuk mengetahui faktor-faktor yang berhubungan dengan komorbiditas tuberkulosis-diabetes melitus.* ***Metode:*** *Desain penelitian menggunakan case-control study, sampel kasus adalah penderita TB dengan DM sebanyak 15 orang, sedangkan sampel kontrol adalah penderita TB tanpa DM sebanyak 30 orang. Variabel bebas meliputi usia, pendidikan, pekerjaan, tingkat keparahan TB, indeks massa tubuh, dan kualitas hidup, sedangkan variabel terikat adalah komorbiditas TB-DM. Instrumen yang digunakan adalah World Health Organization's Quality of Life Brief Version (WHOQOL-BREF). Analisis data dilakukan dengan menggunakan uji Chi-Square dan Independent T-test.* ***Hasil:*** *Hasil penelitian ini menunjukkan bahwa variabel domain usia (p= 0,011; OR= 6; 95% CI= 1,39-25,85), pendidikan (p= 0,03; OR= 4,12; 95% CI= 1,06-16,03), keparahan TB (p= 0,02; OR= 4,57; 95% CI= 1,18-17,67), dan kualitas hidup berhubungan secara signifikan dengan TB-DM dengan komorbiditas: fisik (p= 0,00; OR= 42,25; 95% CI= 6,82-261,61), psikologis (p= 0,03; OR= 4; 95% CI= 1,07-14,89) dan lingkungan (p= 0,01; OR= 10,54; 95% CI= 1,06-105,03).* ***Simpulan:*** *Faktor-faktor yang memengaruhi komorbiditas antara TB-DM meliputi usia, tingkat pendidikan, tingkat keparahan TB, dan kualitas hidup. Peningkatan imunitas pada pasien TB sangat penting untuk mengurangi keparahan TB dan komorbiditas TB-DM, dengan rekomendasi dukungan dari keluarga, orang tua, anak, dan teman untuk meningkatkan kualitas hidup bagi mereka yang menderita TB-DM.*

INTRODUCTION

The association between tuberculosis (TB) and diabetes mellitus (DM) has been recognized for hundreds of years. However, this association was overlooked once treatment for both illnesses became accessible. The International Diabetes Federation estimated that, in 2021, 537 million individuals were affected by diabetes, with 80% of diabetes mellitus cases occurring in developing nations (1). The prevalence of DM in Indonesia was estimated at 6.20% in 2019 and increased to 10.80% in 2021. Based on the 2018 basic health research in Indonesia, 10.90% of individuals aged 15 and older have type 2 diabetes mellitus (T2DM) (2). According to the Global Tuberculosis Report 2023, approximately 10.60 million people will develop tuberculosis in 2022, with Indonesia holding the second highest incidence of TB cases (1.60 million) following India (3).

Diabetes mellitus is highly prevalent among patients with tuberculosis, particularly in several countries with double burden of both infectious disease such as tuberculosis and non-communicable disease like diabetes mellitus type 2. The increasing number of people with TB and DM can affect the relationship between the both diseases. Findings from TB and DM screening show that the prevalence of TB in individuals with DM and the prevalence of DM in those with TB varies between 2% and 35% for both conditions. TB and DM signify a dual burden and pose a public health issue, becoming an increasing concern in low and middle-income countries facing high TB rates, such as in Indonesia (2). Based on the Integrated Tuberculosis Information System, Ministry of Health of Republic Indonesia reported that in October 2022 as many as

3,628 people with diabetes mellitus were screened for tuberculosis from 214,105 (1.69%) (4).

Several studies have reported on screening for DM in patients with TB. Prevalence of diabetes mellitus among tuberculosis patients in Asia is: South Korea 24.02%, India 15.82%, Thailand 7.11%, Indonesia 14.80%, and China 16.26%. In Africa it is: Ethiopia 8.28%, in North America it is Mexico 19.29% and Canada 19.71% and the United Kingdom is15.03% (5). Research by Ugarte-Gill et al (6) about comorbidity TB-DM from four TB-endemic countries shows that, out of 2186 TB patients, 267 had DM (12.50%). Age standardized prevalence of DM ranges from 10.90% in South Africa to 19.70% in Indonesia. In research by Puetri et al (7) at Banda Aceh, Indonesia, on tuberculosis patients, the result of testing HbA1c examination found 28.90% categorized DM and 19.90% categorized pre-diabetes. The prevalence of DM in patients with tuberculosis in Jember, Indonesia, as much as 23.40% (8).

