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Determinants of Type II Diabetes Mellitus among Tuberculosis Patients in Yangon Region, Myanmar

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ABSTRACT

Background: Although having Diabetes Mellitus might adversely affect tuberculosis treatment outcomes and reduce the likelihood of a favorable outcome, studies are still limited to identify many problems related to diabetes mellitus.

Objectives: To identify factors influencing Type 2 diabetes mellitus among tuberculosis patients in Yangon region, Myanmar.

Methods: A case control study conducted in the Yangon Region of Myanmar. Structured interview questionnaires were used for data collection after obtaining the informed consent. This study included 73 cases (TB patients with DM) and 146 controls (TB patients without DM) who were under tuberculosis treatment in 2023. Unconditional multivariable logistic regressions, crude odds ratios, and Adjusted Odds Ratios (AOR) with 95% confidence intervals and P-values < 0.05 were applied for significant association.

Results: Of the 219 TB patients, 112 (51.14%) were male and 107 (48.86%) were female. The study observed that the risk factors of type 2 diabetes mellitus comorbidity among tuberculosis patients were: female TB patients (AOR= 2.84, 95% CI:1.36-5.94), aged 45 years and older (AOR=3.04, 95% CI: 1.45-6.37), who were married (AOR=2.28,95% CI:1.03-5.04), diagnosed by GeneXpert (AOR=2.66, 95% CI:1.22-5.79), those who had a family history of DM (AOR=4.08, 95% CI: 1.94-8.58), and those who had BMI ≥25 (AOR=9.00, 95% CI: 2.71-29.95).

Conclusion: Based on findings, women TB patients, TB patients aged 45 years and older, married TB patients, TB patients detected by GeneXpert results, and TB patients with a family history of DM and a higher BMI were strong determinants of having TBDM. Therefore, encouraging health promotion on physical exercise, TB awareness campaign, pre-diabetes and diabetes screening and management among TB patients is crucial for the management of lifestyle and effective measures for the TB and comorbid disease control program.

Keywords: Diabetes Mellitus, Tuberculosis, Age, Obesity, Myanmar

1. Introduction

Tuberculosis (TB) is a disease caused by *Mycobacterium Tuberculosis* that mostly affects the lungs; however, it is a curable and preventable disease [1]. It is one of the preventable major health problems and the top ten leading cause of death in Myanmar [2]. Myanmar is one of the 30 most TB/TB-HIV/MDR-TB prevalent countries in the world [3, 4]. According to the WHO SEA Region 2020 report, 43% of new cases were found in the SEA Region. Among them, 86% of new TB cases occurred in the 30th highest TB burden countries [5]. In comparison to other regions and states in Myanmar, Yangon Region has 10% TB prevalence rate among newly diagnosed TB cases that is twice than that of other regions.

Diabetes Mellitus (DM) is one of the most documented diseases among tuberculosis patients, which can worsen TB treatment and its complications [6] and has a great impact on socio-economic conditions [7]. Moreover, DM is the global top ten cause of death [8], and it was estimated that DM prevalence in 2019 was 9.3% (463 million people), rising to 10.2% (578 million) by 2030 [9].The majority is type 2 diabetes mellitus (T2DM), which affects more than 95% of people with diabetes, and around 8.5% of DM cases were found among those aged 18 years and older in 2014 [10]. According to the 2014 WHO Stepwise National Survey, DM prevalence of Myanmar was 10.5%. Yangon Region has the highest DM prevalence (18.2%) [11].

Although having DM might adversely affect TB treatment outcomes, reduce the likelihood of a favorable outcome, and increase drug resistance, limited studies have been conducted to identify many of the problems related to T2DM among TB patients in Myanmar. Therefore, this study aimed to identify influencing factors associated with type 2 DM among adult TB patients in Yangon Region, Myanmar.

2. Methodology

2.1 Study Design

This study was an observational, unmatched case-control study conducted in the Yangon Region of Myanmar in 2023. For this study, a simple random sampling method was used to select participants in accordance with inclusion and exclusion criteria. Data collection was done through interview questionnaires after obtaining informed consent. This study included 73 cases and 146 controls who had been under tuberculosis treatment in 2023.

