

ASSOCIATION BETWEEN INSULIN THERAPY ADHERENCE AND GLYCATED HAEMOGLOBIN (HbA1c) AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS ATTENDING A COMMUNITY HEALTH CLINIC

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Abstract: Introduction: Insulin therapy is a recommended treatment for diabetes mellitus. Despite knowing insulin is one of the recommended treatments for glycemic control, adherence to insulin therapy still plays the main challenge in achieving good control of glycated haemoglobin (HbA1c). **Objective:** This study aims to determine adherence and compare HbA1c levels before and after six months of insulin therapy among type 2 diabetes patients (T2DM). **Method:** This cross-sectional study was conducted among 300 participants with T2DM at Sungai Buloh community health clinic, Selangor. A self-administered questionnaire Morisky Insulin Adherence Scale (MIAS), was used to measure the study adherence variable. Data were analysed using a statistical package for the social science (SPSS) version 23. **Result:** Eleven (3.7%) of respondents had good adherence, 109 (36.3%) had moderate adherence, and 180 (60%) were poor adherence. The mean HbA1c at baseline is 9.654 mmol/L and reduced to 9.194 mmol/L after six months of insulin therapy. Education shows an association towards adherence level with p -value = 0.004 and significantly found an association between HbA1c and insulin adherence with $p < 0.05$. **Conclusion:** The study found that most respondents have poor adherence to insulin therapy. Therefore, essential to highlight adherence issued to achieve good glycaemic control.

Keywords: Adherences, HbA1c, glycated haemoglobin, type 2 Diabetes, Malaysia.

Abbreviations: HbA1c, T2DM

Introduction

Type 2 diabetes is a metabolic disease characterised by progressive loss of adequate β -cell insulin secretion, frequently because of insulin resistance (American Diabetes Association, 2020). Most patients who develop type 2 diabetes mellitus (T2DM) have some degree of endogenous insulin production where the production is insufficient for sustaining usual carbohydrates homeostasis. At the earlier phases of the disease process, insulin secretion increases, and subsequent hyperinsulinemia is due to insulin resistance conditions.

Diabetes prevalence has rapidly increased among global populations. Diabetes affects an estimated 463 million people worldwide as of 2018 and is expected to rise to nearly 700 million

by 2045. Malaysia led the Western Pacific region in diabetes prevalence in 2018, with 16.8%. (International Diabetes Federation, 2019).

The primary purpose of adherence towards insulin therapy is to achieve good glycaemic control and reduce the risk of developing diabetes complications. Although insulin therapy benefits T2DM patients, adherence issues remain global challenges to achieving good glycaemic control. People with diabetes risk developing macrovascular and microvascular complications, including cardiovascular, cerebrovascular, peripheral vascular disorders, retinopathy, nephropathy, and neuropathy (Saeedi *et al.*, 2019). These complications accelerate significant premature mortalities, loss of productivity and poor quality of life (Afroz *et al.*, 2018).

Diabetes has severe direct and indirect effects on patients that are amplified. While the indirect costs mostly consist of financial losses due to disability and deaths, travel expenses, nutrition costs, productivity losses, and income loss, the direct costs primarily concern the consumption of healthcare resources such as pharmaceuticals, outpatient, and inpatient costs (Hu *et al.*, 2015). According to the Malaysia budget report Ministry of Finance (2020), in 2018, budget allocation for the Ministry of Health (MOH) Malaysia was MYR 28.7 billion (equivalent to USD 7.1 billion), accounting for approximately 9% of the total budget spending and government revenues.

Meanwhile, according to American Diabetes Association (2016), insulin therapy can delay the risk of patients toward macrovascular and microvascular complications by achieving good glycaemic control. Importance to improve insulin adherence to achieve ideal glycaemic control. Thus, this study aims to identify the level of adherence, compare HbA1c levels before and after six months of insulin therapy and identify the association between insulin adherences and the HbA1c level among T2DM patients undergoing insulin therapy treatment.