Association between comorbidity TB-DM is not entirely understood, several researches indicate that DM can be caused by depressed immune system, through macrophage and lymphocyte activity, it can promote active TB disease. On the other hand, TB can be induced by glucose intolerance in individuals with DM (9), which can be increased to worse clinical outcomes related to TB-DM (10). Diabetes mellitus is a chronic disease which if not managed with proper treatments and care, can reduce the quality of life (QOL) of patients with tuberculosis, as well as for sufferers of co-morbidity TB-DM. Quality of life assesses individuals' perceptions of their position in life within the context of the culture and value systems in which they live with their concerns, standards, goals and their expectations (11). Quality of life of tuberculosis patients with DM overall is good and their perception about health is satisfied when they are given social support from family and close friends. This study was conducted to determine factors associated with tuberculosis-diabetes mellitus comorbidity.

METHODS

The research design used a case-control study. Sample cases consist of individuals diagnosed with tuberculosis and comorbidity type 2 diabetes mellitus (TB-DM) during the period from January to May 2019, sourced from medical records at six Public Health Centers in Bandung (Dago, Padasuka, Ujungberung Indah, Arcamanik, Antapani and Achmad Yani Public Health Center)

as many as 15 respondents. Sample controls are TB patients without a diagnosis of type-2 DM in their medical records. The case to control ratio employed was 1:2, resulting in a total of 30 respondents in the control group.

Inclusion criteria for case samples consist of patients diagnosed with TB who have positive acid-fast bacilli and are experiencing comorbidity with type 2 diabetes mellitus (DM) indicated by fasting blood sugar levels exceeding >126 mg/dl. The control samples consisted of TB patients without type 2 diabetes mellitus, originating from the same area of the Public Health Centre as the sample cases. The criteria for exclusion in this study included being younger than 14 years old and having an incomplete medical record. The sampling technique uses non-probability sampling for case sample and utilizes purposive sampling for control sample. Information was gathered through in-person interviews utilizing a structured questionnaire.

Independent variables include socio-demographic factors (age, education, occupation), severity of tuberculosis, body mass index (BMI), and quality of life, the dependent variable is the comorbidity TB and DM. The age variable was divided into < 40 years and ≥ 40 years of age. Education was classified into primary education (elementary school), secondary education (junior high school) and higher education (high school and university), while occupation was divided into employed and unemployed. Body mass index was classified as $\geq 25 \text{ kg/m}^2$ and $< 25 \text{ kg/m}^2$. To evaluate the severity of tuberculosis, we utilize clinical scoring; in this system, one point is assigned for each major symptom present, including cough, fever, weight loss, night sweats, anorexia, hemoptysis and malaise. The total score can range from 0, (absence of symptoms) to 7 (presence of all symptoms), patients with a score of ≥ 4 (cough, fever, night sweats, and weight loss) were categorized as having severe tuberculosis (12).

The quality of life was assessed using the World Health Organization's Quality of Life Brief Version (WHOQOL-BREF). The questionnaire consists of 26 items that are multiple-choice questions. There are additionally two questions from the perspective of participants regarding a person's overall assessment of quality of life (question 1) and a person's overall evaluation of general health (question 2). The remaining 24 questions were categorized into four domains: physical domain (7 questions), psychological domain (6 questions), social relationship domain (3 questions), and environmental domain (8

questions). The answer of each question was on a 5-point Likert Scale ranging from 1-5. The raw score in each domain was transformed into a range score from 1-100 following the WHOQOL-BREF guidelines. A quality of life domain score under 50% was classified as low QOL for every domain (11,13). The WHOQOL-BREF questionnaire which has been validated and translated into Indonesian, was evaluated in prior studies, revealing that all domain scores demonstrated excellent construct validity and strong internal consistency. A total Cronbach's alpha value of 0.62 was established, indicating sufficient reliability (14).