2.2 Study Area

This study was carried out in Yangon Region which is the most populous region in the Union of Myanmar and includes 4 districts and 44 townships with the covered population of around 7.4 million as of 2014 census data. In Yangon, 8 townships that included Hlaingtharya, Insein, Dawbon, Dala, Hlegu Mingalartaungnyunt, Twantay, & Thongwa Townships were randomly selected for this study.

2.3 Study Population

Tuberculosis patients, both with DM and without DM, both sex, male and female, aged 18 years and above who had been diagnosed and registered under National TB program for the treatment were recruited in this study.

2.4 Inclusion and Exclusion Criteria

Patients with all forms of diagnosed tuberculosis cases of both sexes aged 18 years and above who were willing to participate in this study were included in this study. For the case, it included TB patients with T2DM, but TB patients without DM were under control. The critically ill patients included mental or psychologically ill patients, institutionalized individuals (members of the armed forces, hospitalized patients, prisoners) and those who did not provide consent were excluded from the study. To avoid fasting effect, religious groups such as monk/ nun and people from Muslim community were excluded.

2.5 Sample Size and Sampling Techniques

The sample size for this study was 219, comprising of 73 cases and 146 controls. The participants were over 18 years old and undergoing drug-sensitive TB treatment under the national TB program during the tine of data collection. Case patients were selected based on the inclusion and exclusion criteria. However, control TB patients were randomly selected from among the participants with TB who didn't have diabetes mellitus in the blood sugar test or diagnosed by medical doctor from national TB program.

2.5.1 Definitions of Case and Control

The cases included TB patients with T2DM who were on TB treatment at the time of data collection, diagnosed by the National Tuberculosis Program (NTP) as T2DM or by testing blood glucose level using WHO cut off point (fasting, >126 mg/dl (≥ 7.0 mmol/l) or as random,>/200mg/dl (≥ 11.1 mmol/l).

For the control, patients having TB without T2DM were included, i.e., those who were registered as TB patients under the NTP,

however not diagnosed as T2DM either by NTP or blood glucose testing.

2.6 Ethical Clearance

This study has been approved by the Human Research and Ethics Committees of the Khon Kaen University of Thailand and the MHAA organization (HE662102 and MHAA approval no. 4.3.01:19/2566). Informed consent was obtained from all the respondents and participants.

2.7 Research Instruments

A structured interview questionnaire was used to identify the characteristics of T2DM, and the factors associated with T2DM among TB patients for the following variables. The pre-test consisted of five parts as follows:

Part I: Socio-demographic factors

Part II: Health Status Characteristics

Part III: History of Disease

Part IV: Behavior and Environmental Factors

Part V: Knowledge and Attitude on Diabetes Mellitus

2.8 Data Collection

In this study, there were two sources of information; (1) secondary data from the TB patient register; patient ID, TB diagnostic results including information and treatment category, DM screening result, and types of TB, and (2) a structured questionnaire along with anthropometric measurement, and fasting blood glucose test. Volunteers were interviewed using a systematic, previously tested questionnaire to gather information on socio-demographic traits, behavior, knowledge, attitude, and findings of the disease related factors around 15-20 minutes. The study's questionnaires were written in English and translated into Burmese (languages spoken by study participants). Those questionnaires were collected via Google form. The questionnaires were pretested on 30 TB patients beforehand to see if the items were consistent and clear.

2.9 Data Analysis

The baseline characteristics of the respondents, such as gender, age, education, occupation, income, BMI, physical activity, smoking, alcohol consumption, and eating habits were presented with frequency distribution and percentages for categorical data; the mean, standard deviation, median, maximum, and minimum showed the results of the continuous data. Frequency and percentage values for environmental and occupational factors, including metabolic factors, knowledge, and attitude of the patients were provided as categorical

variables. The dependent variable, DM among TB patients, was dichotomized as yes or no and subjected to bivariate, multivariable, and conditional logistic regression.

