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Performance of the IIEF-5 Score for Erectile Dysfunction in Predicting Silent Myocardial Ischaemia in Patients Living with Type 2 Diabetes

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Abstract

Introduction: Cardiovascular complications are the leading cause of death in patients with type 2 diabetes. The pathophysiological mechanism, which is at least partly similar to that of erectile dysfunction (ED) in diabetes, suggests an association between the two conditions. Therefore, the main objective of this study was to investigate whether erectile dysfunction could be a predictive marker of silent myocardial ischaemia (SMI) in these patients. **Method:** We conducted a cross-sectional analytical study in men with type 2 diabetes in the Endocrinology Department of the Yaoundé Central Hospital. All adult men aged between 35 and 65 years who consented to participate were included. All those with conditions that could cause ED were excluded. ED was assessed using the IIEF-5 questionnaire, and silent myocardial ischaemia was screened for by performing a stress ECG. Bivariate analyses with odds ratios were used to study the association between ED and silent myocardial ischaemia. **Results:** We recruited 54 participants, with an average age of 53.9 ± 9.0 years. The average duration of diabetes was 3.1 ± 2.6 years. The prevalence of ED was 49.1% (n = 26), and it was mild in 32.1%. Participants who smoked had a higher risk of developping ED (OR = 0.67; 95% CI). The prevalence of SMI in the entire study population was 49.1%. In patients with ED, the frequency of SMI was 48.3% (n = 14), while in those without ED it was 50%. There was a non-significant association between ED and SMI (OR = 4.5; 95% CI). However, the pre-

cision-recall curves indicated that the IIEF-5 score could predict both the presence and absence of ischaemia. **Conclusion**: Although the IIEF-5 score has predictive value, it is not perfect and its accuracy depends on the desired level of recall.

Keywords

Type 2 Diabetes, Erectile Dysfunction, Silent Myocardial Ischaemia

1. Introduction

Cardiovascular disease is the leading cause of death in patients with type 2 diabetes. The common pathophysiological mechanism is based on endothelial dysfunction. It is aggravated by chronic hyperglycaemia and insulin resistance. These phenomena are also involved in erectile dysfunction in patients with type 2 diabetes [1]. Moreover, a correlation has been suggested between ED and CVD, making ED a potential early marker of symptomatic CVD [2] [3]. One of the specific features of myocardial damage in T2D patients is its silent nature, making early detection crucial to prevent cardiovascular mortality in these patients. Although the European Society of Cardiology (ESC) recommends targeted, risk-stratified screening, access to screening tools in developing countries may be limited [4] [5]. It was therefore essential to study the relationship between erectile dysfunction and silent myocardial ischaemia in people with type 2 diabetes. The aim was to prevent the occurrence of silent ischaemia and optimise the management of these patients.

2. Method

2.1. Study Design

We conducted a cross-sectional, analytical study over 8 months (November 2023 to June 2024) at the Endocrinology and Metabolic Diseases Department of the Yaoundé Central Hospital.

2.2. Inclusion Criteria

We included adult men between the ages of 35 and 65 years, with type 2 diabetes who gave their informed consent.

2.3. Exclusion Criteria

The following were excluded:

- ✓ Any patient with clinical signs of hypogonadism or sexual differentiation disorder.
- ✓ Any subject with psychogenic disorders.
- ✓ Any subject on antidepressant treatment or other medications that alter erectile function.

- ✓ Any subject with a foot ul who could not perform a stress electrocardiogram.
- ✓ Any subject who had undergone urogenital surgery.

2.4. Sample Size Determination: We Used Consecutive Non-Exhaustive Sampling

We used the Whitney and Ball's formula for calculating the appropriated sample size.

$$n = \frac{\left[p1(1-p1)+p2(1-p2)\right]\times Cp, power}{(p1-p2)2} \quad [6]$$

- n = number of subjects required in each subgroup.
- $P1$ is the proportion of silent myocardial ischemia in T2D patients: 58% [7].
- $P2$ is the proportion of silent myocardial ischemia in asymptomatic T2D patients: 19% [8].

The minimum sample size was 34 participants.

2.5. Assessment of Erectile Dysfunction

Erectile function was assessed using the IIEF-5 (International Index of Erectile Function 5-item version) questionnaire. This is a self-administered questionnaire consisting of five questions, with answers scored from 0 to 5 per question. After completing the questionnaire, patients were classified as follows: severe erectile dysfunction (5 - 10), moderate (11 - 15), mild (16 - 20). Erectile function was considered normal (21 - 25) or uninterpretable (1 - 4).