Materials and Methods

A cross-sectional study was conducted among patients with T2DM who received insulin therapy as a treatment in the Sungai Buloh health clinic from 1st Mac 2020 to 30th May 2020. Sungai Buloh health clinic was chosen due to the highest number of active diabetes patients in Selangor, with estimated 3412 patients and been registered under Malaysia National Diabetes Registration (NDR) system.

Sample Size

The sample size of this study is calculated using Raosoft Software sample size calculation. According to the Sungai Buloh health clinic database, the National Diabetes Registration in 2018 shows the numbers of active patients are 3412 and the number of patients and

insulin patients is 1352. Therefore, referring to the Raosoft Sample Size calculation, the recommended sample size will be 300 respondents.

Inclusive and Exclusive Criteria

The inclusive criteria are T2DM, being prescribed for insulin therapy with minimal one-year duration, having a record of HbA1c level before and after six months of insulin therapy, age ≥ 18 years old, and using an insulin pen only. Meanwhile, pregnant women with T1DM, prediabetes, on oral glucose-lowering drugs (OGLD) only, and present with nephropathy, neuropathy, cardiovascular, retinopathy, and stroke patients were excluded from this study. Participation is voluntary, and respondents can withdraw anytime during the study.

Ethical Consideration

This study had ethical approval from Malaysia National Medical Research Register (NMRR-19-3459-48044). Data collection started after ethical approval from University Teknologi Mara (UiTM) and Sungai Buloh health clinic. All participants received the patient's information sheet (PIS) regarding study information in English or Malay before continuing with the study consent and questionnaire session.

Data Collection Procedure

After ethical approval, research assistants (RAs) started data collection by identifying respondents based on the inclusive criteria guide. The patients were recruited during diabetes clinic appointment sessions from Monday to Friday. Participants were given thirty minutes to answer the whole questionnaire. Meanwhile, informed consent and data collection occurred before or after participants' clinic appointments. Research assistants (RAs) assisted the participants who could not read or write during the questionnaire by reading and explaining the process, procedure, and questionnaires. In addition, to measure the HbA1c before and after six months of insulin therapy, RAs obtained medical record

information of glycated haemoglobin A1C (HbA1C) in clinic electronic medical records (EMR).

Measures Instruments

Demographic and Diabetes Characteristics

All participants were asked to answer a questionnaire on their gender, age, and education level. Meanwhile, RAs collected information regarding the type of prescribed insulin, number of insulin injections and glycated haemoglobin (HbA1c) from the clinic's electronic medical record. HbA1c levels are based on the Canadian Diabetes Association (2013) target categories: tight (<7.0% or <53 mmol/mol), moderate (7.0%–8.5%, 53 mmol/mol–69.5 mmol/mol) and uncontrolled (>8.5% or >69.5 mmol/mol).

Morisky Insulin Adherence Scale (MIAS)

The eight-item Morisky Medication Adherence Scale (MMAS; Morisky *et al.*, 2008) was adapted to assess insulin adherence by replacing condition-specific language like "blood pressure medicine" with "insulin," but maintaining each item's meaning and scoring. Consistent with the MMAS (Morisky *et al.*, 2008), the MIAS includes seven yes/no questions and one on a 5-point Likert scale. Respondents answered "no" to all questions, but "yes" to item 5 (reverse coded) and "never/rarely" to item Adherence was categorised into good (score 8), moderate (score 6–<8), and poor (score <6). Validation for the questionnaire used back-to-back translation by a linguistic person (lectures). Meanwhile, a pilot study was run among ten respondents to evaluate the validity and result of the content of Cronbach's alpha is 0.89.

Data Analyses

Statistical Package for the Social Science (SPSS) version 23 for all analyses and restricted our analyses to include only those participants prescribed insulin or insulin plus oral glucose-lowering agents (N = 300). SPSS was used to analyse independent variables (adherence level) and dependent variables (HbA1c level) and

answered the objective of this study. Paired *t*-tests were used to identify the comparison between the total mean of glycated haemoglobin (HbA1c) before and after insulin therapy. Meanwhile, Pearson chi-square was used to determine an association between sociodemographics (age, gender, education) and insulin therapy adherence. Cronbach's α and item-total correlations assessed the MIAS' internal consistency reliability. Item rest correlations ≥ 0.30 indicate items are conceptually similar to other items, and Cronbach's $\alpha \geq 0.70$ indicates good internal consistency reliability (DeVellis, 1991; Nunnally *et al.*, 1994). The Cronbach's alpha for this pilot study is 0.89.