The link between the variables was assessed using simple logistic regression (bivariate analysis), utilizing the crude Odds Ratio (OR) and 95% Confidence Interval (CI) for each variable. An unconditional logistic regression analysis was simultaneously included for the variables with a P-value <0.25. For the final model using backward elimination, the variables with a P-value <0.05 were inferred as associated factors. All analyses were performed using Stata version 18.0. The variables with a P-value <0.05 were inferred as associated factors.

3. Results

In this study, a total of 219 patients (case=73, control=146) were randomly enrolled from 8 townships in Yangon Region, Myanmar. Table 1 shows socio-demographic characteristics: most of the participants in the case were female (48, 65.75%) and in the control were male (87, 59.59%). Majority of the TB patients with DM were aged ≥45 years (51, 69.86%); however, the control aged <45 years (75, 51.37%). More than 72% of the respondents, both case and control, lived in urban areas. Most cases (78.08%) were married, compared to the control (61.64%) in the study population.

In addition, the health status and history of DM, only around (37, 50.68%) of the cases and controls (26, 17.81%) had a family history of DM.

Table 1: Basic Characteristics of the respondents (Case=73, Control=146)

Characteristics	Case (n=73)		Control (n=146)	
	Number (n)	%	Number (n)	%
Gender				
Male	25	34.25	87	59.59
Female	48	65.75	59	40.41
Age				
<45 years	22	30.14	75	51.37
≥45 years	51	69.86	71	48.63
Mean (SD)	51.47 (±9.58)		44.78 (±15.15)	
Median (Min:Max)	52 (30:73)		43 (18:75)	
Place of residence				
Urban	53	72.60	107	73.29
Rural	20	27.40	39	26.71
Marital status				
Single	5	6.85	37	25.34
Married	57	78.08	90	61.64
Separated	3	4.11	6	4.11

Characteristics	Case (n=73)		Control (n=146)	
	Number (n)	%	Number (n)	%
Widow/Widower	7	9.59	11	7.53
Others	1	1.37	2	1.37
Occupation				
Unemployment	37	50.68	49	33.56
Manual Worker	9	12.33	36	24.66
Civil services	5	6.85	5	3.42
Private staff	3	4.11	21	14.38
Own Business	19	26.03	35	23.97
Gene-Xpert results				
Not detected	22	30.14	56	38.36
Detected	51	69.86	90	61.64
Family History of DM				
No	36	49.32	120	82.19
Yes	37	50.68	26	17.81
Age of DM diagnosis (years)				
<45	24	32.88	75	51.37
≥45	49	67.12	71	48.63
Mean (S.D)	51.15(±9.56)		44.30 (±15.19)	
Median (Min:Max)	52(30:73)		43(17:74)	
Smoking				
Nonsmoker	54	73.97	85	58.22
Current Smoker	4	5.48	24	16.44
Ever smoker but now quitted	15	20.55	37	25.34
Alcohol consumption				
Never drink	60	82.19	107	73.29
Current drinking	4	5.48	12	8.22
Ever smoker but now quitted	9	12.33	27	18.49
Dietary Patterns				
Healthy (<12 scores)	19	26.03	20	13.70
Moderate (≥12 to <18 scores)	38	52.05	104	71.23
Poor (≥ 18 scores)	16	21.92	22	15.07
Physical Exercise				
Less (<7 scores)	24	32.88	40	27.40
Inadequate (≥7 to <11 scores)	28	38.36	49	33.56
Adequate (≥11 scores)	21	28.77	57	39.04
Knowledge on TB&DM				
Poor (<60 scores)	2	2.74	6	4.11
Moderate (≥60 & <80 scores)	29	39.73	77	52.74
Good (≥80 scores)	42	57.53	63	43.15
Attitude on TB&DM				
Poor (<60 scores)	4	5.48	7	4.79
Moderate (≥60 & <80 scores)	52	71.23	102	69.86
Good (≥80 scores)	17	23.29	37	25.34
Body Mass Index (BMI)				
Underweight (18.5)	8	10.95	60	41.10
Normal (≥18.5 to <23)	30	41.10	68	46.58