2.6. Silent Myocardial Ischemia Screening

SMI was screened for by performing an ECG at rest and then during exercise in all patients. The stress ECG was performed on an ergonomic bicycle. The test was graded and standardised, performed in frequency increments, taking into account the age of each patient. The theoretical maximum frequency (TMF) was calculated using the formula 220-age. During the test, blood pressure and heart rate were regularly recorded. The test was interrupted in the event of: a positive test result, exhaustion of the participant, and the occurrence of complications (severe hypertension, hypotension, threatening ventricular hyperexcitability). Monitoring and recording continued for up to ten minutes after the exercise (recovery).

Interpretation of the stress test: the following ECG abnormalities suggestive of SMI are described in Table 1 below.

Table 1. Repolarisation changes suggestive of myocardial ischaemia.

Horizontal or downsloping ST segment depression ≥ 1 mm, 60 - 80 ms after the J point
Upsloping ST segment depression ≥ 1.5 mm, 80 ms after point J
ST segment elevation ≥ 1 mm
ST/HR index ≥ 1.6 µV/beats.min^{-1}
Clockwise ST/HR loop

2.7. Statistical Analyses

The statistical tests used were the Chi-square and Fischer tests with a statistical significance threshold of $p < 0.05$. The precision-recall curve was used to evaluate the performance of the IIEF-5 total score in predicting silent myocardial ischaemia.

3. Results

3.1. Characteristics of the Study Population

54 participants were selected. The average age of participants was 53.9 ± 8.9 years, and the majority were in a relationship (77.4%). The average duration of diabetes was 2.4 ± 1 years. Clinically, the average BMI was 27.4 kg/m^2. Abdominal obesity was present in 14 (26.4%) of the participants. The majority of participants were hypertensive (94.4%). Tobacco use was present in 37% (n = 20), while 88.7% consumed alcohol. Physical activity level was low in 48% of participants (Tables 2-3).

Table 2. Clinical characteristics of participants.

	Modality	Mean	Median	Range	Maximum	Minimum	Counts	Frequency
BMI (Kg/m^2)		27.4	27.	21.9	43	21.1		
Abdominal circumference (cm)		71	67	93	128	35		
SBP (mmHg)		127	127	63	159	96		
DBP (mmHg)		79	79	52	102	50		
Hypertension	grade I						**17**	**94.4%**
	grade II						0	0%
	grade III						1	5.6%
Android obesity	Yes						14	26.4%
	No						**39**	**73.6%**

Table 3. Comorbidities of participants.

Comorbidity	Modality	Counts (n = 54)	Frequency (%)
Smoking	Yes	20	37.03%
	No	35	66.0%
Alcohol	Yes	47	88.7%
	No	6	11.3%
Hypertension	Yes	19	36.5%
	No	33	63.5%c

3.2. Assessment of Erectile Dysfunction

3.2.1. Frequency, Severity and Associated Factors

The prevalence of ED in the population was 54.7% (n = 29). It was severe in 15.1%

of cases according to the IIEF-5 score (Table 4).

Table 4. Prevalence and severity of erectile dysfunction in our study population (N = 54).

Variables	Modality	Counts	Frequency
Erectile dysfunction	**Yes**	**29**	**54.7%**
	No	24	45.3%
Classification of erectile dysfunction according to the IIEF-5 score	Severe erectile dysfunction (5 to 10)	8	15.1%
	Moderate (11 to 15)	4	7.5%
	Mild (16 to 20)	17	32.1%
	Normal erectile function (21 to 25)	23	43.4%
	Uninterpretable (1 to 4)	1	1.9%

3.2.2. Associated Factors with ED

ED was compared within the study population according to various clinical variables (age, duration of diabetes, chronic complications, BMI, abdominal obesity and hypertension). The bivariate analysis revealed a significant association between current smoking (p = 0.016) and erectile dysfunction, with a higher risk of ED among smokers (OR = 0.67; 95% CI: (0.000 - 248.349). In addition, high alcohol consumption (>20 g/day) tends to be associated with an increased risk of ED (OR = 25.10; 95% CI: 0.016 - 39061.973). Analysis of IIEF-5 scores by age group reveals an increase in erectile dysfunction with age (Table 5).

Table 5. Factors associated with erectile dysfunction in the sample: results of bivariate analysis.

