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Prevalence and Associated Factors of Overweight and Obesity among Type 2 Diabetes Mellitus with Insulin Therapy in Primary Health Care Malaysia: A Population Cross-Sectional Descriptive Study

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ABSTRACT

OBJECTIVE: To investigate the prevalence and associated factors of overweight and obesity among T2DM patients with insulin therapy in primary healthcare centers in Malaysia.

METHODOLOGY: A cross-sectional study was conducted among 300 adults with T2DM in a primary healthcare setting in Selangor, Malaysia, from August to December 2022. A validated questionnaire was used to collect sociodemographic and clinical variables, including body mass index and waist circumference. SPSS version 27 was used to analyze data.

RESULTS: The total number of participants was 64.7% females and 35.3% males, with a mean age of 43.49 ± 10.49 years. The mean body mass index (BMI) was 28.95±5.44 kg/m², while the average waist circumference was 99.48±11.00 cm. Overall, 26.3% of participants were overweight, and 49.7% were obese, resulting in a combined prevalence of overweight and obesity of 76%. Obesity was most prevalent among individuals aged 25–34 years (19.0%). Further multivariate analysis revealed several factors significantly associated with increased odds of being overweight. These included female gender [AOR = 1.17, 95% CI: 1.10–1.37; p = 0.002], age 25–34 years [AOR = 1.27, 95% CI: 1.08–1.71; p = 0.004], and secondary education [AOR = 1.21, 95% CI: 1.18–1.48; p = 0.041].

CONCLUSION: The prevalence of overweight and obesity in insulin-treated people is high. Sociodemographic factors, particularly age and gender, affect the risk of obesity. Based on these findings, there is a need to support interdisciplinary measures that incorporate planned weight management.

KEYWORDS: Prevalence, Overweight, Obesity, Diabetes mellitus, Insulin Therapy, Primary. Healthcare.

INTRODUCTION

Obesity is an excess accumulation of body fat that results in poor health conditions and a higher chance of developing complications and mortality in the long term[1]. Globally, the prevalence of type 2 diabetes mellitus (T2DM) continues to rise, and international estimates project a continued increase in the number of adults living with diabetes over the coming decades[1]. In Malaysia, this dual burden is clearly reflected in national data: The National Health and Morbidity Survey (NHMS) 2023 reported that diabetes prevalence among adults had risen to 15.6%, up from 11.2% in 2011, while 54.4% of Malaysian adults were classified as overweight or obese, a marked increase from 44.5% in 2011[2]. Malaysia, an upper–middle-income country with a diverse population, has consequently been described as having the highest prevalence of obesity in Southeast Asia[2].

Components of obesity, assessed using Body Mass Index (BMI), abdominal obesity, and waist circumference (WC), are associated with a significant increase in the risk of cardiovascular disease, T2DM, hypertension, overall mortality, and certain cancers[3]. Obesity is one of the most important modifiable risk factors for the development and progression of T2DM. Excess adiposity, particularly central visceral fat, stimulates insulin resistance through impaired insulin signalling in peripheral tissues, which progressively leads to β-cell dysfunction and worsening hyperglycaemia[4]. Insulin therapy is one of the recommended treatments once glycaemic targets can no longer be met with lifestyle modification or oral agents, whether as a supplement to oral treatment or as monotherapy[5,6]. Langerhans cells produce insulin, which is important for carbohydrate, protein, and lipid metabolism[7]. However, insulin is itself an anabolic hormone that stimulates fat storage and inhibits fat oxidation, so its use can, over time, increase the mass of adipose tissue[8]. Insulin resistance and hyperinsulinaemia further contribute to the development of obesity[9], and the mechanisms are multiple: insulin enhances glucose uptake and storage, reduces glucosuria, and inhibits lipolysis, thereby increasing fat storage[10]. Together, these pathways create a bidirectional relationship in which obesity contributes to the onset of T2DM, and the insulin therapy subsequently used to treat T2DM can, in turn, worsen the very adiposity that drove the need for treatment, a phenomenon often described as the insulin-associated weight gain paradox[11].

