

The Effect of Insulin Use On Body Mass Index in Type 2 Diabetes Mellitus Patients at RSAL Mintohardjo

Meilawati Diana Soetardjo¹, Fajar Amirulah^{2*}, Muhammad Zakir Chohan³, Ria Anggraeni⁴, Widya Handayani⁵

^{1,2,3} Pharmacy Departemen, Faculty of Pharmacy Universitas 17 Agustus 1945 Jakarta, Jakarta, Indonesia
Email: fajar.amirulah12@gmail.com

Abstract

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disease characterized by hyperglycemia due to insulin resistance and impaired insulin secretion. Insulin therapy is widely used in T2DM management; however, it may affect body weight and Body Mass Index (BMI). This study aimed to determine the effect of insulin use on BMI in Type 2 Diabetes Mellitus patients at RSAL Mintohardjo in 2025. This study used a retrospective cohort design with a quantitative approach. A total of 150 patients were selected using a total sampling technique from outpatient medical records that met the inclusion and exclusion criteria. The independent variable was insulin use, while BMI was the dependent variable. Corticosteroid and metformin use were included as confounding variables. Data analysis was conducted using univariate and bivariate analysis with the Wilcoxon Signed-Rank Test. The results showed that most respondents were male (54.7%) and aged ≥ 60 years (62.7%). Insulin therapy was used by 32.7% of patients, while metformin was used by 73.3% and corticosteroids by 17.3% of patients. The mean BMI category increased from 3.04 ± 1.016 before insulin therapy to 3.39 ± 1.116 after insulin therapy. The Wilcoxon Signed-Rank Test showed a significant difference between BMI before and after insulin therapy ($p < 0.001$). In conclusion, insulin use significantly affected BMI changes in Type 2 Diabetes Mellitus patients at RSAL Mintohardjo. Regular monitoring of nutritional status and body weight is important in patients receiving insulin therapy.

Keywords: Type 2 Diabetes Mellitus; Insulin; Body Mass Index; Corticosteroids; Metformin

1. INTRODUCTION

Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both [1]. Type 2 Diabetes Mellitus (T2DM) is the most common form of diabetes and has become a major global health concern due to its increasing prevalence and associated complications [2]. The International Diabetes Federation reported that the number of adults living with diabetes continues to rise worldwide, particularly in developing countries with rapid urbanization and lifestyle changes [3].

The development of T2DM is strongly associated with obesity, aging, unhealthy dietary patterns, physical inactivity, and insulin resistance [4]. Obesity, especially central obesity, contributes to metabolic dysfunction through increased inflammatory cytokines and free fatty acids, which impair insulin sensitivity and glucose metabolism [5]. Increased Body Mass Index (BMI) has been identified as a major predictor of poor glycemic control and metabolic complications in diabetic patients [6]. Aging is another important risk factor for T2DM. Older adults experience physiological changes, including decreased pancreatic β -cell function and increased insulin resistance, which contribute to impaired glucose homeostasis [7]. Previous studies have shown that the prevalence of T2DM is higher among individuals aged ≥ 60 years and is often associated with obesity and cardiovascular risk factors [8].

*Corresponding author: Fajar Amirulah, Pharmacy Departemen, Faculty of Pharmacy Universitas 17 Agustus 1945 Jakarta, Jakarta, Indonesia.

E-mail : fajar.amirulah12@gmail.com

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Insulin therapy is commonly initiated when oral antidiabetic agents fail to maintain adequate glycemic control. Insulin effectively reduces blood glucose levels and prevents long-term diabetic complications [9]. However, insulin therapy may also cause weight gain due to its anabolic effects on glucose utilization and fat storage [10]. Increased body weight after insulin initiation is considered one of the challenges in diabetes management because it may worsen insulin resistance and increase cardiovascular risk.

BMI is widely used as an anthropometric indicator to evaluate nutritional status and obesity-related metabolic risk. Increased BMI in T2DM patients is associated with poor glycemic control, dyslipidemia, hypertension, and cardiovascular complications [4]. According to the World Health Organization, obesity significantly increases the risk of metabolic syndrome and diabetes-related complications [6].