The relationships between variables were identified using bivariate analysis, using the chi-square test. The magnitude of the risk factor for comorbidity TB-DM was measured using the odds ratio (OR) and 95% confidence interval. Independent T-test was measured to differentiate scores of scores of ages, BMI physical domains, psychological domain, social relationship domain and environmental domain with co-morbidity TB-DM. The p-value was used as a significant test, with a significance level of 95% (alpha=0.05). This study has received approval from the Ethics Committee in School of Health Science Jenderal Achmad Yani Cimahi with registration Number: 18/KEPK/VII/2019. Written informed consent was obtained from all participants.

RESULTS

As shown in Table 1, patients with tuberculosis comorbidity with type 2 diabetes mellitus (TB-DM) were higher in age $\geq$ 45 years (80%) than age < 45 years old (20%). This study found that age was significantly statistical with a comorbidity TB-DM with p-value= 0.01. The magnitude of the risk factor for comorbidity TB with DM used odds ratio (OR) and found that OR=6, (95% CI= 1.39-25.85), which indicates that age $\geq$45 years is six times more likely to have comorbidity TB with DM compared to age <45 years old.

The comorbidity TB-DM occurs more often in respondents with primary education (73.30%) compared to secondary and higher education (26.70%). There was a significant difference of education level (p-value= 0.03) with comorbidity TB-DM, magnitude of the OR= 4.12 (95% CI= 1.06-16.03), which means that primary education has comorbidity TB-DM 4.12 times compared to secondary and higher education. Based on occupation, of respondents with comorbidity TB-DM the majority are working people (60%) as opposed to not working people (40%). However, the study didn't show a statistically significant association between occupation and comorbidity TB with DM (p-value= 0.24); OR= 2.10 (95%CI= 0.57-8.32).

Patients with tuberculosis with comorbidity diabetes mellitus have IMT $\geq$ 25 kg/m^2 higher (60%) compared to < 25 kg/m^2 (40%). The study didn't show a statistically significant association between IMT and comorbidity TB with DM (p-value= 0.99); OR= 0.86 (95%CI= 0.24-3.09). In this research, it was found that respondents with a clinical score $\geq$ 4 points was higher in patients with comorbidity TB-DM (53.30%) compared to TB patients without DM (20%). Severity of disease based on clinical score in patients' tuberculosis was significantly associated with comorbidity TB-DM (p-value= 0.02, with OR= 4.57, 95% CI= 1.18-17.67; it means that TB patients with clinical score $\geq$ 4 points are more at risk of developing comorbidity TB-DM than TB patients with clinical score < 4 points.

Of tuberculosis patients with comorbidity DM, the majority have poor physical quality of life (86.70%) compared to TB patients without DM (13.30%). Physical domain quality of life was associated with comorbidity TB-DM (p-value= 0.00), with OR= 42.25; 95% CI= 6.82-261.61. Poor psychological quality of life in patients with TB-DM was higher (66.70%) than without DM (33.30%); it was significantly associated with comorbidity TB-DM (p-value= 0.03, with OR= 4; 95% CI= 1.07-14.89. The majority of TB patients with DM have poor social quality of life (20%) compared to TB patients without DM (3.30%), although in this study social quality of life wasn't associated with comorbidity TB-DM (p-value= 0.06), with OR= 7.25; 95% CI= 0.68-76.86. Environment quality of life significantly associated with TB-DM (p-value= 0.01), with OR= 10.54; 95% CI= 1.06-105.03. Among tuberculosis patients with DM, the majority have a poor quality of life (26.70%) compared to patients without DM (3.30%).

