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COMPARISON OF BLOOD GLUCOSE LEVELS IN TUBERCULOSIS PATIENTS DURING THE INITIAL AND CONTINUATION PHASES OF TREATMENT AT X HOSPITAL, TANGERANG CITY

Septiatul Awaliah[1], Citra Trisna[2*], Mardyana Nizar[3], , Aminah Aminah[4]

[1]Department of Medical Laboratory Technology, Poltekkes Kemenkes Banten, septiatulawaliah@gmail.com
[2]Department of Medical Laboratory Technology, Poltekkes Kemenkes Banten, citra.trisna@poltekkesbanten.ac.id
[3]Department of Medical Laboratory Technology, Poltekkes Kemenkes Palembang, mardyana.nizar88@gmail.com
[4]Department of Medical Laboratory Technology, Poltekkes Kemenkes Banten, aminah@poltekkesbanten.ac.id
Corresponding author: citra.trisna@poltekkesbanten.ac.id

ABSTRACT

Abstract. Tuberculosis remains a major global health problem and continues to be one of the leading causes of death from infectious diseases, even in developed countries. The administration of anti-tuberculosis drugs (OAT) is divided into two phases: the initial phase and the continuation phase. However, the use of OAT is not without side effects, as its duration of use may influence blood glucose levels. This study aimed to examine differences in blood glucose levels among tuberculosis patients undergoing the initial and continuation phases of treatment at X Hospital in Tangerang City. A comparative study design was employed to compare two groups with distinct treatment phases. Samples were selected through purposive sampling, consisting of 30 participants: 15 in the initial phase and 15 in the continuation phase. Fasting blood glucose levels were measured using the POCT method, and data were analyzed with the Mann-Whitney test. The percentage of abnormal fasting blood glucose results in the initial treatment group was 27%, compared to 67% in the continuation group. Based on the Mann-Whitney test, a p-value of 0.006 was obtained ($p < 0.05$), indicating a significant difference in blood glucose levels between tuberculosis patients in the initial and continuation phases of treatment.

Keywords: early stage TB treatment; advanced stage TB treatment; blood glucose

INTRODUCTION

Tuberculosis remains a major global health problem and continues to be the most common fatal infectious disease worldwide, even in developed countries (Diantara 2022). According to data from the World Health Organization (WHO) in 2021, an estimated 10.6 million people worldwide were affected by tuberculosis, with 1.6 million deaths. This makes tuberculosis the second leading cause of death from infectious diseases after COVID-19. WHO reported that in 2020, eight countries accounted for more than two-thirds of global tuberculosis cases, with Indonesia ranking second after India, followed by China, the Philippines, Pakistan, Nigeria, Bangladesh, and the Democratic Republic of the Congo (WHO 2022a). Based on the Global Tuberculosis Report 2022, Indonesia recorded an incidence rate of 354 per 100,000 population and a mortality rate of 52 per 100,000 population in 2021. These figures increased compared to 2020, when the incidence rate was 301 per 100,000 and the mortality rate was 34 per 100,000 population (WHO 2022b). In 2021, Banten Province ranked fifth among Indonesian provinces with the highest number of tuberculosis cases, reporting 23,343 cases (Ahdiat 2022). In Tangerang City, there were 4,414 tuberculosis cases in 2021, of which 35 (0.8%) resulted in death (Pemkot Tangerang 2022).

The administration of anti-tuberculosis drugs (OAT) in tuberculosis patients aims to eliminate Mycobacterium bacteria and is divided into two phases: the initial phase (lasting 2 months) and the continuation phase (lasting 4 months) (Asman 2022; KEpmenkes RI 2019). However, the use of OAT is not without side effects. Several anti-tuberculosis drugs are hepatotoxic, and hepatotoxicity can impair liver

function, which plays a crucial role in maintaining glucose homeostasis, thereby making blood glucose regulation more difficult. This condition may trigger either hyperglycemia or hypoglycemia (Arimbawa 2019). The aim of this study was to determine blood glucose levels in tuberculosis patients undergoing the initial and continuation phases of treatment, as well as to analyze blood glucose levels based on age and sex.

MATERIALS AND METHODS

This study employed a comparative design by comparing two groups with different characteristics. The research was conducted at the Laboratory of X Hospital, Tangerang, from January to March 2023. The population consisted of all tuberculosis patients undergoing treatment at X Hospital, Tangerang, during the January–March 2023 period. The sample comprised 30 participants, consisting of 15 patients in the initial treatment phase and 15 patients in the continuation phase. The sampling technique used was purposive sampling.