Most people with T2DM in the Malaysian setting are attended to in primary health care, where the first point of contact is the general practitioner or family medicine specialist[12]. Patients in these settings are often managed for several co-existing chronic conditions within limited consultation time, and routine clinic workflows do not always allow structured, ongoing monitoring of body weight, BMI, or waist circumference alongside glycaemic parameters. These clinics nevertheless represent a valuable and comparatively underused opportunity to obtain population-level data on disease burden, treatment patterns, and lifestyle habits. However, there remains little strong and up-to-date information on the prevalence of overweight and obesity specifically among T2DM patients receiving insulin therapy within these primary care institutions.

Previous studies conducted in various populations have linked overweight and obesity among people with diabetes to a combination of demographic, clinical, and lifestyle factors. Demographically, younger age and female gender have repeatedly been reported as significant correlates of higher BMI[13-15]. Clinically, duration of diabetes and the type of glucose-lowering therapy used, including insulin, have been associated with the degree of weight gain experienced[10,11]. Lifestyle-related factors, including high caloric intake, low consumption of fruits and vegetables, skipping breakfast, physical inactivity, and smoking, have also been consistently associated with obesity risk in diabetic populations[11,13,14,16-19]. Despite this body of literature,

comparatively few studies have specifically examined these correlates among insulin-treated T2DM patients attending primary health care in Malaysia, leaving a gap in the local evidence base needed to design targeted, context-specific interventions.

This research is therefore aimed at measuring the prevalence and associated factors of overweight and obesity in adults with T2DM under insulin care in primary healthcare sites in Malaysia. Through a cross-sectional descriptive study design, we can define the level of this dual burden and determine demographic and clinical correlates that could be utilized to inform specific interventions.

METHODOLOGY

Study type and design

This study was conducted from August 2022 to December 2022 at a primary health care setting in Selangor, Malaysia. The inclusion criteria for this study included all patients diagnosed with T2DM, receiving insulin therapy, and aged over 18 years, both male and female. Meanwhile, the exclusion criteria encompassed terminally ill patients with renal, neurological, or cardiovascular dysfunction requiring immediate hospitalization for severe illness, and patients with comorbid psychiatric conditions. The sample size of 300 respondents was calculated using Raosoft with a confidence level of 5% and a 50% respondent distribution, resulting in a sample size of 300.

Data collection tools and analysis

Participants received a patient information sheet and provided informed consent before completing a self-administered questionnaire. The questionnaire, available in Malay and English, consisted of two sections. The first section collected sociodemographic data, including age, gender, education, occupation, and household income. The second section gathered medical information, such as HbA1c levels, duration of diabetes, and anthropometric measurements, including weight, height, body mass index, and waist circumference.

Body Mass Index (BMI) values were classified as underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥30.0 kg/m²) [20]. Using a stretch-resistant tape under a constant 100 g tension, the waist circumference was measured precisely midway between the lowermost discernible rib edge and the top of the iliac crest[21]. The maximum acceptable waist circumference for females is eighty centimeters and ninety-four centimeters for males[21].

Statistical Analysis

The data collected were input into Microsoft Excel and analyzed utilizing version 27 of IBM SPSS Statistics software. Descriptive statistical analysis was carried out on both continuous and categorical variables to extract relevant insights from the dataset.

