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ORIGINAL ARTICLE

Assessment of Clinical Presentation and Risk Factors with Exercise Tolerance Test in Type 2 Diabetics Patients in a Tertiary Care Hospital

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ABSTRACT

Introduction: *Cardiovascular disease remains the leading cause of morbidity and mortality in type 2 diabetes mellitus (T2DM) patients. Exercise tolerance test (ETT) is an accessible tool for ischemia detection and assessment of cardiovascular risk in high-risk patients.* ***Objectives:*** *The aim of this study was to assess the clinical presentation and risk factors with exercise tolerance test in type 2 diabetics patients.* ***Methods & Materials:*** *This cross-sectional observational study was conducted in the Department of Cardiology, BIRDEM general hospital, Dhaka, Bangladesh June 2022 to May 2023. Total 82 patients with type 2 diabetes aged between 31-63 years attending in out-patient department of Cardiology and Medicine and also from in-patient department of the respective disciplines were included in this study.* ***Results:*** *Mean age was 47.36 ± 16.38 years with male predominance (67.07%). Classic chest pain (74.39%) and dyspnea (41.46%) correlated strongly with ETT positivity. Poor glycemic control (mean HbA1c 9.4%) and dyslipidemia were prevalent. Dyslipidemia (79.26%), hypertension (71.95%), family history of ischemic heart disease (65.85%), and smoking (59.75%) were all significantly more prevalent in ETT positives.* ***Conclusion:*** *It is more probable that individuals with T2DM and multiple cardiovascular risk factors with compromised metabolic control will present with ischemia that can be detected on ETT. Early detection and prevention of cardiovascular events in resource-limited environments might be facilitated through routine use of ETT in the high-risk population.*

Keywords: *Clinical Presentation, Risk Factors, Exercise Tolerance Test, and Type 2 Diabetics Patients*

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INTRODUCTION

Type 2 diabetes mellitus (T2DM) has emerged as one of the most critical global health emergencies of the 21st century, with prevalence accelerating at alarming rates in both developing and developed nations. According to global epidemiological estimates, more than 400 million individuals are already afflicted with T2DM, and the number is anticipated to increase significantly over the coming decades.[1] The condition is associated not only with profound metabolic derangements but also with premature morbidity and mortality, in large part driven by its cardiovascular complications. Cardiovascular disease (CVD) remains the most frequent cause of death among individuals with T2DM, accounting for over half of diabetes-attributable deaths worldwide.[2] Alarmingly, younger age groups are now more affected, with early-onset T2DM having particularly high risks of premature cardiovascular death.[3]

The pathophysiological processes involved in T2DM and cardiovascular impairment are multifactorial, including endothelial dysfunction, autonomic neuropathy, impaired skeletal muscle perfusion, and reduced cardiac reserve. These effects respectively manifest clinically as reduced exercise tolerance and a heightened burden of both symptomatic and asymptomatic coronary artery disease (CAD).[4] Particularly concerning is the high prevalence of silent myocardial ischemia in patients with T2DM, where ischemic episodes are not accompanied by typical anginal symptoms due to autonomic neuropathy and altered pain perception. Several studies have reported that a notable percentage of asymptomatic T2DM patients have silent ischemia, which can be identified only with the help of functional testing

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procedures like the exercise tolerance test (ETT).[5-7] This is one of the biggest diagnostic dilemmas since consideration of only clinical symptoms can lead to a delay in the identification of underlying ischemic heart disease.

Exercise intolerance in the absence of overt ischemia has also been shown to be an early marker of cardiovascular risk in T2DM cohorts. Mechanistic studies have shown that impaired skeletal muscle blood flow reserve and poor cardiorespiratory fitness precede CAD symptoms at the clinical level, emphasizing the importance of functional capacity assessment in the management of diabetes.[4] The ETT in this case is a readily available, low-cost, and non-invasive investigative tool. It not only assists in the detection of myocardial ischemia but also provides prognostic information by assessing exercise capacity, hemodynamic responses, and arrhythmogenic potential.[8] For practitioners who deal with high-risk populations such as T2DM patients, the ETT remains a highly relevant investigation, especially in resource-constrained tertiary care facilities where advanced imaging might not always be feasible.

