DOI: https://doi.org/10.54393/pjhs.v4i10.1112

PAKISTAN JOURNAL OF HEALTH SCIENCES
https://thejas.com.pk/index.php/pjhs
Volume 4, Issue 10 (October 2023)

Original Article

Duke Treadmill Score Predicts Coronary Artery Disease Severity in Diabetics and Non-Diabetics

Muhammad Khalil[1*], Muhammad Shafique Arshad[1], Asma Zafar Khawaja[2], Iffat Aqeel[3], Hidayatullah[1], Mahboob Ur Rehman[1], Sumeet Kumar[1] and Shoaib Ahmed[1]

[1]Department of Cardiology, Pakistan Institute of Medical Sciences (PIMS), Islamabad, Pakistan
[2]Department of cardiology, Armed Forces Institute of Cardiology (AFIC), Rawalpindi, Pakistan
[3]Department of Cardiology, Shalamar Institute of Health Sciences, Lahore, Pakistan

ARTICLE INFO

Key Words:
Duke Treadmill Score, Coronary Angiography, Diabetes Mellitus, Exercise Stress Testing

How to Cite:
Khalil, M., Arshad, M. S., Khawaja, A. Z., Aqeel, I., Hidayatullah, ., Rehman, M. U., Kumar, S., & Ahmed, S. (2023). Duke Treadmill Score Predicts Coronary Artery Disease Severity in Diabetics and Non-Diabetics: Coronary Artery Disease Severity. Pakistan Journal of Health Sciences, 4(10). https://doi.org/10.54393/pjhs.v4i10.1112

***Corresponding Author:**
Muhammad Khalil
Department of Cardiology, PIMS, Islamabad
m.khalil329@yahoo.com

Received Date: 10th October, 2023
Acceptance Date: 28th October, 2023
Published Date: 31st October, 2023

ABSTRACT

Coronary artery disease (CAD) is a significant cause of mortality and morbidity on a global scale. The Duke Treadmill Score (DTS) is a clinical evaluation that uses exercise stress testing to determine the severity of coronary artery disease (CAD). **Objective:** This study was to see how well DTS predicted the severity of CAD in diabetic and non-diabetic individuals. **Methods**: A prospective cohort study was conducted in the Department of Cardiology, PIMS, Islamabad, from March 2023 to September 2023. Total 450 patients were separated into diabetes (225) and non-diabetic (225) groups. Diabetes was diagnosed using American Diabetes Association criteria. The validated DTS scores exercise duration, ST-segment deviation, and angina symptoms to predict severe CAD. -11 or above is high risk, -10 to +4 is moderate, and +5 or more is low risk. **Results:** A study of 450 patients comprised 282 (62.6%) male and 168 (37.3%) female, with an average age of 58.4±13.2years. On coronary angiography, 170 diabetics (75.6%) and 130 non-diabetics (57.8%) had substantial CAD. Hypertension was 52.9% in diabetics and 49.3% in non-diabetics (p=0.920). Diabetics had 10.6% dyslipidemia and non-diabetics 9.3% (p=0.058). **Conclusions:** DTS may predict CAD severity in diabetics and non-diabetics, according to one study. Diabetes is a key risk factor for CAD, and DTS may aid in risk estimation. DTS findings and CAD risk assessment may potentially be affected by patient characteristics, exercise capacity, and treadmill technique.

INTRODUCTION

Coronary artery disease (CAD), a leading cause of morbidity and mortality, is a significant global health challenge [1]. Diabetes mellitus is associated with chronic hyperglycemia, which is a well-established risk factor for the development and advancement of coronary artery disease (CAD) [2]. Diabetics are more likely to develop CAD and have more diffuse and severe coronary lesions. After CAD symptoms appear, diagnostic and treatment approaches are expensive. East Java lacks MSCT, MRI, and nuclear imaging capabilities in the age of sophisticated cardiac imaging. Offering the identification of risk factors and early detection of coronary artery disease (CAD) using a reliable and uncomplicated method is of utmost importance, even before any clinical symptoms occur. Current CAD diagnosis and treatment recommendations are based on stratified risk [3]. One example of such a system is the Framingham risk model, which was constructed utilizing a range of risk variables [4]. It does not predict CAD severity or schedule invasive and noninvasive tests. Ischemic heart disease patients' Coronary artery count and prognosis may be estimated using the Duke treadmill score (DTS). DTS also correlates strongly with coronary lesion severity determined by Syntax value [5]. Before performing coronary angiography,

