MEDICAL SCIENCE

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DISCOVERY
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Risk factors of erectile dysfunction among type 2 diabetes mellitus patients: A retrospective real-world study in the Hospital Universiti Sains Malaysia

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ABSTRACT

Introduction: Erectile dysfunction (ED) is a common complication in men with type 2 diabetes mellitus and can significantly impact their quality of life and relationships. However, the prevalence of erectile dysfunction is usually underestimated in developing countries due to social stigma, lack of awareness, limited access to healthcare, and underdiagnosis. This study aims to identify the risk factors associated with ED in type 2 male diabetics. *Methodology:* A retrospective study was conducted at the Hospital Universiti Sains Malaysia involving T2DM male patients who also experienced ED. The patient's medical records were reviewed to identify potential risk factors for ED by using Structural Equation Modelling (SEM), including direct and indirect effects. The best SEM model was identified based on goodness-of-fit measures. The models were created and analyzed using IBM SPSS Amos 20 software. *Results*: The results of our study showed that the final model had a good fit, and only three independent predictors, including old age, FBS, and TC, had a direct statistically significant effect on erectile dysfunction among T2DM patients in our study population. Other variables, such as BMI, HBA1C count, antidepressant status, and smoking status, did not significantly affect. The goodness of fit statistics, such as GFI, NFI, CFI, TLI, and RMSEA values, indicate a good model fit. *Conclusion*: Our findings suggest that early detection and management of these risk factors could help prevent or reduce the risk of ED in T2DM patients. Comprehensive care of T2DM patients is essential to prevent or reduce the risk of ED.

Keywords: Erectile Dysfunction, Type 2 Diabetes Mellitus, Risk Factors, Structural Equation Modelling

1. INTRODUCTION

One of the most widespread chronic diseases worldwide is diabetes mellitus (DM). According to Giugliano et al., (2010), diabetes is also linked to a higher risk of erectile dysfunction (ED) in men. One of the most frequent complications for men with type 2 diabetes mellitus (T2DM) is erectile dysfunction (ED). The inability to obtain or maintain an erection strong enough for sexual activity is known as ED. Compared to the general population, men with T2DM have a higher prevalence of ED. ED can significantly negatively affect T2DM patients' quality of life, resulting in relationship issues, depression, and anxiety (Parmar et al., 2022).

Men's social interactions, emotional and psychological well-being, and romantic relationships have all been found to suffer when they have ED. According to Shiferaw et al., (2020), 322 million men worldwide will experience ED by 2025. For various reasons, the prevalence of erectile dysfunction is frequently underestimated in developing nations. Firstly, in many developing countries, a social stigma is associated with sexual problems, and men may feel ashamed or embarrassed to talk about their ED. As a result, they may not seek medical attention, and the true prevalence of ED may be underestimated.

Second, many men in developing countries may not be aware that ED is a medical condition that can be treated. They may believe that it is a normal part of ageing or that nothing can be done to address it. This lack of awareness can lead to under reporting of ED cases. Next, there may be limited access to healthcare facilities, and men may not have the opportunity to receive a diagnosis and treatment for ED. This can also contribute to underreporting of cases. Last, healthcare providers in developing countries may not be trained to recognize and diagnose ED, which can lead to underdiagnoses of the condition (Idung et al., 2012).

Several risk factors have been identified for ED in T2DM patients, including socio-demographic factors such as age (Asaduzzaman et al., 2020), occupation, monthly income (Seid et al., 2017), educational status (Costa et al., 2014), marital status (Adebusoye et al., 2012), and residence (Idung et al., 2012). Moreover, clinical factors such as duration of diabetes (Mutagaywa et al., 2014; Ugwu et al., 2016; Chaudhary et al., 2016), testosterone deficiency, peripheral neuropathy, peripheral vascular disease (Shiferaw et al., 2020), body mass index (BMI) (Adebusoye et al., 2012), fasting blood sugar level (FBS) (Asaduzzaman et al., 2020), type of DM (Roth et al., 2003), Hypertension (Ugwu et al., 2016; Idung et al., 2012) and Type of anti-diabetic drugs (Ugwu et al., 2016), also the determinant factors of ED among DM patients.