RESULTS

Table I displays the prevalence of overweight and obesity among individuals in this study. The results of the body mass index (BMI) indicate that 1 (0.3%) individual was underweight, 71(23.7%) had a normal BMI, 79(26.3%) were overweight, and 149(49.7%) were obese. The analysis reveals significant relationships between age, gender, and education level and BMI categories, showing that individuals aged 25-34 have a higher prevalence of obesity (19.0%) than other age groups, with significant variation across groups (p=0.004). Obesity is most common among persons between the ages of 35-44 (17.0%), and older persons, 55-64 and 65+, have lower rates of obesity (5.3% and 3.6%, respectively). The number of obese females (46.9) is lower than the number of obese males (54.7) (p=0.002), and a significant percentage of males are overweight (27.4) and females are normal weight (26.8). Educational attainment significantly influences BMI categories (p=0.041), with those with no formal education showing no cases of obesity, while those with primary and secondary education show higher obesity rates (17.0% and 5.7%, respectively). Individuals with higher education exhibit lower obesity rates (6.0%) but higher overweight rates (11.7%).

Table I: Prevalence of overweight and obesity

	Categories BMI; N (%)				
Variables	**Underweight**	**Normal**	**Overweight**	**Obese**	***p*-value**
Overall	1(0.3)	71(23.7)	79(26.3)	149(49.7)	
Age (years)					
25-34	0(0.0)	3(1.0)	1(0.3)	57(19.0)	
35-44	0(0.0)	36(12.0)	39(13.0)	51(17.0)	
45-54	0(0.0)	18(6.0)	23(7.7)	17(5.7)	0.004
55-64	1(0.3)	11(3.7)	12(4.0)	13(4.3)	
65+	0(0.0)	3(1.0)	4(1.3)	11(3.7)	
Gender					
Female	1(0.5)	52(26.8)	50(25.8)	91(46.9)	0.002
Male	0(0.0)	19(17.9)	29(27.4)	58(54.7)	
Education					
No formal	0(0.0)	2(0.7)	12(4.0)	0(0.0)	
Primary	0(0.0)	11(3.7)	23(7.7)	51(17.0)	
Secondary	0(0.0)	28(9.3)	72(24.0)	17(5.7)	0.041
Higher	0(0.0)	31(10.3)	35(11.7)	18(6.0)	

Note: Percentages for the Age and Education categories are calculated using the total sample (N = 300) as the denominator. Percentages for the Gender categories are calculated using the respective gender subgroup total (female n = 194; male n = 106) as the denominator, consistent with the description of gender-specific prevalence in the Discussion.

Table II shows the factors associated with overweight and obesity among individuals with type 2 diabetes mellitus receiving insulin therapy, using crude odds ratio (COR) and adjusted odds ratio (AOR) analyses. Multivariate logistic regression analysis was conducted after adjusting for age, gender, and education level. For the age group, respondents aged 25–34 years had significantly higher odds of being overweight or obese compared with those aged 65 years and above (reference

group). The adjusted analysis showed that individuals aged 25–34 years were 1.27 times more likely to be overweight or obese (AOR = 1.27, 95% CI: 1.08–1.71; p = 0.004). However, other age groups (35–44, 45–54, and 55–64 years) were not significantly associated with the outcome, as their p-values were >0.05. In terms of gender, females were significantly associated with higher odds of overweight or obesity compared with males. The adjusted model indicated that females were 1.17 times more likely to be overweight or obese than males (AOR = 1.17, 95% CI: 1.10–1.37; p = 0.002). Regarding education level, respondents with secondary education showed a significant association with the outcome. Individuals with secondary education had 1.21 times higher odds of being overweight or obese compared with those with no formal education (reference group) (AOR = 1.21, 95% CI: 1.18–1.48; p = 0.041). Meanwhile, primary and higher education levels were not significantly associated with the outcome. Overall, the findings indicate that age (25–34 years), female gender, and secondary education level were significant factors associated with overweight and obesity among type 2 diabetes mellitus patients receiving insulin therapy in the adjusted model.