Table 1

The Relationship between Age, Education, Occupation and Quality of Life in Patients with Comorbidity TB-DM and TB Patients

Variable	Comorbidity TB-DM				p-value	OR (95% CI)
	TB-DM		TB			
	n	%	n	%		
Age						
≥ 45 years	12	80	12	40	0.01	6 (1.39-25.85)
< 45 years	3	20	18	60		
Education						
Primary Education	11	73.30	12	40	0.03	4.12 (1.06-16.03
Secondary and higher education	4	26.70	18	60		
Occupation						
Not Working	6	40	7	23.30	0.24	2.1 (0.57-8.32)
Working	9	60	23	76.70		
Body Mass Index						
≥ 25 kg/m2	9	60	19	63.30	0.99	0.86 (0.24-3.09)
< 25 kg/m2	6	40	11	36.70		
TB Severity						
Severe TB (score ≥ 4)	8	53.30	6	20	0.02	4.57 (1.18-17.67)
Mild TB (Score < 4)	7	46.70	24	80		
Physical Domain						
Poor QOL	13	86.70	4	13.30	0.00	42.25 (6.82-261.61)
Good QOL	2	9.30	26	86.70		
Psychological Domain						
Poor QOL	10	66.70	10	33.30	0.03	4 (1.07-14.89)
Good QOL	5	33.30	20	66.70		
Social Domain						
Poor QOL	3	20	1	3.30	0.06	7.25 (0.68-76.86)
Good QOL	12	80	29	96.70		
Environment Domain						
Poor QOL	4	26.70	1	3.30	0.01	10.54 (1.06-105.03)
Good QOL	11	73.30	29	96.70		
Total	15	100	30	100		

Table 2

The Mean Difference between Age, BMI and Quality of Life

Variable	TB-DM (Mean±SD)	TB (Mean±SD)	p-value
Age	49.80±9.57	42.07±17.91	0.06
BMI	21.36±4.33	18.72±4.00	0.04
Physical Domain	41.07±9.46	59.03±11.55	0.00
Psychological Domain	45.53±12.40	58.93±25.72	0.00
Social Relationship Domain	52.87±10.26	68.13±14.52	0.00
Environmental Domain	49.60±6.19	61.10±12.36	0.00

Differentiated scores of ages, BMI and physical domains, psychological domain, social relationship domain and environmental domain with co-morbidity TB-DM are shown in Table 2. This research found that the average age in TB-DM patients was older (49.80±9.57 years) than TB patients without DM (42.07±17.91 years). However, in this research the age variable was not significant statistically with comorbidity TB-DM. This research found that respondents with TB-DM had BMI shown slightly higher (21.36±4.33) than TB patients without DM (18.72±4.00).

In this study there were differences in quality of-life scores in tuberculosis patients with and without DM based on the Physical Domain (p-value ≤0.05), Psychological Domain (p-value ≤0.05),

Social Relationship Domain (p-value= 0.00) and Environmental Domain (p-value= 0.00). Raw score for each domain of WHOQOL-BREF was transformed into a range score from 1-100, the higher score in each domain indicates a better quality of life (11). Table 2 shows that the mean±SD (standard deviation) for the physical domain of respondents with comorbidity TB-DM was 41.07±9.46, for psychological domain was 45.53±12.40, social relationship domain was 52.87±10.26 and for environmental domain was 49.60±6.19. Meanwhile, the mean±SD QOL in non-diabetic TB was found to be a higher value, which means that the quality of life in patients without DM was higher compared to respondents with TB-DM comorbidity.

DISCUSSION

Diabetes mellitus is a risk factor for development of active pulmonary tuberculosis, and TB patient with comorbidity with DM have a three times higher risk to suffer active TB. Patients with TB who have diabetes mellitus are more difficult to treat, resulting in poorer TB treatment outcomes, a higher chance of recurrence after treatment, and uncontrolled blood glucose levels that can lead to multi-drug resistant tuberculosis, thus increasing the risk of transmitting TB within the community(7,15). Individuals with diabetes mellitus who undergo anti-tuberculosis treatment are more likely to experience therapy failure and have a higher risk of mortality during treatment (15).