		Erectile Dysfunction					
		Yes n = 29		No = 24		P-values	OR (CI 95%)
		Count	Column N %	Count	Column N %		
Duration of diabetes (months)	<24	6	20.7%	9	37.5%	0.176	0.000
	>24	23	79.3%	15	62.5%		
Age (years)	]45	4	13.8%	8	33.3%	0.29	3.171 (0.075 - 134.671)
	]46 - 53]	5	17.2%	5	20.8%		
	]54 - 60]	9	31.0%	6	25.0%		
	]61-[	11	37.9%	5	20.8%		
ARB II	Yes	3	21.4%	2	33.3%	0.57	1.095 (0.016 - 73.544)
	No	11	78.6%	4	66.7%		
ACE i	Yes	5	35.7%	2	33.3%	0.91	0.989 (0.006 - 158.228)
	No	9	64.3%	4	66.7%		
Alcohol intake	Yes	27	93.1%	20	83.3%	0.264	25.10 (0.016 - 39061.973)
	No	2	6.9%	4	16.7%		
Smoking	Yes	14	48.3%	4	16.7%	**0.016**	0.67 (0.000 - 248.349)
	No	15	51.7%	20	83.3%		

Continued

BMI (kg/m^2)	<= 25.0	13	44.8%	8	33.3%	0.394	1.625 (0.530 - 4.984)
	> 25.0	16	55.2%	16	66.7%		
Active smoking	Yes	2	14.3%	0	0.0%	**0.037**	74016678835.532070
	No	12	85.7%	5	100.0%		
Android obesity	Yes	8	27.6%	6	25.0%	0.832	0.000
	No	21	72.4%	18	75.0%		

3.3. Screening for SMI

3.3.1. Prevalence of Silent Myocardial Ischaemia and Associated Factors

The prevalence of SMI in the overall study population was 49.1% (n = 26). It was 48.3% (14/29) in participants with ED and 50% in patients without ED (12/24). Upto 21% had an ST/HR index abnormality above 1.6 μv/beats min. Moreover, 17.6% had ST segment elevation above 1 mm. Most participants had a combination of several abnormalities. There was a non-significant association between SMI, abdominal obesity (OR = 0.511, p = 0.184) and BMI ≥ 25 (OR = 0.729, p = 0.196) (Table 6).

Table 6. Factors associated with silent myocardial ischaemia.

		Silent myocardial ischaemia					
		Yes		No		p-values	OR (CI 95%)
		Counts (n)	Frequency (%)	Counts (n)	Frequency (%)		
Hypertension	Yes	11	44.0%	8	29.6%	0.282	1.866 (0.595 - 5.851)
	No	14	56.0%	19	70.4%		
Smoking	Yes	7	26.9%	11	40.7%	0.288	0.521 (0.109 - 2.500)
	No	19	73.1%	16	59.3%		
Alcohol	Yes	21	80.8%	26	96.3%	0.075	0.128 (0.009 - 1.903)
	No	5	19.2%	1	3.7%		
Android Obesity	Yes	9	34.6%	5	18.5%	0.184	0.511 (0.064 - 4.111)
	No	17	65.4%	22	81.5%		
BMI (kg/m^2)	<= 25.0	8	30.8%	13	48.1%	0.196	0.729 (0.152 - 3.494)
	> 25.0	18	69.2%	14	51.9%		
Duration of diabetes (months)	<24	8	30.8%	7	25.9%	0.153	4.21 (0.080 - 2.115)
	>24	18	69.2%	20	74.1%		
Age (years)	]45	5	19.2%	7	25.9%	0.590	0.807 (0.434 - 1.499)
	]46 - 53]	5	19.2%	5	18.5%		
	]54 - 60]	6	23.1%	9	33.3%		
	]61-[	10	38.5%	6	22.2%		
Resting ECG	Normal	10	38.5%	14	53.8%	0.266	0.576 (1.43- 2.325)
	Abnormal	16	61.5%	12	46.2%		

Continued

Diabetes complications	stroke	0	0.0%	1	20.0%	0.262	0.726 (0.382-1.380)
	Signs of PAD	2	25.0%	1	20.0%		
	CKD	1	12.5%	1	20.0%		
	Diabetic foot ulcer	4	50.0%	0	0.0%		
	Other	1	12.5%	2	40.0%		

3.3.2. Relationship between SMI and Erectile Dysfunction

We observed a non-significant association between a total erectile dysfunction score ≥ 16 (OR = 4.485, p = 0.406) and silent myocardial ischaemia. Both precision-recall curves, showed moderate to high precision. However, precision decreases as recall increases, meaning that the model becomes less accurate as it seeks to identify more cases (Figure 1).