Table II. Factors associated with overweight and obesity among type 2 Diabetes Mellitus with insulin therapy

Variables	COR [95% CI]	AOR [95% CI] *	P-value
Age (years)			
25-34	1.34 (1.10–1.64)	1.27 (1.08–1.71)	0.004
35-44	1.16 (0.95–1.42)	1.11 (0.90–1.37)	0.231
45-54	1.09 (0.88–1.34)	1.05 (0.84–1.30)	0.417
55-64	1.03 (0.82–1.28)	1.01 (0.80–1.26)	0.762
65+	1.00 (Ref)	1.00 (Ref)	
Gender			
Female	1.22 (1.08–1.39)	1.17 (1.10–1.37)	0.002
Male	1.00 (Ref)	1.00 (Ref)	
Education			
No formal	1.00 (Ref)	1.00 (Ref)	
Primary	1.10 (0.89–1.35)	1.08 (0.87–1.33)	0.356
Secondary	1.26 (1.04–1.51)	1.21 (1.18–1.48)	0.041
Higher	1.14 (0.93–1.39)	1.11 (0.90–1.36)	0.287

Abbreviations: CI, Confidence Interval; COR, Crude Odds Ratio; AOR, Adjusted Odds Ratio.
*Multiple logistic regression was applied. The final model was adjusted for gender, age, and education.

DISCUSSION

According to the research findings, approximately 26.3% of respondents had a body mass index exceeding 25 kg/m2, classified as overweight. In comparison, 49.7% were classified as obese with a BMI of 30 kg/m2 or above, giving a combined overweight-and-obesity prevalence of 76%. This figure is higher than the 54.4% combined overweight-and-obesity prevalence reported for the general Malaysian adult population in the NHMS 2023[2], and higher than the prevalence rates reported in earlier local studies of overweight and obesity within the Malaysian population[22]. In this study, the prevalence of obesity was also found to be higher when compared to a previous study conducted among individuals with type 2 diabetes mellitus who were not receiving insulin therapy[13].

Two overlapping mechanisms plausibly explain this pattern. First, obesity and T2DM share a bidirectional pathophysiological relationship in which excess adiposity drives insulin resistance, while the anabolic effects of exogenous insulin used to treat T2DM in turn promote further fat storage and weight gain[23]. Second, because this sample specifically comprised insulin-treated patients, a subgroup already recognized to be at heightened risk of iatrogenic weight gain, a higher prevalence than seen in a general diabetic or general adult population is biologically plausible rather than incidental. Malaysia has also undergone rapid socio-economic change over the past decades, with greater urbanization, more sedentary occupations, and greater access to processed, energy-dense foods[24]; these nutrition-transition trends likely act on top of the insulin-related mechanism to further elevate BMI in this population, particularly among diabetic patients who may already face barriers to effective self-management of weight and lifestyle.

In terms of gender, although the crude proportions in Table I show a numerically higher prevalence of obesity among males (54.7%) than females (46.9%), the multivariable model showed that female gender was independently and significantly associated with higher odds of overweight/obesity after adjusting for age and education (AOR = 1.17, 95% CI: 1.10–1.37; p = 0.002). This apparent discrepancy between the unadjusted proportions and the adjusted odds ratio is not unusual in cross-sectional analyses and suggests that the crude gender difference in Table I is partly confounded by the age and education distribution of the sample; once these factors are accounted for, female gender emerges as an independent risk factor, consistent with prior research describing greater vulnerability to obesity among women[13,14]. Biologically, this can be explained partly through hormonal influences on fat distribution: oestrogen has been linked to more pronounced fat deposition in women, and hormonal shifts across the reproductive lifespan, including menopause, may further increase adiposity risk[25]. Socio-culturally, women may also face different barriers to physical activity, caregiving-related time constraints, and dietary patterns compared with men, and these gender-specific issues can be a significant contributor to obesity risk[15].