Multiple studies have indicated that a rise in TB incidence may lead to higher prevalence of DM over time. A South Asian study discovered that 11.24% of individuals with TB also have DM as a comorbidity, with variations such as in India (14-15%) and Indonesia 14.8% (5,16). The prevalence occurrence of non-communicable disease, such as DM rises with age, and various studies have shown that TB patients who also have type 2 diabetes mellitus tend to be older than those without DM. Increasing age was associated with increase in people having TB-DM comorbidity. Research by Kibirige et al. (2024) found that respondents having comorbidity TB-DM were older with mean=42.50 (95%CI= 37-53.50 years) than TB patients without DM, mean= 33.50 (95%CI= 25-42 years) and age ≥ 40 years was associated with comorbidity of TB-DM, and age was significantly related with TB-DM with adjusted odds ratio (AOR) = 3.12 (95%CI= 1.35-7.23, p value= 0.08)

(17). Research by Nababan et al (18) found prevalence of type 2 diabetes mellitus higher in age ≥ 40 years (60.98%). Patients aged ≥ 45 years were higher among TB-DM (78.90%) compared to non-diabetic TB (39.20%) with p value < 0.01 (19). Research by Anyanwu et al (20) found prevalence of TB-DM higher for older persons (≥ 45 years) as much as 35.70% and there was significant difference between age and TB-DM comorbidity with p value= 0.00. Research by Tenaye et al (21) found the age of tuberculosis patients was a strong predictor for incidence of DM, with OR= 9 (≥ 41 years), and OR= 6 (for 26-40 years).

In this research, the majority of patients with comorbidity of TB-DM had primary education compared with secondary and higher education. TB-DM comorbidity was higher in respondents with no formal education and primary school (31.70%) and had significant association of education level with comorbidity of TB-DM (p value= 0.02) (20). TB patients with DM have no formal education as much as 21.40% (21). Several factors affect health status of people in a community, such as low-level education, whereas it can be related to several diseases for communicable and non-communicable disease, higher stress level and lower self-esteem. It is important to provide educational programs to the community, including increasing knowledge about disease prevention and complication, self-care management behavior such as adherence to treatment for TB and diabetic medication, and healthy life (20).

Additional factors related to risk factors for DM, such as obesity, can lead to more susceptibility for development of diabetes in TB patients. This research found that respondents with TB-DM had BMI slightly higher than TB patients without DM. Patients with TB-DM have BMI 21.90 (3.80%), compared to non-diabetic TB with BMI= 19.70 (3.30%) (22). Study by Kibirige et al (17) shows that patients with TB-DM have BMI 19 (17.50-22.50 kg/m2), compared to non-diabetic TB with BMI= 19.20 (95%CI= 17.80-21.30 kg/m2). In this research, prevalence of obesity was higher in people with TB-DM compared to non-diabetic DM. People with comorbidity of TB-DM and categorized obesity was 25% (23).

The relationship for BMI in comorbidity TB-DM is complex, while obesity and overweight are an increasing risk factor for DM type2, but it is a protective factor for TB. Weight loss due to uncontrolled DM can reduce this protection and can be the risk factor for tuberculosis disease. Long period of DM is associated with uncontrolled level

of blood glucose and can impair immune response to elimination of Mycobacterium tuberculosis, especially with regard to reducing bactericidal activity of leukocytes. Diabetes mellitus can weaken the immune system and be more susceptibility to TB infection. Hyperglycemia in people with DM has been assumed to increase the growth of bacteria and propagation of Mycobacterium tuberculosis (5).

Increasing TB in people with DM causes a defect and delay in function of innate immunity and adaptive immunity and decreases host defense mechanism, such as a depressed function of polymorph nuclear leukocyte, phagocytosis and defect in alveolar macrophages or delayed antigen presenting cell and T-helper cells activation (24,25). Comorbidity TB-DM can cause decrease in immunity and alteration of immune function in patients, such as depressed innate immunity, dysfunction for alveolar macrophage activity, low production of interferon gamma and reduction of intleukin-12, where the immune system plays a role in eliminating TB bacteria. This will affect the progression of TB disease, becoming extensive and severe in patients with comorbidity TB-DM (25,26).