DOI: https://doi.org/10.54393/pjhs.v4i10.1112

DTS could determine the degree and existence of CAD. It can also identify the kind of revascularization that will be necessary after the operation [6]. Gabaldo *et al.*, [7] detected substantial coronary lesions or weight in all high-risk DTS patients. 50%-90% of moderate- and mild-risk DTS patients had no large coronary lesions. High-risk DTS scores need emergency coronary angiography. Clinicians might use this study to improve risk stratification and clinical decision-making for CAD patients, particularly diabetics. An important element of cardiovascular care, accurate risk assessment may help CAD patients get early treatment and better results. Our research at Territory Care Hospital examined how DTS predicts CAD severity in diabetic and non-diabetic individuals.

METHODS

A prospective cohort study was conducted in the Department of Cardiology, PIMS, Islamabad, from March 2023 to September 2023. 450 patients were separated into diabetes (225) and non-diabetic (225) groups. Diabetes was diagnosed using American Diabetes Association criteria. Symptom-limited exercise treadmill tests utilizing the Duke Treadmill Score (DTS) methodology was performed on all patients. The validated DTS scores exercise duration, ST-segment deviation, and angina symptoms to predict severe CAD. -11 or above is high risk, -10 to +4 is moderate, and +5 or more is low risk. This study included participants aged 18 and above who could do the treadmill test and were diagnosed with diabetes using American Diabetes Association criteria. Non-diabetic patients were also included and age and gender matched to the diabetes group. This study excluded patients with a history of coronary artery bypass graft surgery or percutaneous coronary intervention, heart failure, valvular heart disease, cardiomyopathy, chronic kidney disease or end-stage renal disease, peripheral arterial disease, stroke or transient ischemic attack, malignancy, and incomplete or missing data. These criteria were used to ensure that the study population had suspected coronary artery disease and that no confounding factors affected the results. The study's sample size was determined using the formula $n = (Z\alpha/2)^2 * p * (1-p) / d^2$, where n represents the required sample size, $Z\alpha/2$ denotes the crucial value for the desired confidence level, p represents the estimated proportion of severe CAD patients, and d represents the intended margin of error. Prior research estimated that 50% of persons suffer from significant coronary artery disease (CAD). The specified error margin was 5%. The sample size consisted of 384 patients, using these specific variables. The research included a total of 450 patients in order to account for any dropouts or insufficient data. Participants were enrolled using non-probability consecutive sampling technique. SPSS version 25.0 was used to analyze the data. To summarize the patient demographics and clinical features, descriptive statistics were utilized. Categorical data were presented as frequencies and percentages, whilst continuous variables were represented as means and standard deviations. Institutional Review Board (IRB) approved this study by securely storing anonymized patient data, confidentiality was maintained.

RESULTS

In this study, 450 patients were included, with 282 (62.6%) male and 168 (37.3%) female, with an average age of 58.4±13.2years. On coronary angiography, 170 diabetics (75.6%) and 130 non-diabetics (57.8%) had significant CAD. Diabetics had a significantly lower mean DTS (-2.1 5.4 vs. -0.7 4.9, *p*<0.05). A threshold DTS of -5 had 78.2%sensitivity and 64.4%specificity for identifying significant CAD in diabetics and 89.2% and 42.2% in non-diabetics. Diabetics had an area under the curve for DTS of 0.741 (95% CI: 0.674-0.808) and non-diabetics 0.701 (95% CI: 0.633-0.769) Table 1.

Table 1: Gender Distribution of Diabetic and Non-Diabetic patients.