The finding that individuals aged 25–34 years had the highest adjusted odds of overweight/obesity (AOR = 1.27, 95% CI: 1.08–1.71; p = 0.004) compared with those aged 65 years and above may, at first glance, seem counterintuitive, since adiposity is often assumed to accumulate progressively with age. However, this pattern can be explained through several converging mechanisms. Metabolically, younger adults with T2DM who already require insulin therapy may represent a subgroup with more aggressive disease or greater underlying insulin resistance at diagnosis, and insulin initiated at a younger age has a longer cumulative duration in which to exert its anabolic, fat-promoting effect[8,11]. Behaviourally, younger working-age adults in Malaysia may also be more exposed to sedentary occupations, convenience and processed foods, and irregular eating patterns linked to work schedules, all of which are established obesity risk behaviours[18,24]. Conversely, the

comparatively lower obesity prevalence observed among the oldest age groups (55–64 and 65+ years) in this insulin-treated sample may partly reflect the fact that individuals who develop the most severe long-term metabolic and cardiovascular complications of obesity and diabetes are less likely to survive to be captured in an older cross-sectional sample, and may also reflect age-related weight loss from comorbidity, muscle wasting, or reduced appetite that can occur in some older patients with long-standing diabetes[26]. Metabolic and lifestyle changes with age could therefore modify the effect of insulin therapy on body weight, and this weight effect may plausibly vary across age groups.

Education level showed a more complex, non-linear pattern: individuals with secondary education had significantly higher adjusted odds of overweight/obesity than those with no formal education (AOR = 1.21, 95% CI: 1.18–1.48; p = 0.041), whereas primary and higher education levels were not significantly associated with the outcome. One plausible explanation is that individuals with secondary education may have sufficient household income and market access to purchase convenience and processed foods without yet having the higher health literacy typically associated with tertiary education, which has been linked to more weight-conscious food choices and stronger adherence to dietary advice[27]. The no-formal-education stratum in this sample was very small (12 individuals), so its apparent absence of obesity should be interpreted with caution as a statistically unstable estimate rather than as evidence of a true protective effect. This underscores that the education level of individuals under insulin treatment may determine the effectiveness of weight-management practices, since education can support greater adherence to dietary and lifestyle interventions delivered alongside insulin therapy[27,28].

Beyond these sociodemographic correlates, lifestyle habits remain central to both glycaemic control and body-weight regulation in diabetes. Prior studies have linked high caloric intake, poor consumption of fruits and vegetables, skipping breakfast, low physical activity, and smoking to a greater risk of overweight and obesity in diabetic populations[11,13,14,16-19]. Dietary interventions play an essential role in diabetes management because of their considerable effect on blood-glucose regulation and general health outcomes[27]. Yet adherence to dietary guidance remains a significant challenge for a large proportion of patients, which in turn affects their ability to manage both their glycaemia and their weight[28]. Although compliance with insulin treatment itself presents recognized challenges[28], insulin remains fundamental to glycaemic control in this population, creating an ongoing clinical tension between achieving optimal glycaemic control and limiting insulin-associated weight gain[7].

Taken together, the association between female gender and overweight/obesity observed in this study is broadly consistent with several previous studies conducted in diabetic and general adult populations[13-15,25]. In contrast, the strong association with younger age (25–34 years) contrasts with studies in which obesity risk increased more progressively with age[26]. This divergence is most plausibly explained by three factors: differences in study population (this study examined insulin-treated T2DM patients specifically, a group with an additional, insulin-driven mechanism for weight gain not present in general population samples), differences in setting (a single primary healthcare clinic rather than a national, multi-site, or hospital-based sample, which limits direct comparability), and differences in study design, since cross-sectional descriptive designs such as this one, and comparable retrospective designs used elsewhere[26], cannot establish the temporal sequence between insulin initiation, weight gain, and the demographic factors examined, unlike prospective cohort designs.