The inclusion criteria for respondents in this study were tuberculosis patients undergoing either the initial or continuation phase of treatment and aged between 10 and 59 years. The equipment used for blood glucose testing included a POCT device, sterile lancets, autoclick, dongle, glucose test chips, capillary blood, 70% alcohol swabs, dry cotton, and glucose test strips. The variables in this study consisted of independent variables—age, sex, and treatment phase (initial and continuation)—and the dependent variable, which was blood glucose level in tuberculosis patients. Research data were obtained from questionnaires completed by respondents and blood glucose level examinations. Statistical analysis was performed using the Mann-Whitney test with SPSS software.

RESULTS AND DISCUSSION

This study involved 30 respondents, consisting of 15 tuberculosis patients in the initial phase of treatment and 15 patients in the continuation phase. The distribution of fasting blood glucose levels based on patient characteristics is presented in the following Table 1–8.

Table 1. Frequency distribution of blood glucose levels during the initial phase of treatment

Age (years)	Normal Fasting Blood Glucose		Abormal Fasting Blood Glucose	
	Frequency	%	Frequency	%
10–19	1	7	0	0
20–44	7	47	3	20
45–59	2	13	2	13
Total	**10**	**67**	**5**	**33**

Table 1 shows that among tuberculosis patients in the initial treatment phase, the 20–44 year age group demonstrated the highest proportion of abnormal fasting blood glucose levels, accounting for 20% of the total sample.

Table 2. Frequency distribution of blood glucose levels during the continuation phase of treatment based on age

Age (years)	Normal Fasting Blood Glucose		Abormal Fasting Blood Glucose	
	Frequency	%	Frequency	%
10–19	1	7	0	0
20–44	4	26	7	47
45–59	1	7	2	13
Total	**6**	**40**	**9**	**60**

Table 2 shows that among tuberculosis patients in the continuation phase of treatment, the 20–44 year age group had the highest proportion of abnormal fasting blood glucose levels, accounting for 47% of the total sample.

Table 3. Frequency distribution of blood glucose levels during the initial phase of treatment based on sex

Age (years)	Normal Fasting Blood Glucose		Abormal Fasting Blood Glucose	
	Frequency	%	Frequency	%
Male	2	13	2	13
Female	8	54	3	20
Total	**10**	**67**	**5**	**33**

Table 3 shows that among tuberculosis patients in the initial phase of treatment, the percentage of abnormal fasting blood glucose levels was higher in females than in males, with females accounting for 20%.

Table 4. Frequency distribution of blood glucose levels during the continuation phase of treatment based on sex

Age (years)	Normal Fasting Blood Glucose		Abormal Fasting Blood Glucose	
	Frequency	%	Frequency	%
Male	1	7	5	33
Female	4	27	5	33
Total	**5**	**34**	**10**	**66**

Table 4 shows that among tuberculosis patients in the continuation phase of treatment, the percentage of abnormal fasting blood glucose levels was the same for both females and males, each accounting for 33%.

Table 5. Average blood glucose levels based on treatment phase

	Initial treatment phase	Continuation treatment phase
Average Blood Glucose Level (mg/dL)	**101.40**	**184.07**

Table 5 shows that the average fasting blood glucose level in the initial treatment phase group was 101.40 mg/dL, while in the continuation phase group, the average fasting blood glucose level was elevated at 184.07 mg/dL, indicating an abnormal value.

Table 6. Descriptive analysis table of differences in blood glucose levels among tuberculosis patients in the initial and continuation phases of treatment

Treatment Phase	Statistic	Value
Initial Phase	Mean	101.40
	Median	100.00
	Variance	856.543
	Standard Deviation	29.267
	Minimum	73
	Maximum	184
Continuation Phase	Mean	184.07
	Median	170.00
	Variance	7.947.000
	Standard Deviation	89.145
	Minimum	79
	Maximum	345

The fasting blood glucose test data were tested for normality using the Shapiro–Wilk test, as the sample size was less than 50. The results of the normality test are presented in the following table.

Table 7. Data normality test

Treatment Phase	Kolmogorov–Smirnov			Shapiro–Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Initial Phase	0.166	15	0.200*	0.834	15	0.010
Continuation Phase	0.187	15	0.165	0.906	15	0.116

The normality test using the Shapiro–Wilk method showed that the significance value for the initial treatment phase was 0.010 ($p < 0.05$), indicating that the data were not normally distributed. Meanwhile, the continuation phase had a significance value of 0.116 ($p > 0.05$), indicating that the data were normally distributed. Because one of the data groups did not meet the assumption of normality, further analysis was performed using the nonparametric Mann–Whitney test. The Mann–Whitney test produced an Asymp. Sig. (2-tailed) value of 0.006 ($p < 0.05$), indicating a statistically significant difference in fasting blood glucose levels between tuberculosis patients in the initial and continuation phases of treatment.