In this research, the majority of respondents experienced cough, weight loss, anorexia, night sweats, malaise and fever. To assess tuberculosis disease severity, we use clinical score for presence of each major symptom of TB, and categorize severe TB if clinical score ≥4 points, including cough, fever, night sweats and weight loss (12). The majority of TB symptoms are cough (96.90%), weight loss (78.10%), night sweat (56.30%) and fever (40.60%), although in this study there was no relationship between symptoms of TB with TB-DM comorbidity (17). Patients with comorbidity TB-DM frequently exhibited symptoms classically higher than in patients with TB-DM, such as fever, cough, night sweat, dyspnea and weight loss. Patients had fatigue higher in TB-DM (58.30%) compared to TB without DM (47.50%), with p value=0.01, and loss of weight higher in TB-DM (8.21± 6.20 kg) compared with TB without DM (5.74± 4 kg) with p value <0.01 (22).

Clinically, people with comorbidity of TB-DM have more symptoms compared with people with non-diabetic TB, such as cough, night sweats, weight loss, dyspnea, and longer duration of fever; this will affect their daily activities or sleep. Tuberculosis patients with DM find a higher bacterial burden, and this condition can be impacted to delay sputum smear and culture conversion time. Severity of disease and more clinical presentation

can result into adverse treatment in patients with TB-DM, such as treatment failure, delay in bacterial clearance, relapse, drug resistant for tuberculosis, and increased mortality (24). Individuals with comorbid TB-DM will receive a greater number of drugs for medical therapy than patients without DM; this can decrease the level of compliance and anti-tuberculosis drugs have more side effects, such us tiredness, nausea and psychological disorder. Comorbidity of COVID-19 in patients with type 2 diabetes mellitus was found to have a vulnerable psychological impact such as severe stress and anxiety (27).

In this research, the majority of respondents with comorbidity of TB-DM had a poor quality of life compared to non-diabetic TB. Respondents who had suffered from a chronic disease such as type 2 diabetes mellitus and also had other diseases such as tuberculosis, can worsen the disease and reduce quality of life score. The score of quality of life before and after anti-tuberculosis drugs administration is higher in patients without DM (41.72%) compared to patients with DM (26.38%) (28).

In this research, physical domain quality of life, psychological domain and environment domain quality of life were associated with comorbidity TB-DM. Respondents with TB-DM have a higher poor physical quality of life (16.70%) compared to non-diabetic DM (9.70%) (13). TB patients with DM have a poor quality of life term physical domain, they have more symptoms such as cough, night sweats, anorexia, fever, and experience physical effect such a fatigue, shortness of breath, decreased quality of sleep, nausea, vomiting, and dizziness, so it will decrease quality of live and affect daily activities, as well as the ability to interact in community or abilities in the workplace (29).

The psychological domain was significant with comorbidity TB-DM (p-value= 0.00) (13). The domain of quality of life for physical functioning, vitality, social functioning and general of health were statistically significantly in quality of life before and after anti-tuberculosis drugs administration with p value < 0.01 (28).

People who have tuberculosis were not satisfied with their personal relationship and don't have support from their friends, despite having a poor physical health quality of life, as it caused fear of TB infection (11). People with comorbidity TB-DM have psychological effect , such as depression because they get social stigma of the disease from the community, have low social support from

family, friends or significant others and complex treatment of the disease and its side effects (29).

Policy Implication

Coordinated actions are essential to enhance treatment monitoring in TB patients through treatment initiatives in primary care, like Public Health Centers that practice Directly Observed Shorts Course Therapy (DOTS), and provide adequate nutritional support for TB patients, to help mitigate the progression and intensity of TB disease and prevent the development of TB-DM comorbidities. Screening for DM is essential for all TB patients to ensure that treatment starts promptly and to avoid the deterioration of the disease.

TB patients with DM are suggested to have support from family, parent, children, and friends to reduce the impact of tuberculosis on their quality of life. Healthcare and professionals can be a consideration in maintaining of the disease such as self-management support in order to involve the families and friends to improve their quality of life (11).