Parameter	Total (n=450)	Diabetic (n=225)	Non-Diabetic (n=225)
Gender			
Male	282(62.6%)	148(65.77%)	134(60.36%)
Female	168(37.4%)	77(34.23%)	91(40.44%)
Mean Age (years)	58.4±13.2		
Positive Cor Angiography (%)		170 (75.6%)	130 (57.8%)
Mean Duke Treadmill Score (DTS)		-2.1 ± 5.4	-0.7 ± 4.9
Sensitivity for Substantial CAD (%)		78.2%	89.2%
Specificity for Substantial CAD (%)		64.4%	42.2%

Hypertension was 52.9% in diabetics and 49.3% in non-diabetics (p=0.920). As a risk factor, hypertension affects both populations significantly. Diabetes is a risk factor in diabetic individuals, with 29.7% is compared to 16.8% in non-diabetic group (p=0.018). Diabetes has long been linked to coronary artery disease, highlighting its role as a major risk factor. Dyslipidemia was 10.6% in diabetics and 9.3% in non-diabetics (p=0.058). Smoking was not significantly different between diabetics and non-diabetics, with 36.8% and 32.4% reporting smoking (p=0.753). Family history of CAD, which affected 7.5% of diabetics and 6.5% of non-diabetics, was not significantly different (p=0.425). Finally, 9.7% of diabetics and 3.6% of non-diabetics were obese (p=0.523) Table 2. Figure 1.

Table 2: Common Risk Factors of both Group

CAD risk factors	Diabetics n=225	Non-Diabetics n =225	P-value
Hypertension	119(52.9%)	111(49.3%)	0.920
Diabetes	67(29.7%)	38 (16.8%)	0.018
Dyslipidemia	24 (10.6%)	21(9.3%)	0.058
Smoking	83(36.8%)	73(32.4%)	0.753

DOI: https://doi.org/10.54393/pjhs.v4i10.1112

Family history CAD	17(7.5%)	15(6.5%)	0.425
Obesity	22(9.7%)	8(3.6%)	0.523

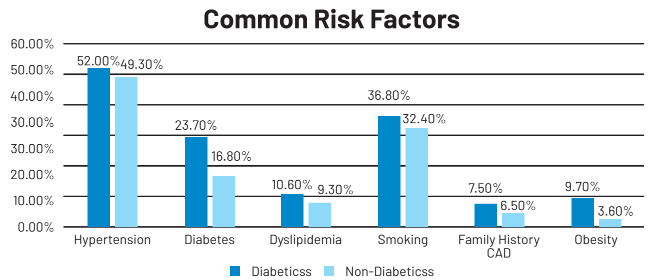

Figure 1: Common Risk Factors for CAD in diabetics and non-diabetics.

Patients with DTS > 5 had a substantially lower mean age (52.53 years) compared to DTS 4-10 (57.55 years) and DTS ≤ -11 (58.65 years) (p=0.036). Mean BMI was similar throughout DTS groups (p=0.815). Those with DTS > 5 had significantly higher mean METs (metabolic equivalents) of 9.48 compared to 9.88 and 5.75 in the DTS 4-(-10) and DTS ≤ -11 groups (p=0.028). DTS ≥ 5 patients had a substantially higher mean DTS of 6.75, compared to -2.13 in the DTS 4-(-10) group and -14.12 in the DTS ≤ -11 group (p=0.001). Diabetes mellitus prevalence was decreased in the DTS ≥ 5 group (6.25%) compared to DTS 4-(-10), DTS ≤ -11 (17.97%, 23.28%), but not statistically significant (p=0.090). DTS groups had similar hypertension, dyslipidemia, smoking, familial history of CAD, and obesity. Patients with DTS > 5 were more likely to have the Bruce treadmill technique (59.37%) compared to those with DTS 4-(-10) (72.46%) and DTS ≤ -11 (58.90%) (p=0.914). DTS 4-(-10) used modified Bruce protocol 25.79% more than other groups. Patients in the DTS 4-(-10) group had more non-significant coronary lesions (21.15%) than those in DTS ≥ 5 (18.75%) and DTS ≤ -11 (39.72%) (p = 0.078) Table 3.