Results

Sociodemographic characteristics (gender, age, education) and glycated haemoglobin (HbA1c) level results are shown in Table 1. Data analysed found 106 (35.3%) respondents are male, 194 (64.7%) are female, and the highest number of respondents are more than 60 years old, with 125 (41.7%). Education level shows that most respondents received secondary school with 139 (46.3%) and glycated haemoglobin (HbA1c) mean level before insulin therapy is 9.65% and 9.19% after the six-month insulin therapy intervention.

The comparison numbers of participants according to HbA1c group level before and after six-month insulin therapy are shown in Table 2. The number of participants with control HbA1c (<7.0%) increased from seven (2.3%) to twenty-four (8%) after insulin therapy. In addition, the numbers of participants with uncontrolled HbA1c (>8.5%) reduce from 250(83.3%) to 225(75%) after insulin therapy.

The mean range level of glycated haemoglobin (HbA1c) before and after six-month insulin therapy is shown in Table 3. The paired *t*-test result found a reduction in the total mean of glycated haemoglobin (HbA1c) from $9.65\% \pm 1.92$ (before starting insulin therapy) to $9.19\% \pm 1.83$ (after six-month insulin therapy) with a *p*-value of 0.001.

Table 1: Sociodemographic characteristics for the study variables

Variables	Frequency	Percentage (%)
Gender		
Male	106	35.3
Female	194	64.7
Age		
>18 -30 years	2	0.7
31 - 50 years	81	27.0
51 - 60 years	92	30.7
> 60 years	125	41.7
Education Level		
No educated	29	9.7
Primary school	72	24.0
Secondary school	139	46.3
Diploma/Degree/PhD	60	20.1
Total	300	100

Table 2: Comparison numbers of participants according to HbA1c group level before and after six-month insulin therapy

Variables (HbA1c group)	Before Insulin Therapy		After 6 Months Insulin Therapy	
	Frequency	Percentages (%)	Frequency	Percentages (%)
Control (<7.0%)	7	2.3	24	8.0
Moderate control (7.0%–8.5%)	43	14.3	51	17.0
Uncontrolled (>8.5%)	250	83.3	225	75.0
Total	300	100	300	100

Table 3: Mean level of glycosylated haemoglobin (HbA1c) before and after six months of Insulin therapy

Variables	Mean (SD)	p-value*
HbA1c level before insulin therapy (%)	9.65 (1.92)	
HbA1c level after six-month insulin therapy (%)	9.19 (1.83)	0.001

*Paired t-test, SD (standard deviation), *significant $p < 0.005$

Insulin adherence levels among respondents are shown in Table 4. The result found that 180(60%) participants have poor adherence towards insulin therapy. Only eleven (3.7%)

participants show good adherence, meanwhile, 109(36.3%) participants have moderate adherence.

Table 4: Level of insulin adherence among respondents

Variables (level of insulin adherence)	Frequency	Percentage (%)
Poor adherence	180	60
Moderate adherence	109	36.3
Good adherence	11	3.7
Total	300	100

An association between sociodemographics (gender, age, education) toward insulin adherence level is shown in Table 5. No associations were found between gender or age towards adherences with *p-value* =0.479 and *p-value* =0.397, respectively, except education shows a significant association with *p-value* =0.004 <0.05).

The Chi-Square test study found a significant association between insulin therapy adherence and glycated haemoglobin (HbA1c) level with a *p-value* <0.005.