Characteristics	Case (n=73)		Control (n=146)	
	Number (n)	%	Number (n)	%
Overweight (≥23 to <25)	16	21.92	6	4.11
Obese (≥25 and above)	19	26.03	12	8.22
Mean (S.D)	23.30 (±4.67)		19.63 (±3.29)	
Median (Min: Max)	18.90 (14.36: 39.88)		22.82 (14.01:32.88)	
Waist Circumference (cm)				
Normal (Male <90 cm & Female <80 cm)	39	53.42	131	89.73
Central Obesity (Male ≥90 cm & Female ≥80 cm)	34	46.58	15	10.27
Mean (S.D)	83.24 (±10.65)		73.26(±9.77)	
Median (Min: Max)	82 (60:112)		72 (33:98)	

Table 2 revealed that risk factors associated with type 2 DM among TB patients. According to the study results, female TB patients (OR= 2.83, 95% CI: 1.57-5.09, p-value <0.001), participants aged ≥45 years (OR=2.45, 95% CI: 1.35-4.44, p-value 0.003), and those who were married (OR= 2.22, 95% CI: 1.16-2.23, p-value 0.012) had a significant risk of having T2DM. In addition, the participants who had central obesity had 7.6 times higher risk of getting T2DM with OR= 7.6 (95% CI of 3.76-15.41, p-value of <0.001). Similarly, the patients who had a family history of DM had five times higher chance of having T2DM (OR = 4.74, 95% CI: 2.54-8.85, p-value, 0.001). However, the TB patients who did physical activity (OR = 0.51; 95% CI, 0.26-0.99; p-value, 0.042) were less likely to have T2DM.

Table 2. Risk of T2DM among TB patients: Bivariate Analysis

Risk Factors	Case (n=73)		Control (n=146)		COR	95% CI	P Value
	Number	%	Number	%			
Gender							<0.001
Male	25	34.25	87	59.59	1	1	
Female	48	65.75	59	40.41	2.83	1.57-5.09	
Age group							0.003
<45 years	22	30.14	75	51.37	1	1	
≥45 years	51	69.86	71	48.63	2.45	1.35-4.44	
Marital status							0.012
Single	16	21.92	56	38.36	1	1	
Married	57	78.08	90	61.64	2.22	1.16-4.23	
Occupation							0.014
Unemployment	37	50.68	49	33.56	1	1	
Employment	36	49.32	97	66.44	0.49	1.16-4.23	
Body Mass Index (BMI)							<0.001
Underweight	8	10.95	60	41.10	1	1	
Normal	30	41.10	68	46.58	3.31	1.41-7.77	

Risk Factors	Case (n=73) Number	%	Control (n=146) Number	%	COR	95% CI	P Value
Overweight	16	21.92	6	4.11	20	6.06-65.97	
Obese	19	26.03	12	8.22	11.88	4.23-33.35	
Waist Circumference (cm)							<0.001
Normal	39	53.42	131	89.73	1	1	
Central Obesity	34	46.58	15	10.27	7.61	3.76-15.41	
Gene-Xpert results							0.228
Not detected	22	30.14	56	38.36	1	1	
Detected	51	69.86	90	61.64	1.44	0.79-2.63	
Age of DM diagnosis							0.009
<45 years	24	32.88	75	51.37	1	1	
≥45 years	49	67.12	71	48.63	2.16	1.19-3.88	
Family history of DM							0.001
No	36	49.32	120	82.19	1	1	
Yes	37	50.68	26	17.81	4.74	2.54-8.85	
History of smoking							0.021
Nonsmoker	54	73.97	85	58.22	1	1	
Smoker	19	26.03	61	41.78	0.7	0.51-0.95	
History of alcohol consumption							0.137
Never drink	60	82.19	107	73.29	1	1	
Drinker	13	17.81	39	26.71	0.59	0.29-1.20	
Dietary patterns							0.028
Healthy Food	19	26.03	20	13.70	1	1	
Unhealthy Food	54	73.97	126	86.30	0.67	0.47-0.96	
Physical Exercise							0.042
Inadequate	58	79.45	97	66.44	1	1	
Adequate	15	20.55	49	33.56	0.51	0.26-0.99	