CONCLUSION

This research showed that social-demographic variables (age, education) and severity of tuberculosis were significantly associated with comorbidity TB-DM. Based on domain in quality of life, only the social domain wasn't significant with comorbidity TB-DM. The average age in TB-DM patients was older, and BMI was slightly higher compared to TB patients without DM. In the quality of life domain, the mean score indicated that the majority of tuberculosis patients with comorbidity DM had a poor quality of life compared to tuberculosis patients without DM.

Future studies should use larger sample sizes and more detailed questionnaires and include other variables such as physical environment, which includes inadequate house ventilation and contact with TB patients, and clinical conditions, which include undernutrition and inadequate glycemic control.

CONFLICT OF INTEREST

The authors declare there is no conflict of interest that might have affected the performance of the work described in this manuscript.

AUTHOR CONTRIBUTIONS

All authors contributed to the research. DKN: developed the proposal, developed the instrument, performed data analysis and interpreting data, and drafted manuscript. IK: developed instrument, data collecting. TAB: methodology, processing data. NEM: administration and supervision, revised this manuscript.

REFERENCES

1. International Diabetes Federation. IDF diatebes atlas 10th edition. 10 th. Diabetes Research and Clinical Practice. 2021.
2. Soeatmadji DW, Rosandi R, Saraswati MR, Sibarani RP, Tarigan WO. Clinicodemographic profile and outcomes of type 2 Diabetes Mellitus in the Indonesian Cohort of DISCOVER: a 3-year prospective cohort study. J ASEAN Fed Endocr Soc. 2023;38(1):68–74.
3. WHO. Global tuberculosis report [Internet]. France; 2018.
4. Ministry of Health of the Republic of Indonesia. Tuberculosis control in Indonesia 2022. 2022.
5. Khattak M, Rehman A ur, Muqaddas T, Hussain R, Rasool MF, Saleem Z, et al. Tuberculosis (TB) treatment challenges in TB-diabetes comorbid patients: a systematic review and meta-analysis. Ann Med. 2024;56(1).
6. Ruiz-Grosso P, Cachay R, de la Flor A, Schwalb A, Ugarte-Gil C. Association between tuberculosis and depression on negative outcomes of tuberculosis treatment: A systematic review and meta-analysis. PLoS One. 2020;15(1):e0227472.
7. Puetri NR, Hadifah Z, Nur A, Hanum S. Comparison of HbA1c levels in patients with TB-DM and TB-non DM. Maj Kedokt Bandung. 2019;51(3):141–6.
8. Sasmita HY, Prasetyowati I, Wahjudi P. Prevalence and risk factors of diabetes mellitus in tuberculosis patient at Patrang

District Indonesia. Indones J Trop Infect Dis. 2019;7(4):79.

9. Wang Q, Ma A, Han X, Zhao S, Cai J, Ma Y, et al. Prevalence of type 2 diabetes among newly detected pulmonary tuberculosis patients in china: A community based cohort study. PLoS One. 2013;8(12):1–8.

10. Gil-Santana L, Almeida JL, Oliveira CAM, Hickson LS, Daltro C, Castro S, et al. Diabetes is associated with worse clinical presentation in tuberculosis patients from Brazil: A retrospective cohort study. PLoS One. 2016;11(1):1–13.

11. Tornu E, Quarcoopome L. Correlates of quality of life among persons living with tuberculosis: A cross-sectional study. PLoS One. 2022;17(11 November):1–13.

12. Baik Y, Rickman HM, Hanrahan CF, Mmolawa L, Kitonsa PJ, Sewelana T, et al. A clinical score for identifying active tuberculosis while awaiting microbiological results: Development and validation of a multivariable prediction model in sub-Saharan Africa. PLoS Med. 2020;17(11):1–23.

13. Yadav K, N S, RK Y, CS Gu. Assessment of health-related quality of life among tuberculosis patients with and without diabetes in western region of Nepal. SAARC J Tuberc. 2019;17(2):15–21.