Several studies have investigated the relationship between insulin therapy and BMI changes. Prinz et al. reported that some patients experienced increased BMI after initiating insulin therapy, particularly during the early treatment phase [11]. Similarly, Edens et al. found that insulin initiation in T2DM patients was associated with excessive weight gain due to improved caloric retention and decreased glucosuria [10]. Metformin remains the first-line therapy for T2DM because it improves insulin sensitivity and decreases hepatic glucose production [12]. Unlike insulin, metformin has neutral or weight-reducing effects, making it beneficial for overweight diabetic patients [13]. In contrast, corticosteroid therapy may increase body weight through increased appetite, fluid retention, and altered lipid metabolism [14].

Previous studies have mainly focused on glycemic control and insulin efficacy, while limited studies have evaluated BMI changes in Indonesian patients receiving insulin therapy. Furthermore, variations in demographic and clinical characteristics may influence the metabolic effects of insulin therapy. Therefore, evaluating BMI changes among insulin-treated patients remains important for improving diabetes management and preventing metabolic complications.

Based on these considerations, this study aimed to determine the effect of insulin use on Body Mass Index (BMI) changes in Type 2 Diabetes Mellitus patients at RSAL Mintohardjo. The findings of this study are expected to provide valuable information for clinicians in monitoring nutritional status and optimizing insulin therapy in diabetic patients.

2. METHODS

This study used a retrospective cohort design with a quantitative approach. The study was conducted at RSAL Mintohardjo using outpatient medical record data from 2025. The study population consisted of all Type 2 Diabetes Mellitus patients receiving treatment at RSAL Mintohardjo. A total of 150 patients who met the inclusion and exclusion criteria were selected using a total sampling technique.

The independent variable was insulin use, while BMI was the dependent variable. Metformin and corticosteroid use were included as confounding variables. Data analysis was performed using SPSS software. Univariate analysis was used to describe respondent characteristics and variable distributions. Normality testing was conducted using the Kolmogorov-Smirnov test because the sample size was greater than 50. Since the data were not normally distributed, the Wilcoxon Signed-Rank Test was used for bivariate analysis with a significance level of $p < 0.05$.

3. RESULTS

Respondent Characteristics

The characteristics of respondents included gender and age distribution. Most respondents were male, accounting for 54.7% of the total sample, while female respondents accounted for 45.3%. In terms of age, the majority of patients were aged ≥ 60 years (62.7%). These findings indicate that older adults were more dominant among Type 2 Diabetes Mellitus patients in this study. Aging is associated with reduced pancreatic β -cell function and increased insulin resistance, which contribute to impaired glucose metabolism [7]. Similar findings were reported by Hafizi et al, who stated that increasing age and male gender are associated with a higher risk of developing Type 2 Diabetes Mellitus [8].

Tabel 1. Respondent Characteristics

Variables	Categories	N	%
Gender	Male	82	54.7
	Female	68	45.3
Age	<60 years	56	37.3
	≥60 years	94	62.7

BMI Distribution Before and After Insulin Therapy

The distribution of BMI categories before insulin therapy showed that most patients were classified as Obesity I. After insulin therapy, there was an increase in patients categorized as Obesity II, indicating a tendency toward BMI elevation following insulin administration. As shown in Table 2, the mean BMI category increased from 3.04 ± 1.016 before insulin therapy to 3.39 ± 1.116 after therapy.

BMI is an important indicator for evaluating nutritional status and metabolic risk in patients with Type 2 Diabetes Mellitus. Increased BMI is strongly associated with insulin resistance and poor glycemic control [5]. Obesity contributes to metabolic dysfunction through increased inflammatory mediators and free fatty acids that interfere with insulin signaling pathways. Similar results were reported by Zheng et al, who found that obesity significantly contributes to worsening metabolic outcomes in diabetic patients [4].

Table 2. BMI Distribution Before and After Insulin Therapy

Variables	Mean $\pm$ SD	Min	Max
BMI Before	3.04 ± 1.016	1	5
BMI After	3.39 ± 1.116	1	5

Distribution of Therapy Use

The results showed that metformin was the most frequently used therapy, accounting for 73.3% ($n = 110$) of the study population. Insulin therapy was received by 49 patients (32.7%), whereas 101 patients (67.3%) did not receive insulin. Corticosteroid use was identified in 26 patients (17.3%). As shown in Table 3, metformin was the most commonly used antidiabetic therapy among the 150 patients included in this study.

The predominance of metformin use is consistent with its established role in the pharmacological management of Type 2 Diabetes Mellitus. Metformin improves insulin sensitivity and decreases hepatic glucose production and generally has a neutral or weight-reducing effect [13].