Another dimension of cardiovascular risk in T2DM is the presence of multiple risk factors. Hypertension, dyslipidemia, obesity, and smoking are frequent companions of diabetes, and their cumulative load contributes significantly to the risk of cardiac events.[9] Evidence exists that each increment in cardiovascular risk factor exponentially raises the risk of CAD development, thereby emphasizing the need for global risk profiling.[10] Despite these well-established associations, region-specific data, particularly from tertiary care centers of low- and middle-income countries, regarding the influence of such clustering of risk factors on ETT outcomes and clinical manifestations in T2DM patients is limited. Therefore, this current study aims to assess the clinical presentation and risk factors with exercise tolerance test in type 2 diabetics patients in a tertiary care hospital.

OBJECTIVES

To assess the clinical presentation and risk factors with exercise tolerance test in type 2 diabetics patients.

METHODS & MATERIALS

This cross-sectional observational study was conducted in the Department of Cardiology, BIRDEM general hospital, Dhaka, Bangladesh June 2022 to May 2023. Total 82 patients with type 2 diabetes aged between 31-63 years attending in out-patient department of Cardiology and Medicine, also from in-patient department of the respective disciplines were included in this study. Patients with Acute coronary syndrome, severe aortic stenosis, mitral stenosis, hypertrophic obstructive cardiomyopathy, ECG findings suggestive of false positive ETT e.g. LBBB, left ventricular hypertrophy, WPW, and digoxin toxicity were excluded from the study. Informed consent was obtained from all participants prior to inclusion. Ethical clearance was obtained from ethical review board of BIRDEM academy.

Each participant underwent a detailed clinical evaluation, including baseline physical examination, resting electrocardiogram (ECG), and exercise tolerance test (ETT). Continuous 12-lead ECG monitoring was performed during each ETT procedure. The target heart rate for each patient was calculated as 85% of the maximum predicted heart rate (MPHR = 220 – age). The ETT was interpreted using established diagnostic criteria. A test was considered positive if at least two ECG leads demonstrated upsloping ST-segment depression of 1.5 mm or down sloping/horizontal ST-segment depression of 1.0 mm; an early positive response occurring within six minutes; persistence of ST-segment depression for more than six minutes into recovery; ST-segment depression in five or more leads; exertional hypotension; or the development of typical angina symptoms during the test.

Tests were deemed inconclusive or equivocal in cases where participants failed to achieve >85% of the MPHR, experienced atypical chest pain or unexplained exertional dyspnea despite negative ECG findings, or developed clinically significant rhythm disturbances or ST-segment changes not meeting the criteria for positivity. All collected data were systematically recorded and subsequently analyzed using Statistical Package for the Social Sciences (SPSS) version 23. Results were presented in the form of tables, figures, and diagrams. A p-value <0.05 was considered statistically significant for all analyses.

RESULTS

The baseline characteristics of the 82 study participants are summarized in Table I. The mean age of the patients was 47.36 ± 16.38 years, with a range between 31 and 63 years. The majority of patients (40.24%) belonged to the 50–59-year age group. Males predominated in the study population, comprising 67.07% (n = 55), while females accounted for 32.93% (n = 27). The mean body mass index (BMI) was 26.06 ± 10.46 kg/m^2, with an average pulse rate of 82 ± 24 beats per minute. The mean systolic blood pressure was 145 ± 35 mmHg and the mean diastolic blood pressure was 80 ± 20 mmHg. Regarding diabetes duration, nearly half of the patients (45.12%) had diabetes for 10–14 years, 20.74% for ≥15 years, 18.29% for 5–9 years, and 15.85% for ≤5 years, with the overall mean duration being 8.34 ± 5.92 years (Figure 1).

The distribution of associated symptoms is presented in Table II. Typical chest pain was the most frequently reported symptom, observed in 74.39% of the patients, with a significantly higher proportion among ETT-positive individuals (46.36%) compared to those who were ETT-negative or equivocal (28.03%, p = 0.042). Atypical chest pain was reported by 23.17% of patients, also more common in ETT-positive cases (12.19% vs. 10.98%, p = 0.026). Non-specific chest pain was relatively uncommon, affecting only 2.42% of the total cohort, without significant difference between groups (p = 0.057). Breathlessness was reported by 41.46% of the patients, again significantly associated with ETT positivity (26.82% vs. 14.64%, p = 0.011). Palpitations were observed in 34.14% of patients, with no significant group differences (p = 0.073).

Key biochemical and metabolic parameters of the study cohort are shown in Table III. The mean fasting blood glucose (FBG) was 10.23 ± 5.2 mmol/L, with values ranging from 6.2

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to 21.7 mmol/L. Glycated hemoglobin (HbA1c) was elevated, with a mean of 9.4 ± 3.5%, ranging between 5.9% and 13.4%, reflecting poor long-term glycemic control in the study population. The mean total cholesterol level was 184 ± 93.5 mg/dL, triglyceride levels were elevated at 228 ± 137 mg/dL, and low-density lipoprotein (LDL) cholesterol was 122 ± 45.5 mg/dL. High-density lipoprotein (HDL) cholesterol averaged 51.22 ± 29.67 mg/dL, with values ranging between 31 and 83 mg/dL. These findings indicate a high prevalence of dyslipidemia and suboptimal metabolic control among participants.