14. Sartika I, Insani W, Abdulah R. Assessment of health-related quality of life among tuberculosis patients in a public primary care facility in Indonesia. J Glob Infect Dis. 2019;11(3):102–6.

15. Anasulfalah H, Tamtomo DG, Murti B. Effect of diabetes mellitus comorbidity on mortality risk in tuberculosis patients who received tuberculosis treatment: a meta-analysis. J Epidemiol Public Heal. 2022;7(4):441–53.

16. Boadu AA, Yeboah-Manu M, Osei-Wusu S, Yeboah-Manu D. Tuberculosis and diabetes mellitus: The complexity of the comorbid interactions. Int J Infect Dis. 2024;146:107140.

17. Kibirige D, Andia-Biraro I, Olum R, Adakun S, Zawedde-Muyanja S, Sekaggya-Wiltshire C, et al. Tuberculosis and diabetes mellitus comorbidity in an adult Ugandan population. BMC Infect Dis. 2024;24(1):1–9.

18. Nababan M, Umbul Wahyuni C, Aguslina Siregar F. Factors associated with type 2 Diabetes Mellitus at Adam Malik General Hospital, Medan, Indonesia. J Berk Epidemiol. 2023;11(2):189–97.

19. Jiang W, Trimawartinah, Rahman FM, Wibowo A, Sanjaya A, Silitonga PII, et al. The co-management of tuberculosis-diabetes co-morbidities in Indonesia under the National Tuberculosis Control Program: results from a cross-sectional study from 2017 to 2019. BMC Public Health. 2022;22(1):1–10.

20. Anyanwu MO, Ajumobi OO, Afolabi NB, Usman A, Kehinde A. Diabetes mellitus and its associated factors among patients with tuberculosis attending directly observed treatment centres in Oyo State, Nigeria: a cross-sectional evaluation. BMJ Open. 2022;12(4):1–7.

21. Tenaye L, Mengiste B, Baraki N, Mulu E. Diabetes Mellitus among adult tuberculosis patients attending tuberculosis clinics in Eastern Ethiopia. Biomed Res Int. 2019;2019(Dm).

22. Tong X, Wang D, Wang H, Liao Y, Song Y, Li Y, et al. Clinical features in pulmonary tuberculosis patients combined with diabetes mellitus in China: An observational study. Clin Respir J. 2021;15(9):1012–8.

23. Araia ZZ, Mesfin AB, Mebrahtu AH, Tewelde AG, Osman R, Tuumzghi HA. Diabetes mellitus and its associated factors in tuberculosis patients in Maekel region, eritrea: Analytical cross-sectional study. Diabetes, Metab Syndr Obes. 2021;14:515–23.

24. Cáceres G, Calderon R, Ugarte-gil C. Tuberculosis and comorbidities : treatment challenges in patients with comorbid diabetes mellitus and depression. 2022;1–17.

25. Liberty P, Liberty M. Type 2 Diabetes Mellitus and pulmonary tuberculosis : literature review of a bidirectional relationship epidemiology of T2DM and pulmonary. Scr SCORE Sci Med J 2023; 5. 2023;5(1):69–75.

26. Foe-Essomba JR, Kenmoe S, Tchatchouang S, Ebogo-Belobo JT, Mbaga DS, Kengne-Ndé C, et al. Diabetes mellitus and tuberculosis, a systematic review and meta-analysis with sensitivity analysis for studies comparable for confounders. PLoS One. 2021;16(12 December 2021).

27. Hikmah K, Helda H, Killeen C. Coronavirus-related anxiety with

hyperglycemia in type 2 diabetes patients. J Berk Epidemiol. 2022;10(2):111–20.

28. Ksatriaputra A, Kholis FN, Ngestiningsih D, Bambang Hariyana. Quality of life among tuberculosis patients with and without diabetes mellitus before and after anti-tb drugs administration. J Kedokt Diponegoro. 2020;9(6):475–82.

29. Febi AR, Manu MK, Mohapatra AK, Praharaj SK, Guddattu V. Psychological stress and health-related quality of life among tuberculosis patients: A prospective cohort study. ERJ Open Res. 2021;7(3).