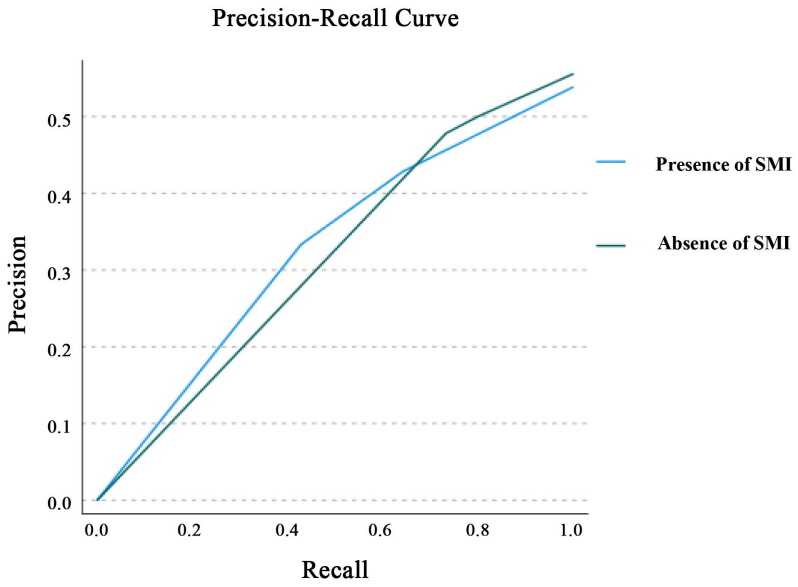

Figure 1. Precision-recall curve for the prediction of erectile dysfunction with the IIEF5 total score in the presence of silent myocardial ischaemia.

4. Discussion

- **Prevalence of ED and SMI**

Silent myocardial ischaemia and erectile dysfunction share a common pathophysiological mechanism involving endothelial dysfunction.

In order to assess whether erectile dysfunction could be a risk marker for silent myocardial ischaemia in type 2 diabetes, patients completed the IIEF-5 questionnaire to assess erectile function and we performed stress ECGs.

The results of our study show that the frequency of silent myocardial ischaemia was as high in patients with ED as in those without ED. However, its severity increased with age. Meena *et al.* found similar results. In this study, cardiovascular risk

was higher in patients with ED compared to those without ED and was more common in participants of age 60 years and above [9]. Indeed, there are physiological changes associated with age. Firstly, the gradual decline in testosterone could be one of the factors linked to the severity of ED, but also the coexistence of other complications, particularly age-related arteriosclerosis, which would explain not only the high frequency of ED at this age, but also its pronounced severity [10].

Furthermore, the high frequency of ED also depends on the presence of other factors. Indeed, we observed a significant association between current smoking ($p = 0.016$) and erectile dysfunction (ED), with a higher risk of ED among smokers (OR = 0.67; 95% CI: 0.000 - 248.349). These results corroborate those of Paolo Verze *et al*., who found a significant association between current tobacco use and erectile dysfunction, and that quitting smoking was beneficial for the return to normal erectile function [11]. In Italy, Natali found a high prevalence of ED among current smokers (53.5%) compared to former smokers (9.3%) and those who had never smoked (37.2%) [12].

- **Performance of the IIEF-5 as a predictive marker of SMI**

The study suggests an association between a total erectile dysfunction score ≥ 16 (OR = 4.485, $p = 0.406$) and silent myocardial ischaemia (SMI). These results are consistent with other published studies demonstrating a significant association between ED and SMI [12] [13].

Furthermore, the precision-recall curves evaluating the performance of the total IIEF-5 score in predicting silent myocardial ischaemia show that both curve for absent or present ischemia showed moderate to high precision, indicating that the IIEF-5 score can predict both the presence and absence of ischaemia. However, accuracy decreases as recall increases, meaning that the model becomes less accurate as it seeks to identify more cases. Thus, although the IIEF-5 score has predictive value, it is not perfect and its accuracy depends on the desired level of recall. This result is similar to that proposed by Syndey C *et al*. in South Asia, which demonstrated that IIEF-5 scores were sufficient to predict the severity of coronary artery disease in T2D subjects [14]. Gazzaruso *et al*. demonstrated that ED could predict major cardiac events in patients with diabetes (95% confidence interval 1.6 - 2.6; $p < 0.001$) [15].

5. Conclusion

SMI is present in diabetic patients with and without ED. Although there is no significant association between these two entities, ED may be predictive of SMI in patients with diabetes and warrant systematic screening.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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