Table 3: Clinical characteristics of DTS

Characteristics	DTS≥5 n=32 (7.1%)	DTS 4-(-10) n=345 (76.6%)	DTS≤ -11 n=73 (16.22%)	P-value
Mean age (years)	52.53	57.55	58.65	0.036
Mean BMI (kg/m2)	26.02	28.25	25.81	0.815
Mean METs	9.48	9.88	5.75	0.028
Mean DTS	6.75	-2.13	-14.12	0.001
Gender				
Male	20(62.5%)	242(70.14%)	53(72.60%)	
Female	12(37.5%)	103(29.85%)	20(27.39%)	
Risk factors CAD				
Hypertension	15(46.87%)	162(46.95%)	32(43.83%)	0.091
Dyslipidemia	5(15.62%)	38(11.01%)	6(8.21%)	0.451
Smoker	3(9.37%)	35(10.14%)	8(10.95%)	0.741
Family history CAD	3(9.37%)	7(2.02%)	2(2.73%)	0.715
Obesity	4(12.5%)	41(11.88%)	8(10.95%)	0.378
Treadmill Protocol				
Bruce	19(59.37%)	250(72.46%)	43(58.90%)	0.914
Modified Bruce	11(34.37%)	89(25.79%)	24(32.87%)	0.010
Naughton	2(6.25%)	6(1.73%)	6(8.21%)	
Number of coronary lesions				0.066
Normal	2(6.25%)	9(2.6%)	0(0%)	
1 Vessel disease	0(0%)	18(5.21%)	0(0%)	
2 Vessel disease	2(6.25%)	23(6.66%)	5(6.84%)	
3 Vessel disease	5(15.62%)	39(11.30%)	22(30.13%)	
3 Vessel disease + left main	0(0%)	7(2.02%)	3(4.1%)	
Coronary lesion				0.078
Normal	2(6.25%)	8(2.31%)	2(2.73%)	
Non-significant	6(18.75%)	73(21.15%)	29(39.72%)	
Significant	0(0%)	14(4.05%)	0(0%)	

DISCUSSION

This study found that research participants average 58 years old. According to 2013 RISKESDAS statistics, the prevalence of coronary heart disease based on doctor interviews or clinical symptoms rises with age [8, 9]. The prevalence was greatest in the 65-74 age group (2.0%) and 3.6%, with a modest reduction in the ≥75 age group. Meanwhile, US statistics for a population of 60-79 years suggested that 23% of men and 15% of women are increasing at age > 80, or 33% and 22%, respectively [10,11]. This study shows that CAD patients are mostly men. As previously documented, women are less populous than males and have CAD patients 12-18 years older than men. Previous studies revealed that CAD prevalence rises in Indonesia and the US in those over 60 years. This research found a mean age older than earlier reports, with the youngest patient 45 years [12, 13]. The current unhealthy habits, such as sedentary lives, high fat and salt diets, and stressful living conditions, may make cardiovascular disease more likely to arise at a younger age. Previous research in Jakarta revealed the average age to be younger and more women, whereas our data indicated CAD to be older and more male. Most cardiovascular risk variables in this research were hypertension 119 (52.9%) and diabetes 67 (29.7%). According to Zheng *et al.*, The overall incidence of known hypertension was 51.8%, and normal glucose regulation (41.2%) [14]. In individuals with severe ST-segment depression (≥2 mm) on the treadmill test, hypertension was shown to be one of the independent predictors of substantial coronary stenosis, according to Korean research [15, 16]. Hypertension and diabetes are major risk factors for cardiovascular disease, although dyslipidemia, obesity, and family history of heart disease are also significant. Because endothelial dysfunction is linked to smoking, CAD risk has been well established. Research indicates that smoking raises the incidence of CAD by 1.66 times for people who smoke <14 cigarettes per day, and nearly twice for those who smoke > 15 cigarettes per day [17]. In a 2018 study, the researchers evaluated coronary angiographic parameters with CHD risk factors