Table IV presents the pre-existing cardiovascular risk factors. Dyslipidemia was the most prevalent, present in 79.26% of patients, and significantly more frequent among ETT-positive individuals (48.78% vs. 30.48%, p = 0.024). Hypertension was observed in 71.95% of the cohort, again with a significant predominance in ETT-positive patients (40.24% vs. 31.71%, p = 0.014). A positive family history of ischemic heart disease (IHD) was reported by 65.85% of participants, more common in the ETT-positive group (40.24% vs. 25.61%, p = 0.035). Smoking was documented in 59.75% of the total sample, with a slightly higher prevalence among ETT-positive patients (30.49% vs. 29.26%, p = 0.043).

Table – I: Baseline characteristics of the study patients (*n*=82)

Characteristics	Number of patients	Percentage (%)
Age group (Years)		
30-39	16	19.51
40-49	20	24.39
50-59	33	40.24
60 and above	13	15.86
Mean± SD	47.36±16.38	
Range	31-63	
Sex		
Male	55	67.07
Female	27	32.93
BMI (Kg/m²)		
Mean± SD	26.06±10.46	
Pulse (per minute)		
Mean± SD	82±24	
Systolic blood pressure (mm of Hg)		
Mean± SD	145±35	
Diastolic blood pressure (mm of Hg)		
Mean± SD	80±20	

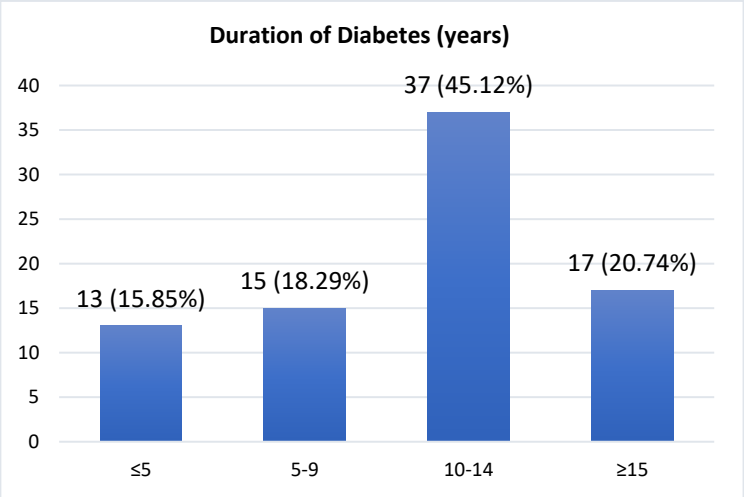

Figure – 1: Distribution of duration of diabetes among the study patients (*n*=82)

Table – II: Distribution of associated symptoms among the study patients (*n*=82)

Symptoms	ETT positive subjects (n/%)	Other than ETT positive subjects (n/%)	Total n (%)	P value
Typical chest pain	38(46.36)	23(28.03)	61 (74.39)	0.042
Atypical chest pain	10(12.19)	09(10.98)	19 (23.17)	0.026
Nonspecific chest pain	01(1.21)	01(1.21)	02 (02.42)	0.057
Breathlessness	22(26.82)	12(14.64)	34 (41.46)	0.011
Palpitation	13(15.85)	15(18.29)	28 (34.14)	0.073

Table – III: Distribution of clinical parameters among the study patients (*n*=82)

Parameters	Mean ± SD	Maximum- Minimum
FBG (mmol/l)	10.23±5.2	21.7-6.2
Hb A_1C%	9.4±3.5	13.4-5.9
Cholesterol (mg/dl)	184±93.5	285-180
Triglyceride (mg/dl)	228±137	521-132
HDL (mg/dl)	51.22±29.67	83-31
LDL (mg/dl)	122±45.5	171-61.7

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Table – IV: Pre-existing risk factors of the study patients (*n*=82)

Pre-existing risk factors	ETT positive subjects (n/%)	Other than ETT positive subjects (n/%)	Total n (%)	P value
Dyslipidemia	40 (48.78)	25 (30.48)	65 (79.26)	0.024
Hypertension	33(40.24)	26(31.71)	59 (71.95)	0.014
Positive family history of IHD	33(40.24)	21(25.61)	54 (65.85)	0.035
Smoking	25(30.49)	24(29.26)	49 (59.75)	0.043