Studies published in Jurnal Farnasimed (JFM) have also demonstrated that metformin is frequently used either as monotherapy or in combination with other oral antidiabetic agents in patients with Type 2 Diabetes Mellitus [15], [16]. In addition, a recent review published in JFM highlighted the important role of both insulin and oral antidiabetic drugs in the management of Type 2 Diabetes Mellitus, particularly when treatment is adjusted according to the patient's glycemic condition and therapeutic needs [17].

Insulin therapy was used by approximately one-third of the patients in the present study. Insulin is generally introduced when adequate glycemic control cannot be achieved with oral antidiabetic therapy or when the patient's clinical condition requires more intensive glucose-lowering treatment. Previous evidence published in JFM similarly reported substantial insulin utilization among patients with Type 2 Diabetes Mellitus and indicated that insulin is commonly prescribed when oral therapy is no longer sufficient to achieve glycemic targets [15], [17]. However, insulin has anabolic effects that may promote glucose uptake and fat storage and consequently contribute to increased body weight.

Corticosteroid use was identified in a smaller proportion of patients and was considered a potential confounding factor because corticosteroids may influence body weight through increased appetite, fluid retention, changes in fat distribution, and alterations in glucose and lipid metabolism [14]. Therefore, the possible effects of concomitant therapies should be considered when interpreting BMI changes among patients receiving insulin.

Importantly, the 150 patients represented the overall study population used to describe treatment patterns. However, the paired before-and-after BMI analysis specifically evaluating insulin therapy was restricted to the 49 patients who actually received insulin. The remaining 101 patients did not receive insulin and were therefore not classified as having a “BMI after insulin therapy.” This distinction was made to ensure that the analysis of BMI changes was consistent with actual insulin exposure and to avoid attributing BMI changes in non-insulin-treated patients to insulin therapy.

Table 3. Distribution of Therapy Use

Variables	Categories	N	%
Insulin Use	Yes	49	32.7
	No	101	67.3
Metformin Use	Yes	110	73.3
	No	40	26.7
Corticosteroid Use	Yes	26	17.3
	No	124	82.7

Normality Test

The normality test was performed using the Kolmogorov-Smirnov test because the sample size exceeded 50 respondents. The results showed that both BMI before and after insulin therapy had significance values of $p < 0.001$, indicating that the data were not normally distributed. Therefore, non-parametric analysis using the Wilcoxon Signed-Rank Test was performed.

Table 4. Normality Test Results

Variables	Kolmogorov-Smirnov Sig.	Conclusion
BMI Before	<0.001	Not normal
BMI After	<0.001	Not normal

Effect of Insulin Use on BMI Changes

The Wilcoxon Signed-Rank Test demonstrated a significant difference between BMI before and after insulin therapy, with $p < 0.001$. As shown in Table 5, insulin therapy significantly affected BMI changes in Type 2 Diabetes Mellitus patients. Insulin promotes glucose uptake and fat storage through its anabolic mechanism, which can result in increased body weight and BMI [10]. Improved glycemic control after insulin initiation also reduces glucosuria, leading to greater caloric retention in the body. These findings are consistent with Prinz et al, who reported that insulin initiation in Type 2 Diabetes Mellitus patients may contribute to BMI increase, particularly during the early phase of therapy [11].

Table 5. Wilcoxon Signed-Rank Test Results

Variables	N	Z	p-value
BMI Before – BMI After	150	6.394	<0.001

The findings of this study suggest that regular monitoring of body weight and nutritional status is necessary in patients receiving insulin therapy. Lifestyle modification, dietary counseling, and physical activity should be emphasized to minimize excessive BMI increase and reduce the risk of metabolic complications.

4. DISCUSSION

The results of this study showed that most respondents were male and aged ≥ 60 years. These findings indicate that older adults were more dominant among Type 2 Diabetes Mellitus patients at RSAL Mintohardjo. Aging is associated with physiological changes, including decreased pancreatic β -cell function and increased insulin resistance, which contribute to impaired glucose metabolism and hyperglycemia [7]. Similar findings were reported by Hafizi et al, who found that increasing age significantly increases the risk of developing Type 2 Diabetes Mellitus [8]. Male respondents were more prevalent than females in this study, which may be related to

differences in body fat distribution and lifestyle patterns between men and women. Men tend to accumulate more visceral fat, which is strongly associated with insulin resistance and metabolic disorders [5]. In addition, unhealthy lifestyle factors such as smoking, low physical activity, and poor dietary habits may contribute to the higher prevalence of diabetes among males [4]. Elderly diabetic patients are also more likely to experience comorbidities such as hypertension, dyslipidemia, and obesity, which may worsen metabolic control and increase the risk of complications [18].