DOI: https://doi.org/10.54393/pjhs.v4i10.1112

and discovered that up current smokers were more prevalent in the CAD group than the non-CAD group (68.2%, and 60.6% respectively) [18]. Our results that the smoker with CAD group were 36.8% and non- CAD group was 32.4% patients with substantial coronary lesions are 45 years old and smokers or risk factors. Diabetes is a risk factor like coronary heart disease that requires specific care. Diabetics have a greater rate of silent ischemia [19]. According to research by Martin-Timon *et al.*, [20] 35.3% of type 2 diabetic patients had high coronary risk was strongly associated with TC, (r = 0.695, p value < 0.000), match with our result that type 2 diabetic patients is 29.7%, and 16.8% with p value =0.018 In diabetic and non-diabetic group respectively. Numerous studies have also shown a substantial correlation between diabetes and the development of large coronary lesions as well as the quantity of blood vessels affected [21].

CONCLUSIONS

This research shows that DTS may predict CAD severity in diabetics and non-diabetics. Diabetes is a major CAD risk factor, and DTS may help estimate risk. Patient features, exercise ability, and treadmill technique may also affect DTS results and CAD risk assessment.

Authors Contribution

Conceptualization: MA, MSA, AZK
Writing, review and editing: MA, H, SA, MUR, IA
Methodology: MK, IA
Formal analysis: SA, SK

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Source of Funding

All authors have read and agreed to the published version of the manuscript.

REFERENCES

[1] Ralapanawa U, Sivakanesan R. Epidemiology and the magnitude of coronary artery disease and acute coronary syndrome: a narrative review. Journal of Epidemiology and Global Health. 2021 Jun; 11(2): 169-77. doi: 10.2991/jegh.k.201217.001.

[2] Su G, Mi S, Tao H, Li Z, Yang H, Zheng H, *et al.*, Association of glycemic variability and the presence and severity of coronary artery disease in patients with type 2 diabetes. Cardiovascular Diabetology. 2011 Dec; 10: 1-9. doi: 10.1186/1475-2840-10-19.

[3] Blomkalns AL, Chen AY, Hochman JS, Peterson ED, Trynosky K, Diercks DB, *et al.*, Gender disparities in the diagnosis and treatment of non-ST-segment elevation acute coronary syndromes: large-scale observations from the CRUSADE (Can Rapid Risk Stratification of Unstable Angina Patients Suppress Adverse Outcomes with early implementation of the American College of Cardiology/American Heart Association Guidelines) national quality improvement initiative. Journal of the American College of Cardiology. 2005 Mar; 45(6): 832-7.

[4] Chi CL, Street WN, Robinson JG, Crawford MA. Individualized patient-centered lifestyle recommendations: An expert system for communicating patient specific cardiovascular risk information and prioritizing lifestyle options. Journal of Biomedical Informatics. 2012 Dec ;45(6): 1164-74. doi: 10.1016/j.jbi.2012.07.011.

[5] Emren SV, Gediz RB, Şenöz O, Karagöz U, Şimşek EÇ, Levent F, *et al.*, Decreased heart rate recovery may predict a high SYNTAX score in patients with stable coronary artery disease. Bosnian Journal of Basic Medical Sciences. 2019 Feb; 19(1): 109-15. doi: 10.17305/bjbms.2019.3725.

[6] Mieres JH, Gulati M, Bairey Merz N, Berman DS, Gerber TC, Hayes SN, *et al.*, Role of noninvasive testing in the clinical evaluation of women with suspected ischemic heart disease: a consensus statement from the American Heart Association. Circulation. 2014 Jul; 130(4): 350-79. doi: 10.1161/CIR.0000000000000061.

[7] Gabaldo K, Hadzibegović I, Prvulović D, Vujeva B, Samardzić P, Danić D. Duke Treadmill Score in prioritizing patients for coronary angiography: retrospective study of a Croatian regional hospital. Coll Antropol. 2008 Jun; 32(2): 375-80.