DISCUSSION

The present study aimed to assess the clinical characteristics, symptom patterns, metabolic control, and cardiovascular risk factors of positive exercise tolerance test (ETT) results in type 2 diabetes mellitus (T2DM) patients in a tertiary care hospital in Bangladesh. The findings highlight predominance of male patients in middle age, prevalence of coexistence of two or more cardiovascular risk factors, poor glycemic and lipid control, and significant correlations between clinical symptoms and ETT positivity. These results are consistent with global evidence, and further provide regional data affirming the important role of early cardiovascular risk assessment among diabetic patients.

The average age of the participants was 47.36 years, with the majority being in the 50–59 years age group. Male predominance was also noted, with a proportion of nearly two-thirds men to participants. These demographic patterns are in line with previous studies, wherein similar age groups and male predominance have been reported for newly diagnosed or hospitalized T2DM populations.[11,12] The mean body mass index (26.06 kg/m^2) was comparable to overweight cut-offs reported in other Asian and European settings, corroborating obesity as a principal force of cardiometabolic risk.[13,14] Furthermore, the median duration of disease was over eight years, and nearly half of patients had a disease duration of over 10 years, reflecting the chronicity and risk factor burden present in tertiary hospital cohorts.[15]

The most prevalent symptom was common chest pain, which was described in nearly three-quarters of the patients and was strongly associated with ETT positivity. Shortness of breath and atypical chest pain were also more common in ETT-positive patients. This is in line with Sharmin et al.[16] and Khan et al.[17], who found typical chest pain and effort dyspnea to be strong predictors of ischemic responses in Bangladeshi diabetic patients who were administered ETT. Meanwhile, Fatima et al.[18] demonstrated that shortness of breath and chest pain occurring during ETT had a strong association with incident coronary artery disease, vindicating symptom analysis as an aid to diagnosis complementary to functional testing. Palpitations, although common, did not predict strongly the positive compared to negative results of ETT, consistent with earlier reports citing palpitations as a non-specific symptom for ischemia assessment.[19]

Biochemical assessment validated inadequate glucose control, as indicated by a mean HbA1c of 9.4% and fasting blood glucose values over the ideal range, in addition to widespread dyslipidemia characterized by elevated triglyceride and LDL cholesterol levels. These findings are corroborated by various studies indicating strong correlations between inadequate glucose control and adverse lipid profiles.[20-22] Elevated triglyceride and LDL along with decreased HDL have been variably associated with increased cardiovascular risk in T2DM patients, and measures such as the triglyceride/HDL ratio have been proposed as prognostic markers of poor glycemic control.[23,24] The results of this present study substantiate this evidence, pointing out the compounded issue of uncontrolled diabetes and dyslipidemia in sustaining ischemic burden.

A very high rate of pre-existing risk factors for cardiovascular disease was present in the study population. Dyslipidemia (79.26%), hypertension (71.95%), positive family history of ischemic heart disease (65.85%), and smoking (59.75%) were all significantly more common in ETT-positive patients. This clustering of risk factors has been already emphasized in local as well as global literature. Lavekar and Salkar[25] showed that smoking, hypertension, and dyslipidemia were significantly associated with positive treadmill test results in Indian asymptomatic T2DM patients. Similarly, Dinges et al.[26] stated that risk factor clustering impaired exercise performance and increased ischemic burden in German T2DM cohorts. The utility of family history as a predictor of risk of ischemic outcomes has also been long proven, with Ghamar-Chehreh et al.[27] showing that family history of cardiovascular disease was an excellent predictor of adverse outcomes in high-risk populations. The findings of this present study therefore maintain the cumulative and multiplicative actions of clustering of risk factors in the diabetic population. Cumulatively, these observations highlight the value of ETT as both a diagnostic and a prognostic marker in patients with T2DM and multiple cardiovascular risk factors.

CONCLUSION

This research revealed that type 2 diabetic patients in a tertiary care hospital in Bangladesh had frequent chest pain, uncontrolled glycemia, dyslipidemia, and aggregation of cardiovascular risk factors, all of which were significantly related to positive ETT outcomes. Male predominance and middle-aged age at onset were notable demographic features. The findings highlight the usefulness of ETT as an economical diagnostic and prognostic tool in the detection of ischemia and stratification of cardiovascular risk in low-resource environments, and previous preventive and management strategies are supported.

Background:

Conflict of Interest Statement: None.

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