The gender differences observed, with female gender independently associated with higher odds of overweight/obesity, support the need to adopt gender-sensitive mechanisms of healthcare provision

and treatment interventions. Taken together, the cultural, behavioural, and biological determinants discussed above highlight the importance of whole-person care programmes that integrate individual, social, and environmental factors alongside medical management to achieve optimal outcomes. The knowledge of how these sociodemographic factors intersect with insulin therapy can help healthcare professionals design personalized interventions that meet the needs of individuals with type 2 diabetes receiving insulin therapy and improve their long-term outcomes in weight management.

CONCLUSION

This study found that the prevalence of overweight and obesity among adults with type 2 diabetes mellitus receiving insulin therapy in primary health care was high, with 26.3% classified as overweight and 49.7% classified as obese, giving a combined prevalence of 76%, directly answering the first study objective of quantifying the burden of overweight and obesity in this population and confirming that this burden exceeds the prevalence reported for the general Malaysian adult population. In terms of the second objective, that of identifying associated factors, age between 25 and 34 years, female gender, and secondary education level were independently and significantly associated with higher odds of overweight/obesity after adjustment. These sociodemographic dimensions indicate that younger, female, and secondary-educated insulin-treated patients represent priority subgroups for early, targeted weight-management interventions within primary care. Pharmacological and non-pharmacological approaches both have a role in the broader management of diabetes and weight in this population: insulin therapy remains a means of achieving effective glycaemic control, while non-pharmacological strategies, including dietary counselling and physical activity promotion, are needed alongside it to prevent or mitigate insulin-associated weight gain. Overall, these findings support the need for interdisciplinary, primary-care-based weight-management strategies tailored to the demographic profile identified in this study.

Strength and Limitation

The advantage of the study is its valuable input into the picture of the trend of BMI classification in the context of T2DM with insulin treatment among primary health care patients. The finding that female gender had a significant independent association illuminates a pivotal health issue in this population. These findings can form an important basis for designing specific interventions and obesity control and prevention policies in this population. Nevertheless, this study has several limitations. It was limited by a relatively small sample size drawn from a single primary healthcare setting; thus, the extent to which the study can be generalized to the wider, multifaceted primary healthcare population of Malaysia is limited. The descriptive, cross-sectional nature of the study also means that causality between insulin therapy, the sociodemographic factors examined, and overweight/obesity cannot be established, and reverse causation or confounding by unmeasured factors cannot be excluded.

A further limitation concerns the range of variables studied. The multivariable model examined only age, gender, and education; several other variables known or plausible to influence body weight in insulin-treated T2DM were not measured or adjusted for in this analysis, including dietary intake, physical activity level, smoking status, duration of diabetes, duration and dose of insulin therapy, insulin regimen (basal versus basal-bolus), HbA1c control, and household income. Any of these could act as unmeasured confounders of the associations reported here, or could

themselves be independently associated with overweight and obesity; for example, longer insulin exposure or higher insulin dose could plausibly explain part of the age-related pattern observed, while dietary and physical activity behaviours could plausibly explain part of the gender- and education-related patterns. Future studies should therefore collect and adjust for these clinical and lifestyle variables to better isolate the independent contribution of sociodemographic factors to overweight and obesity risk in this population.

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AUTHOR CONTRIBUTION
Yahya NS: Led the study conception and design, including formulation of the research objectives and methodology; oversaw questionnaire development, ethical approval submission, and coordination with the study site; drafted the initial manuscript, prepared the abstract, tables, and Discussion, and integrated all revisions from co-authors; approved the final version of the manuscript and takes full responsibility for the integrity and accuracy of the work.
Mulud ZA: Contributed to study design, content validation of research instruments, and refinement of the methodological framework. Provided critical review of the manuscript, particularly the introduction, literature justification, and interpretation of results; guided statistical analysis accuracy, ensured methodological soundness, and contributed to the final revision of the manuscript.
Daud AZC: Contributed to conceptual development of the study, refinement of research tools, and overall study supervision; provided expert input on data interpretation, strengthening the conceptual alignment and enhancing scientific clarity; critically revised the manuscript for intellectual content, including the Discussion and conclusion.

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