[8] Gani A and Abdat M. Prevalence of Coronary Heart Disease with Risk Factors History of Hypertension and Diabetes Mellitus at the Regional Government Hospital dr. Zainoel Abidin in Aceh. In2nd Aceh International Dental Meeting 2021 (AIDEM 2021). Atlantis Press. 2022 Mar; 9-13. doi: 10.2991/ahsr.k.220302.002.

[9] Rubiyaktho D and Tjahjono CT. Comparison of Predicted Significant Coronary Lesion by Duke Treadmill Score among Coronary Heart Disease Risk Factors in Patients with Positive Ischemic Response Treadmill Test. ACI (Acta Cardiologia Indonesiana). 2018; 4(1): 1-8. doi: 10.22146/aci.36632.

[10] In2nd Aceh International Dental Meeting 2021 (AIDEM 2021). Atlantis Press. 2022 Mar; 9-13.

[11] Wéber A. Revising Incidence and Mortality of Lung Cancer in Central Europe: An Epidemiology Review From Hungary. Frontiers Oncology. 2019 Oct; 9: 361-65. doi: 10.3389/fonc.2019.01051.

DOI: https://doi.org/10.54393/pjhs.v4i10.1112

[12] Lortet-Tieulent J, Soriano J, JL LC, Ancochea J, Coebergh JW, Soerjomataram I. Comparative international trends in chronic obstructive pulmonary disease and lung cancer mortality of cancer and chronic obstructive pulmonary disease. 2016: 189.
[13] Einarson TR, Acs A, Ludwig C, Panton UH. Prevalence of cardiovascular disease in type 2 diabetes: a systematic literature review of scientific evidence from across the world in 2007–2017. Cardiovascular Diabetology. 2018 Dec; 17(1): 1-9. doi: 10.1186/s12933-018-0728-6.
[14] Qiu M, Shen W, Song X, Ju L, Tong W, Wang H, *et al.*, Effects of prediabetes mellitus alone or plus hypertension on subsequent occurrence of cardiovascular disease and diabetes mellitus: longitudinal study. Hypertension. 2015 Mar; 65(3): 525-30. doi: 10.1161/HYPERTENSIONAHA.114.04632.
[15] Cha KS. The exercise treadmill test: predictors of true presence of significant coronary stenosis in patients with severe ST-segment depression. Acta Cardiologica. 2012 Jun; 67(3): 297-302. doi: 10.1080/AC.67.3.2160718.
[16] Kim MK, Baek KH, Song KH, Kwon HS, Lee JM, Kang MI, *et al.*, Exercise treadmill test in detecting asymptomatic coronary artery disease in type 2 diabetes mellitus. Diabetes & Metabolism Journal. 2011 Feb; 35(1): 34-40. doi: 10.4093/dmj.2011.35.1.34.
[17] Barnoya J and Glantz SA. Cardiovascular effects of secondhand smoke: nearly as large as smoking. Circulation. 2005 May; 111(20): 2684-98. doi: 10.1161/CIRCULATIONAHA.104.492215.
[18] Lv S, Liu W, Zhou Y, Liu Y, Shi D, Zhao Y, *et al.*, Hyperuricemia and smoking in young adults suspected of coronary artery disease≤ 35 years of age: a hospital-based observational study. BMC Cardiovascular Disorders. 2018 Dec; 18: 1-7. doi: 10.1186/s12872-018-0910-5.
[19] Chiha M, Njeim M, Chedrawy EG. Diabetes and coronary heart disease: a risk factor for the global epidemic. International Journal of Hypertension. 2012 Sep; 2012. doi: 10.1155/2012/697240.
[20] Martín-Timón I, Sevillano-Collantes C, Segura-Galindo A, del Cañizo-Gómez FJ. Type 2 diabetes and cardiovascular disease: have all risk factors the same strength? World Journal of Diabetes. 2014 Aug; 5(4): 444-70. doi: 10.4239/wjd.v5.i4.444.
[21] Vizioli L, Muscari S, Muscari A. The relationship of mean platelet volume with the risk and prognosis of cardiovascular diseases. International Journal of Clinical Practice. 2009 Oct ;63(10): 1509-15. doi: 10.1111/j.1742-1241.2009.02070.x.