Also, behavioural or lifestyle factors such as smoking (Asaduzzaman et al., 2020), not being involved in physical exercise (Shiferaw et al., 2020; Adebusoye et al., 2012), alcohol drinking (Van-Vo et al., 2017; Costa et al., 2014) and adherence to the drug (Ugwu et al., 2016) is the factors that affect ED among DM patients. There are many risk factors for ED in diabetic patients. This study was designed to study the patient's age, high fasting blood sugar (FBS) levels, elevated total cholesterol (TC), high body mass index (BMI) score, high haemoglobin A1C (HbA1C) count, antidepressant status, HDL, LDL, triglycerides and smoking as risk factors for ED in type 2 male diabetics.

Age is a well-known risk factor for ED, with the prevalence of ED increasing with advancing age. FBS and TC levels have also been shown to be associated with ED, likely due to their effect on vascular function. Similarly, high BMI scores and HbA1C count have been linked to endothelial dysfunction, which can contribute to the development of ED in T2DM patients. Antidepressant use has also been implicated in ED due to its effect on neurotransmitter pathways involved in erectile function. In addition, HDL, LDL, and triglycerides are important lipid profile markers associated with ED in several studies. Finally, smoking is a known risk factor for ED, likely due to its detrimental effect on vascular health (Parmar et al., 2022).

Therefore, this study aims to investigate the relative contribution of these risk factors to the development of ED in type 2 male diabetics at Hospital Universiti Sains Malaysia. Understanding these risk factors is critical in developing effective ED prevention and management strategies for T2DM patients.

2. METHODOLOGY

We conducted a retrospective study of male T2DM patients diagnosed with ED at the Hospital Universiti Sains Malaysia between January 2021 and December 2022. The patient's medical records were reviewed to identify potential risk factors for ED. The inclusion criteria were male patients aged 18 years and above diagnosed with T2DM and ED. The exclusion criteria were patients with a history of prostate cancer or prostatectomy, spinal cord injury, or other neurological disorders that could affect sexual function.

Structural Equation Modelling

A theoretical system of linear observed or unobserved variables can be estimated and evaluated using structural equation modelling (SEM). By utilising the correlation or covariance matrix between the variables, it uses an input format to verify the accuracy of the theoretical model based on the assumption. The presumption was that the population correlation or covariance

matrix would be reproducible by SEM if the theoretical model was accurate and the parameters were defined. The use of latent-variable structural equation modelling is called a path analysis. The forces that are directly affected are those that are unaffected by any other model component.

In this way, direct effects are represented as an arrow from an independent exposure variable to a dependent/outcome variable. Each indirect effect, whether a single one or a group of them, comprises all possible routes through a given variable. Several risk factors for ED among T2DM patients in Kelantan, Malaysia, were clarified by this study. In the following step, building a SEM structure, a conceptual framework was provided by this association analysis of several risk factors. The relationships between all risk factors, their combined action or latent variables, and direct and indirect risk factors were reflected in the SEM. The risk factors used in this study are in (Table 1).

Table 1 Risk Factors of Erectile Dysfunction among Type 2 Diabetes Mellitus Patients

| No.	Variables	Description
1	ED in T2DM	Erectile dysfunction among type 2 diabetes mellitus patients
2	BMI	Body mass index
3	Smoking	Smoking status
4	Age	Age categories (less or more than 40 years old)
5	FBS	Fasting blood sugar
6	TG	Triglycerides
7	HBA1C	Haemoglobin A1c
8	HDL	High-density lipoprotein
9	LDL	Low-density lipoprotein
10	TC	Total cholesterol
11	DEPRESSED	Current status of antidepressants
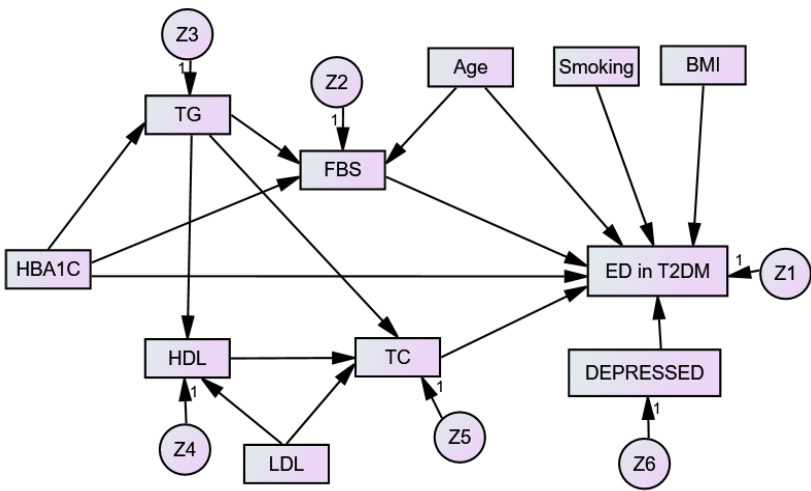
Figure 1 Structural Equation Modelling of Erectile Dysfunction among type 2 diabetes mellitus patients using AMOS