All variables that had shown a possible statistically significant association with DM (p-value <0.25) in the bivariate analysis (excluding the multi-coli nary effect) were considered to a multivariable analysis. In multivariable logistic regression (table 3), female TB patients (AOR, 2.84, 95% CI: 1.36-5.94, p-value, 0.006), aged ≥45 years (AOR, 3.04, 95% CI: 1.45-6.37, p-value, 0.003) and married (AOR, 2.28, 95% CI: 1.03-5.04, p-value, 0.041), diagnosed with GeneXpert (AOR, 2.66, 95% CI: 1.22-5.75, p-value, 0.013), had family history of DM (AOR, 4.08, 95% CI: 1.94–8.58, p-value, <0.001), and those who had higher BMI ≥25 (AOR, 9.0, 95% CI: 2.71–29.9, p-value, <0.001) were more prone to have T2DM.

Table 3.Diterminants of Type II Diabetes Mellitus among Tuberculosis patients: Multivariate Analysis

Risk Factors	Case(n=73) Number	%	Control (n=146) Number	%	COR	AOR	95% CI	P-value
Gender								0.006
Male	25	34.25	87	59.59	1	1	1	
Female	48	65.75	59	40.41	2.83	2.84	1.36-5.94	

Risk Factors	Case(n=73)		Control (n=146)		COR	AOR	95% CI	P-value
	Number	%	Number	%				
Age of DM Diagnosis (Years)								0.003
<45 years	24	32.88	75	51.37	1	1	1	
≥45 years	49	67.12	71	48.63	2.26	3.04	1.45-6.37	
Family history of DM								<0.001
No	36	49.32	120	82.19	1	1	1	
Yes	37	50.68	26	17.81	4.74	4.08	1.94-8.58	
Marital Status								0.041
Single and others	16	21.92	56	38.36	1	1	1	
Married	57	78.08	90	61.64	2.22	2.28	1.03-5.04	
GeneXpert Result								0.013
Not detected	22	30.14	56	38.36	1	1		
Detected	51	69.86	90	61.64	1.44	2.66	1.22-5.75	
Body Mass Index (BMI)								<0.001
Underweight	8	10.95	60	41.10	1	1	1	
Normal	30	41.10	68	46.58	3.31	3.60	1.39-9.29	0.008
Overweight	16	21.92	6	4.11	20	10.98	2.99-40.27	<0.001
Obesity	19	26.03	12	8.22	11.88	9.00	2.71-29.95	<0.001

4. Discussion

According to previous study, DM can increase the risk of getting TB disease, treatment complications, and effects on the treatment result [6]. In this present study, the proportion of female participants in case were around (66%) and (40%) in control. Similarly, a case control study of T2DM in Yangon Region, Myanmar also found that the proportion of women (68.7%) was greater than men (31.3%) [12]. Another study also illustrated that the prevalence of DM among females (11.8%) has a higher risk than that of males (9.1%) [11]. It might be due to the culture of the women; most of the women take responsibility of household tasks that leads to sedentary lifestyle in Myanmar. In contrast, a study from Vietnam showed that men had more high risk behavior than women to have DM as men were more exposed to risk of TB[13].

It is clearly seen that the patients who were more than 45 years of age had 3 times increased risk of having diabetes mellitus compared to patients less than 45 years. Therefore, in this study, age of DM diagnosis had strong association with DM among TB patients. A household-based cross-sectional design, based on the methodology of the WHO STEP wise approach study from Myanmar also found that the risk of having DM was increased with advancing age group compared to 25-34 years old with 2 times higher risk in 35-45 years, 2.7 folds higher odds in 45-54 years and 6.4 times higher risk in 55-64 years [11]. It might be due to the reason that older people spend less time on

physical activities than that of the younger people.