The analysis of fasting blood glucose levels among 30 tuberculosis patients in both the initial and continuation treatment phases demonstrated that individuals aged 20–44 years had the highest proportion of abnormal glucose levels, accounting for 20% in the initial phase and 47% in the continuation phase. These findings align with the study by Lin et al., which examined changes in blood glucose levels in tuberculosis patients before and during anti-tuberculosis therapy in China, where 47% of individuals aged 20–59 years exhibited unstable fasting blood glucose levels (Lin 2017). The increase in blood glucose concentration observed in this age group may be attributed to age-related anatomical, physiological, and biochemical alterations that occur after the age of 30. Degeneration of pancreatic β-cells responsible for insulin production, along with functional changes in the nervous system, glucose-regulating target tissues, and other hormone-producing systems, contribute to impaired glucose homeostasis (Nadrati 2021). This trend is consistent with WHO reports indicating that after the age of 40, fasting blood glucose levels increase by approximately 1–2 mg/dL per year, and postprandial glucose levels rise by 5.6–13 mg/dL within two hours after meals (Fanani 2020).

The analysis of fasting blood glucose levels among tuberculosis patients based on sex showed that in the initial treatment phase ($n = 15$), abnormal glucose levels were observed in 13% of male patients and 20% of female patients. In the continuation phase, both male and female patients exhibited abnormal glucose levels at 33%. These results indicate that the proportion of abnormal fasting blood glucose levels was generally higher in females than in males. This finding is consistent with the study by Hadžić et al., which reported that in cases of active pulmonary tuberculosis, elevated blood glucose levels occurred in 57.1% of female patients compared to 21% of male patients (Hadzic 2017). The higher prevalence of elevated glucose levels among females may be associated with stress-related activation of the hypothalamic–pituitary–adrenal (HPA) axis. Activation of the HPA axis stimulates the secretion of corticotropin-releasing hormone (CRH), which in turn promotes cortisol production by the adrenal glands. Elevated cortisol levels can lead to impaired glucose tolerance and insulin resistance. Moreover, HPA axis responsiveness tends to be higher in females than in males, which may contribute to greater susceptibility to psychosocial stressors and altered glucose metabolism (Fatih 2023).

The association between tuberculosis and diabetes mellitus in relation to blood glucose levels among tuberculosis patients is attributed to the increased prevalence of elevated blood glucose concentrations observed in individuals with tuberculosis (Simamora 2021). Several anti-tuberculosis drugs, such as isoniazid and pyrazinamide, have hepatotoxic effects that can impair liver function. Hepatotoxicity disrupts the liver's critical role as a glucose buffer system. Under normal conditions, when blood glucose levels decrease, the liver releases stored glucose (glycogenolysis) to maintain homeostasis, and conversely, it stores excess glucose following carbohydrate digestion and absorption. Impairment of this regulatory mechanism due to hepatotoxicity can lead to disturbances in glucose metabolism, contributing to abnormal blood glucose levels in tuberculosis patients.

A study conducted by Arimbawa (2019) reported a positive correlation between the duration of anti-tuberculosis treatment and blood glucose concentration in tuberculosis patients. Several anti-tuberculosis drugs, such as isoniazid and pyrazinamide, exhibit hepatotoxic effects that can impair liver function. Hepatotoxicity disrupts the liver's essential role as a glucose-buffering system. Under normal physiological conditions, when blood glucose levels decrease, the liver releases stored glucose to maintain homeostasis, and conversely, stores excess glucose following carbohydrate digestion and absorption (Arimbawa 2019). This finding aligns with the present study, as shown in **Table 5**, where the mean fasting blood glucose level in patients at the initial phase of treatment was 101.40 mg/dL, while in the continuation phase, the mean level

was elevated to 184.07 mg/dL, indicating abnormal glucose regulation. Statistical analysis using the Mann–Whitney test revealed a *p*-value < 0.05, suggesting a statistically significant difference in fasting blood glucose levels between tuberculosis patients in the initial and continuation treatment phases.

This study encountered several limitations, one of which was related to the fasting blood glucose testing procedure that required participants to fast prior to sample collection. This condition posed challenges in synchronizing fasting schedules with medication intake times, particularly among tuberculosis patients in the initial phase of treatment who were required to take multiple doses of medication daily. Such circumstances may have affected participants' adherence to fasting protocols and potentially introduced variability in the measured blood glucose levels.

CONCLUSION

The results of this study indicate that tuberculosis patients in the 20–44-year age group represented the largest proportion of individuals with abnormal blood glucose levels. Male respondents also exhibited abnormal fasting blood glucose levels during the initial phase of treatment. Statistical analysis using the Mann–Whitney test revealed a significant difference in blood glucose levels between tuberculosis patients undergoing the initial and continuation phases of treatment, with a *p*-value of 0.006.

CONFLICT OF INTEREST (if any)

The authors declare that there is no conflict of interest regarding the publication of this study.

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