In this analysis, we provide standardised path coefficients and p-values. Finally, the SEM model with the highest goodness-of-fit score was determined to be the best one. Chi-square testing, root average square approximation error (RMSEA), and the comparative fit index (CFI) are used to evaluate the fitness of the SEM models. The Chi-square test evaluates whether the observed covariance matrix or correlation differs from the model's covariance matrix.

Models with an RMSEA of 0.08 or less are suitable; those with an RMSEA of 0.08 or higher are not. The CFI evaluates how well the current model fits the models of freedom. CFI values over 0.90 indicate a successful model. Using IBM SPSS Amos 20 software, the models were created and estimated. Age, BMI, depression, TC, FBS, and HBA1C are all directly related to erectile dysfunction in type 2 diabetes mellitus patients (Figure 1). Patients with type 2 diabetes mellitus may also experience erectile dysfunction due to TG, HDL, and LDL.

3. RESULTS

The final models fully standardised path coefficients, which had an excellent fit, are in (Figure 2). The coefficients of the effects of the variables and the p-value on type 2 diabetes mellitus patients' erectile dysfunction are in (Table 2). Table 3 displays the model's goodness-of-fit metrics. According to Figure 2 and Table 2, only three independent predictors—old age, FBS, and TC—have a direct statistically significant impact on patients with type 2 diabetes mellitus who experience erectile dysfunction.

In type 2 diabetes mellitus patients, being older than 40 years old (0.691, p = 0.001), having the highest FBS count (0.212, p = 0.021), and having the highest TC count (0.149, p = 0.020) were all significantly linked to erectile dysfunction. In this study, there was no evidence that patients with type 2 diabetes Mellitus BMI (0.109, p = 0.085), HBA1C count (-0.008, p = 0.933), antidepressant use (0.070, p = 0.269), or smoking status (-0.042, p = 0.509) had any significant impact on their erectile dysfunction. The following risk factors, such as age (0.272, p = 0.001), TG (0.337, p = 0.001), and HBA1C (0.454, p = 0.001), have a direct statistically significant effect with FBS but specific indirect effects on erectile dysfunction among type 2 diabetes mellitus patients.

Among patients with type 2 diabetes mellitus, HDL (0.207, p = 0.001), LDL (0.844, p = 0.001), and TG (0.237, p = 0.001) are risk factors that have significant direct effects on TC but indirect effects on erectile dysfunction. In type 2 diabetes mellitus patients, BHA1C (0.430, p = 0.001) is a risk factor to have a significant direct effect with TG but indirect effects on erectile dysfunction. LDL (0.291, p = 0.001) and TG (-0.460, p = 0.001) are risk factors to have a significant direct effect on HDL.
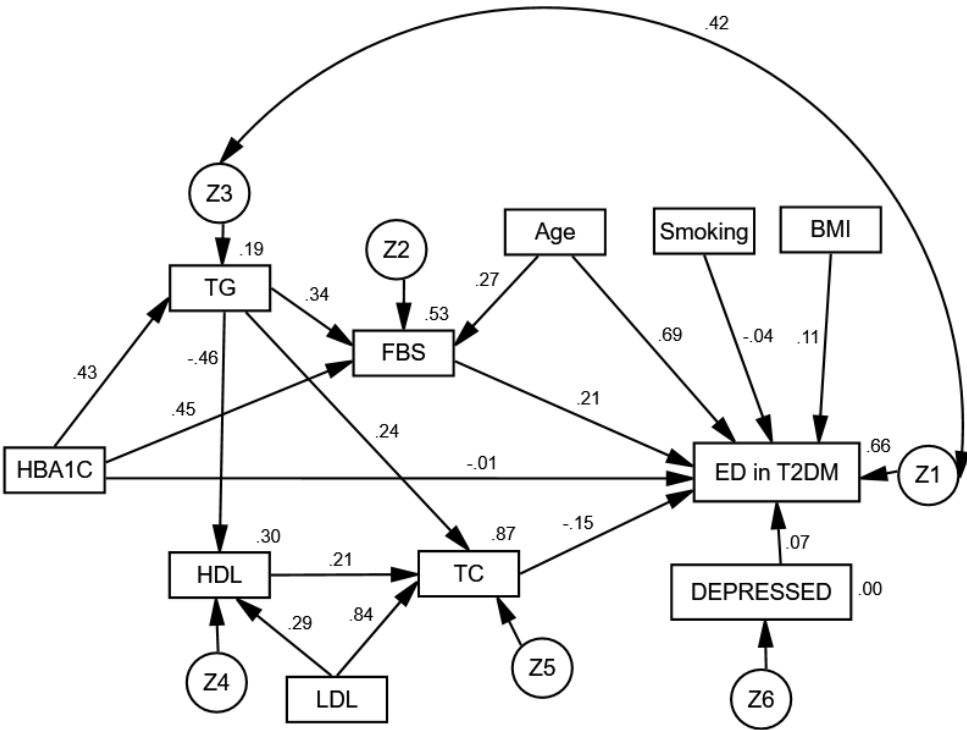