Discussion

In this study, the level of adherence towards insulin therapy was poor, which is similar to studies conducted at the Marmara University School of Medicine Endocrinology outpatient clinic (Gogas et al.,2015) and the Endocrinology and Metabolism Research Centre (EMRC) outpatient diabetes clinic, Tehran (Farsaei et al., 2014). This finding is lower than the results found in Sudan: the level of insulin adherence was 59.2% (Tewabe et al.,2018). The differences in Sudan and this study might be due to methodological variations, including socio-

Table 5: Association between sociodemographic (age, gender, education) and insulin therapy adherence

Variables	Adherence Towards Insulin Therapy			X ² (df)	P-value
	n (%)				
	Poor	Moderate	Good		
Age (years) ^{a b}					
58.78 ± 8.1 ^a				6.243(2)	0.397
21-30	2(1.11)	0(0)	0(0)		
31 - 50	46(25.5)	30(25.5)	5(45.45)		
51 - 60	62(34.44)	28(25.68)	2(18.18)		
>60	70(38.88)	51(46.78)	4(36.36)		
Gender ^b					
Male	65 (61.32)	39 (36.79)	2(1.88)	0.473(2)	0.479
Female	115(59.27)	70 (36.08)	9 (4.63)		
Education ^b					
No educated	18(10.0)	11(10.09)	0(0)		
Primary school	47 (26.11)	20(18.34)	5(45.45)	18.94(4)	*0.004
Secondary School	90 (50)	48(44.03)	1(9.09)		
Diploma/Degree/ Master/PhD)	25 (13.88)	30(27.52)	5(45.45)		

* Pearson Chi-Square, note: ^a Mean ± standard deviation; ^b frequency (%), *significant *p* <0.005

cultural, health service utilisation, perceptions regarding the importance of good adherence, and economic and drug availability characteristics between populations.

In addition, the poor adherence among this population might be due to a lack of knowledge towards insulin therapy and its impact on physical well-being. This study result indicates that asking about and actively listening to patients' beliefs, concerns, or fears about insulin therapy allows clinicians Moreover, people have thought that the biggest problems with insulin therapy adherences are related to injections, how complicated the regimen is, and how often and rigid the dosing schedules are (Petznick *et al.*, 2013). Therefore, increased patient awareness of the importance of insulin therapy will result in better patient adherence and outcomes.

This study found a reduction in the mean of glycated haemoglobin (HbA1c) before and after six-month of insulin therapy. Although the current study found a slight percentage reduction in the mean of glycated haemoglobin (HbA1c), it shows that adherence level needs improvement to achieve good control of HbA1c (Mathes *et al.*, 2014).

Sociodemographic characteristic (education) is significantly associated with insulin adherence. The significant association show that educational background is advantageous to the respondents to help them understand the insulin injection technique, timing, and doses easier and more clearly (Choe *et al.*, 2018). In addition, females show poor compliance compared to men in the current study. This may be due to a woman's average age being between fifty and sixty years old, most of whom are married. This condition could be attributed to the risk of less accountability in remembering the insulin injections, the need to commit to children and family, and being busy with the commitment of being a housewife or working (Tewabe *et al.*, 2018). Another area studied by Choe *et al.* (2018) also found that women had higher glycated haemoglobin (HbA1c) levels and poor insulin adherence levels than men. This factor might be due to

financial issues among housewives. The cost of insulin was substantially associated with insulin therapy adherence (Tarig *et al.*, 2016). In addition, multiple injections per day might contribute to the highest cost of insulin needles. Therefore, patients can use the same needle longer and induce pain (Shady *et al.*, 2014).

Conclusion

In this study level of insulin adherence was 11(3.7%). Determinant factors for insulin adherence need to identify in this study area. As per the recommendations, healthcare providers and responsible bodies are responsible for planning and implementing intensive health education about the importance of insulin therapy adherence and the effect of poor glycaemic control.

Strengthens and Limitations

A strength of this study shows that adherence is an element of good glycaemic control. Multiple programs and interventions can be addressed to promote insulin adherence among T2DM. However, there is a limitation of this study. First, our findings cannot be generalised to the general diabetic population due to the single-centre populations. Secondly, no data on diabetic complications are available, which may also contribute to non-adherence. Despite these limitations, our findings represent a valuable contribution to the literature.

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