In this study, the married TB patients had more than two times odds of having DM compared to TB patients who were single and had other marital status. According to Myanmar culture, most of the married people spend their time with family on enjoyable activities such as gathering, eating, spending sedentary life with family and less outgoing activities. A study found that marital status with TB patients who were separated, divorced, or widowed had 3.7 times and married persons had 3.7 times significantly higher risk of having DM compared with never-married TB patients [14]. It might be due to the reason that married individuals are engaged in income generating activities leading to physically inactive/less active lifestyle.

Similarly, having TB with GeneXpert positive cases were bacteriologically confirmed cases and those had 2.6 times higher risk of having diabetes than that of negative cases. Similar results were also found in one study from Beijing, China in 2019, GeneXpert positive stool patients had nearly 10 times higher risk of having have diabetes than that of patient with negative result [15]. Diabetes is a well-known risk factor and can weaken the immune system to have Tuberculosis and thus, most sputum positive patients have DM [16].

The study also observed that TB patients who had family history of DM had 4.08 times higher risk of having TBDM. A cross-sectional study at TB clinics in Eastern Ethiopia revealed that TB patients with family history of DM had 4 times higher risk of having DM than that of patients with no family history of DM [17]. It is obvious that DM is one of the genetic diseases and people who have family history of DM have more chance to get DM.

According to this study, BMI, the odds of having diabetes mellitus among TB patients was 3.6 times higher for those with normal weight, almost 11 times higher for those classified as overweight, and 9 times higher for those classified as obese, compared to participants classified as underweight (BMI <18.5 kg/m^2). A cross-sectional study conducted in South India to determine the prevalence of DM among TB patients found that the odds of having DM was 3.26 times higher with normal weight, 3.86 times with overweight , and 4.08 times with obesity [14]. It is clearly evident that less physical activity and unhealthy life style lead to

obesity that increase the odds of getting DM [16].

In this study, the respondents were classified as case and control by the blood sugar results. The study might have information bias because researcher trained interviewers for the data collection process. However, questionnaires were tested with 30 participants to obtain clear results with consistency and reliability test.

5. Conclusion

There is a strong association between diabetes and susceptibility to tuberculosis infection. According to this study, TB with DM is strongly associated with gender, age, marital status, family history of DM, GeneXpert, and BMI among tuberculosis patients. Therefore, regular DM screening program (bi-directional program) would enhance the management of impact of TB including comorbid disease like DM, it is particularly important for public health measures to be put in place for early diagnosis and management of DM.

Along with integrated management program, encouraging regular exercise and body weight control through health promotion, identification of pre-diabetes and linkage with private sector for early diagnosis are also important interventions to combat TB. Adaptation of TB treatment protocols in patients with DM may lead to reduction in morbidity, glycemic control, and to get better TB outcomes. This will help to lead towards End-TB Strategy and Sustainable Development Goals for TB elimination.

According to the studies, diabetes mellitus is associated with overweight-obesity which is a modifiable disease and depends on the lifestyle and behavior of the individual. Hence, health promotion program and awareness campaign about regular exercise and healthy body should promote to change the healthy habits and healthy lifestyle with the coordination and collaboration of other sectors including private sectors such as health insurance agencies and ministry of sports. Strong evidence for Comorbid care and treatment is urgently needed.

To be holistic and comprehensive approach, TB-DM comorbid intervention program (bi-directional program) is recommended to implement for the front-line workers and integrated management of TB-DM in all primary health care setting strong linkage with private sectors. These interventions could update appropriate measures for secondary care and prevention of the complication and result in better outcomes that lead to end TB strategy. Bi-directional

screening also needs to take place across Myanmar, encouraging health promotion on physical exercise, TB-DM integrated with DM screening and pre-diabetes management being crucial for lifestyle management and effective measures for TB and comorbid disease control program.

Besides above recommendations, cohort studies also recommend for the future researchers to identify the factors influencing treatment outcomes of TB patients with diabetes that contribute to the integrated management of TB-DM. Therefore, along with the integrated management of TB-DM, universal access to patient-centered care and treatment, multi-sectoral collaboration to combat both diseases and innovative interventions are the crucial steps to End TB strategy.

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Conflict of Interest

Authors declare no conflict of interest in this study.

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