Figure 2 Structural Equations Modelling of Erectile Dysfunction among type 2 diabetes mellitus patients after Modification Index

Table 2 Standardized Path Coefficients and p-value of Variables on Hypertension

Variable	Standardized path coefficients	p-values
ED in T2DM		
Age	0.691	0.001*
FBS	0.212	0.021*
BMI	0.109	0.085
HBA1C	-0.008	0.933
TC	0.149	0.020*
Antidepressant	0.070	0.269
Smoking	-0.042	0.509
FBS		

Age	0.272	0.001*
TG	0.337	0.001*
HBAIC	0.454	0.001*
TC		
HDL	0.207	0.001*
LDL	0.844	0.001*
TG	0.237	0.001*
HDL		
LDL	0.291	0.004*
TG	-0.460	0.001*
TG		
HBA1C	0.430	0.001*

A crucial indicator of how well a Structural Equation Model (SEM) fits the observed data is the goodness of fit. It is used to assess how closely the predicted relationships between the variables in the model match those in the actual data. In accordance with Table 3, the final model showed a good model fit when the Goodness of Fit index (GFI), Normed fit index (NFI), Comparative Fit index (CFI), and Tucker Lewis Index (TLI) values were close to or higher than 0.90. Less than 5.0 allows for a reasonable fit (CMIN/df = 1.575).

An acceptable fit between the hypothetical model and the sample data is indicated by a parsimonious fit to degrees of freedom ratios in the range of 3 to 1. The recommended limit of 0.08 or less is clearly exceeded by the RMSEA value of 0.069. A close fit of the model to the degrees of freedom would be indicated by RMSEA of 0.08 or less. As a result, the model displays a generally satisfactory fit.

Table 3 Goodness-of-Fit Statistics of the Model

Goodness-of-fit statistics	Value
Goodness of Fit index (GFI)	0.887
Normed fit Index (NFI)	0.863
Comparative Fit index (CFI)	0.960
Tucker Lewis Index (TLI)	0.942
Parsimonious fit (CMIN/df)	1.334
RMSEA	0.069

4. DISCUSSION

Our study's findings indicate that the highest TC, FBS, and age greater than 40 are significant risk factors for ED in T2DM patients. These results are in line with earlier research that found these risk factors. Age over 40 years was significantly associated with erectile dysfunction among diabetic patients, according to the most recent study by Shiferaw et al., (2020). Studies by Sharifi et al., (2012), Shi et al., (2014), and Korani and Sonbol, (2018) reported similar findings. Additionally, this result is consistent with earlier research from Turkey (Kiskac et al., 2015), China (Lo et al., 2014), Korea (Cho et al., 2006), Belgium (Enzlin et al., 2003), and Kuwait (Al-Hunayan et al., 2007).

According to our study's findings (Djordjevic et al., 2015), a more thorough prediction of patients with advanced age may include an evaluation of the patient's ED. We discovered that as people aged, ED prevalence rose. The prevalence of ED was more than five times higher in the diabetes population under 40 years old than it was in the diabetes population over 40. According to studies, men with type 2 diabetes are more likely to experience erectile dysfunction if their fasting blood glucose levels are high. A metabolic disorder called type 2 diabetes mellitus impairs the body's capacity to control blood sugar levels. High blood sugar levels can harm the nerves and blood vessels that regulate sexual function, resulting in ED. Fasting blood sugar was recently declared to be an independent predictor of ED by Parmar et al., (2022).