The study demonstrated that the mean BMI category increased after insulin therapy. Before insulin therapy, most patients were classified as Obesity I, while after therapy there was an increase in patients categorized as Obesity II. This finding indicates a tendency toward BMI elevation following insulin administration. BMI is an important anthropometric indicator used to assess nutritional status and metabolic risk in patients with Type 2 Diabetes Mellitus. Increased BMI is strongly associated with insulin resistance, poor glycemic control, and cardiovascular complications [6]. Obesity contributes to chronic inflammation and metabolic dysfunction through increased inflammatory mediators and free fatty acids that interfere with insulin signaling pathways [5]. Zheng et al. also reported that overweight and obesity significantly increase the risk of diabetes progression and metabolic complications. The increase in BMI observed after insulin therapy may also be related to improved glycemic control. When blood glucose levels improve, glucosuria decreases, resulting in greater caloric retention within the body [10]. Consequently, patients may experience weight gain and increased BMI after insulin initiation. In Asian populations, metabolic complications may occur even at lower BMI values compared with Western populations [19], [20]. The WHO Expert Consultation stated that Asian individuals have a higher risk of diabetes and cardiovascular disease at relatively lower BMI levels; therefore, BMI monitoring remains essential in diabetic patients receiving insulin therapy [12].

The results also showed that metformin was the most commonly used therapy among respondents. This finding is consistent with international and national diabetes guidelines recommending metformin as the first-line therapy for Type 2 Diabetes Mellitus [21]. Metformin improves insulin sensitivity and decreases hepatic glucose production through inhibition of gluconeogenesis [12]. Unlike insulin therapy, metformin has neutral or weight-reducing effects, making it beneficial for overweight diabetic patients [13]. Insulin therapy was used by approximately one-third of respondents and is generally initiated when oral antidiabetic agents fail to achieve glycemic targets or when patients present with severe hyperglycemia. Although insulin effectively improves glycemic control, its use is often associated with increased body weight and BMI [12]. The anabolic effect of insulin promotes glucose uptake and fat storage, contributing to weight gain after therapy initiation [22]. Edens et al. also reported that insulin initiation in Type 2 Diabetes Mellitus patients may result in excessive weight gain, particularly during the first phase of treatment. Corticosteroid use was found in a smaller proportion of patients but remained clinically important as a confounding factor. Corticosteroids may increase appetite, fluid retention, and fat accumulation, leading to obesity and metabolic disorders [14]. Cho et al. also reported that glucocorticoid therapy contributes to insulin resistance and weight gain [18].

The Wilcoxon Signed-Rank Test demonstrated a significant difference between BMI before and after insulin therapy, indicating that insulin use significantly affected BMI changes in Type 2 Diabetes Mellitus patients. These findings suggest that insulin therapy contributes to increased body weight and BMI among diabetic patients. Insulin has anabolic properties that stimulate glucose uptake and fat storage within adipose tissue [10]. Improved glycemic control after insulin initiation also reduces glucosuria, resulting in greater caloric retention and subsequent weight gain. This mechanism explains the BMI increase observed in this study. The findings are consistent with previous studies reporting weight gain after insulin therapy initiation. Prinz et al. found that several T2DM patients experienced increased BMI during the early stages of insulin therapy [11]. Similarly, Apriliany et al. reported that insulin-associated weight gain is a common challenge in diabetes management [23]. Although insulin effectively lowers blood glucose levels, increased BMI may worsen insulin resistance and elevate cardiovascular risk [24]. Therefore, regular monitoring of BMI and nutritional status is essential in patients receiving insulin therapy. Healthcare professionals should provide education regarding dietary management, physical activity, and healthy lifestyle modifications to minimize excessive weight gain and improve long-term metabolic outcomes [25].

5. CONCLUSION

Insulin use was associated with increased BMI among patients with Type 2 Diabetes Mellitus at RSAL Mintohardjo. However, due to the retrospective observational design and potential confounding factors, a causal

relationship cannot be established. Regular BMI monitoring and lifestyle management are recommended, while further prospective studies are needed to confirm this association.

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