In order to lower their risk of developing erectile dysfunction and other complications, patients with type 2 diabetes must control their blood glucose levels. According to most studies, drinking alcohol, having diabetes for a long time, and having poor glycemic control are all significantly linked to erectile dysfunction (ED) (Zeleke et al., 2021; Costa et al., 2014). The study's findings

imply that managing ED in people with type 2 diabetes mellitus may depend on lowering fasting blood glucose levels. This finding emphasises the importance of maintaining stable blood sugar levels when managing diabetes for general well-being and sexual function.

According to the study's findings, people with type 2 diabetes with erectile dysfunction (ED) are significantly more likely to have high total cholesterol levels. A metabolic disorder called type 2 diabetes mellitus impairs the body's capacity to control blood sugar levels. Atherosclerosis, or the hardening and narrowing of the arteries, can be brought on by high total cholesterol levels, particularly LDL cholesterol. The erectile function may be hampered by this condition's restriction of blood flow to the penis. LDL and HDL cholesterol are included in the measurement of total cholesterol, which is the total amount of cholesterol in the blood. LDL cholesterol is frequently referred to as "bad" cholesterol because it can aid in the formation of artery plaque.

According to Parmar et al., (2022), serum triglyceride and HDL did not significantly correlate with ED; only serum cholesterol did. In contrast, Shi et al., (2014) discovered a significant association with HDL. These inconsistent results may result from confounding variables like hypolipidemic medications needing to be considered in these studies. Nevertheless, the study's findings imply that controlling high total cholesterol levels may be crucial for treating ED in people with type 2 diabetes. This finding emphasises how crucial it is to manage diabetes while maintaining healthy cholesterol and blood sugar levels.

According to the study, there is no link between type 2 diabetes mellitus patients' body mass index (BMI), HbA1c, depression, smoking, or erectile dysfunction (ED). This study did not find a significant correlation between BMI, HbA1c, depression, or smoking and ED in people with type 2 diabetes mellitus, despite the fact that these factors are known risk factors for a number of health conditions. According to a related study (Seid et al., 2017); there is no correlation between ED and BMI, co-morbidity, glycemic control, or alcohol consumption. According to another study by Sharifi et al., (2012), risk factors such as BMI, SBP, DBP, HbA1c, an impaired lipid profile, a high creatinine level, a high testosterone level, and even a history of smoking did not have any predictive value for the likelihood of developing ED in T2DM patients.

5. CONCLUSION

In conclusion, our study identified several risk factors for ED among T2DM patients, including age, fasting blood sugar (FBS), and total cholesterol (TC). The findings highlight the importance of monitoring and controlling these factors in managing ED among individuals with type 2 diabetes mellitus. Age is an unavoidable risk factor for many health conditions, including ED. However, maintaining good blood sugar control and healthy cholesterol levels may help to prevent or manage ED in individuals with type 2 diabetes mellitus. The study also found that other factors such as BMI, HbA1c, depression, and smoking were not significantly associated with ED among individuals with type 2 diabetes mellitus.

While these factors may still be important to manage overall health and prevent other health conditions associated with diabetes, they may not be significant predictors of ED in this population. Early detection and management of these risk factors could help prevent or reduce the risk of ED among T2DM patients. The comprehensive care of T2DM patients, including the management of comorbidities, is also essential in preventing or reducing the risk of ED. Further studies are needed to explore the effectiveness of interventions targeted at these risk factors in reducing the risk of ED among T2DM patients.

Author Contributions

Wan Mohd Nazlee Wan Zainon: Contributed in reviewing and editing the manuscript, revising the manuscript and final approval.

Mohd Albaihaqi Ahmad Lotopi: Contributed in acquisition of data, analysis, interpretation of data, and final approval.

Nur Syuhada Roslan: Contributed in acquisition of data, analysis, interpretation of data, and final approval.

Norazlina Mat Nawi: Contributed in reviewing and editing the manuscript.

Arsalan Humayun: Contributed in the drafting of the manuscript, analysis, and interpretation of data.

Mohamad Arif Awang Nawi: Contributed in the drafting of the manuscript, conception and design of the study, analysis, interpretation of data and final approval.

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