

Comparative study among the patients with different coronary risk factors for detection of asymptomatic coronary artery disease by treadmill test confirmed by coronary angiography



Moumita Saha Paul¹, Sovan Mitra², Uttam Kumar Saha³, Swapnodeep Sarkar⁴

¹Assistant Professor, Department of Pathology, ²Demonstrator, Department of Physiology, ⁴Assistant Professor, Department of Community Medicine, NRS Medical College and Hospital, ³Chief Interventional Cardiologist, Department of Cardiology, AMRI Hospital, Kolkata, West Bengal, India

Submission: 21-06-2023

Revision: 28-10-2023

Publication: 01-12-2023

ABSTRACT

Background: Cardiovascular diseases (CVD) such as ischemic heart disease (IHD) and cerebrovascular accidents such as stroke lead to 17.7 million deaths and are the leading cause of death worldwide. Global Burden of Disease study found that age-standardized CVD death rate in India (272/100,000 population) is much higher than the global average (235/100,000 population). **Aims and Objectives:** This study aimed to compare among different coronary risk factors like dyslipidemia, diabetes mellitus hypertension (HTN), and obesity which may lead to coronary artery disease (CAD) and early detection of ischemic heart disease by the stress treadmill test (TMT) among the patients having coronary risk factors. **Materials and Methods:** This is a prospective and observational study among 170 patients of age group 18–60 years having one or more coronary risk factors such as dyslipidemia, HTN, diabetes mellitus, and obesity. Patients with diagnosed IHD and other chronic debilitating diseases were excluded from the study. **Results:** Out of 170 patients, 153 patients were males and 17 patients were females. Among all these patients, 42 patients were suffering from dyslipidemia, 44 patients were suffering from Type 2 diabetes, 45 patients were suffering from HTN, and 39 patients were having more than one risk factor. All 170 patients with coronary risk factors performed TMT. Out of those patients, 53 were found to be TMT-positive. Binary regression analysis showed among all the selected risk factors, dyslipidemia ($P < 0.05$; odds ratio [OR]-2.104) and HTN ($P < 0.05$; OR-2.159) were found to be significantly associated with the positive outcome of TMT. All 53 TMT-positive patients were selected for CAG. Out of those patients, 37 were found to be suffering from CAD. Binary regression analysis showed among all the selected risk factors, dyslipidemia ($P < 0.05$; OR-1.964) and HTN ($P < 0.05$; OR-2.125) were found to be significantly associated with the positive outcome of CAG. **Conclusion:** Dyslipidemia and HTN were found to be significantly associated with the TMT-positivity as well as CAD. Diabetes mellitus and obesity were not statistically significant, though OR was more than 1 for both these risk factors.

Key words: Coronary artery disease; Treadmill test; Coronary angiography; Diabetes mellitus; Hypertension; Dyslipidemia; Obesity

INTRODUCTION

Many non-communicable diseases, such as cardiovascular disease (CVD), various cancers, chronic respiratory

illnesses, diabetes, and so on, account for 60% of all deaths. CVDs such as ischemic heart disease (IHD) and cerebrovascular ailments such as stroke lead to 17.7 million deaths and are the leading cause of death worldwide.¹ In

Access this article online

Website:

<http://nepjol.info/index.php/AJMS>

DOI: 10.3126/ajms.v14i12.56614

E-ISSN: 2091-0576

P-ISSN: 2467-9100

Copyright (c) 2023 Asian Journal of Medical Sciences



This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Address for Correspondence:

Dr. Swapnodeep Sarkar, Assistant Professor, Department of Community Medicine, NRS Medical College and Hospital, Kolkata - 700 130, West Bengal, India. **Mobile:** +91-7003801903. **E-mail:** swapno.rgkmc@gmail.com

accordance with the World Health Organization, India has one-fifth of these deaths. Global Burden of Disease study found that age-standardized CVD death rate in India (272/100,000 population) is much higher than the global average (235/100,000 population). This is due to the fact that Indian people suffer from CVDs 10 years earlier than people in other parts of the world.² Surprisingly, most people with risk factors for coronary artery disease (CAD) were unaware of their health condition. From epidemiological perspective, a “risk factor” is a feature of an individual or population that is present early in the life and is associated with increased risk of developing a disease in the future. Common risk factors for CVD are hypertension (HTN), diabetes mellitus, smoking, dyslipidemia, obesity, and physical inactivity.³

In 1956 A.D., Bruce reported a stress test using a treadmill and in 1957 A.D., he used a computer to analyze the exercise stress testing. Stress testing is a simple, reliable, and excellent non-invasive method for diagnosing CAD in asymptomatic patients and predicting future coronary events, especially in those with coronary risk factors. The marks for ST-segment deviation and degree of angina are connected with a straight edge.⁴

When coronary angiography is performed, it allows for visualization of the coronary anatomy under fluoroscopy. This is facilitated by direct injection of contrast media into the epicardial coronary arteries through a catheter advanced from a peripheral artery to the aortic root and into the coronary ostia.⁵

In 1928, Frossmann advanced a catheter through an antecubital vein into his own right atrium to accomplish the first human cardiac catheterization. He also obtained roentgenograms to record the procedure.⁶

Aims and objectives

The aims of this study were as follows:

1. Comparison among different coronary risk factors, that is, dyslipidemia, Type 2 diabetes mellitus, HTN, and obesity
2. Magnitude of CAD among the asymptomatic patients having coronary risk factors
3. Early detection of ischemic heart disease by stress treadmill test (TMT) among the patients having coronary risk factors.

MATERIALS AND METHODS

This prospective and observational study was conducted between October 2018 and June 2021 in South Heart Clinic and Diagnostic Centre located in south Kolkata in collaboration with AMRI Hospital, Kolkata. Institutional

Ethical Committee clearance was obtained and prior consent was taken from the patients before the study.

In this study, 170 individuals with coronary risk factors (i.e., dyslipidemia, diabetes mellitus, HTN, and obesity) for more than 6 months were studied for existence of the CAD, by subjecting them to stress TMT and followed by coronary artery angiography of the TMT-positive patients.

Inclusion criteria for case selection

The following criteria were included in the study:

1. Both male and female in the age group of 18–60 years
2. Individuals with any one of the coronary risk factors, that is,
 - Previously diagnosed dyslipidemia (Cholesterol>200, Triglyceride>150, HDL-C<55, LDL-C>150, VLDL-C>30) and on medication for more than 6 months
 - Previously diagnosed diabetes mellitus and on medication for more than 6 months
 - Previously diagnosed HTN and on medication for more than 6 months
 - Obesity with body mass index (BMI) ≥ 30 kg/m² persisting for more than 6 months.
3. Individual must not be a proven case of coronary artery disease

Exclusion criteria for case selection

The following criteria were excluded from the study:

1. Diagnosed patient of ischemic heart disease
2. Past history or present history of any severe general medical condition or orthopedic conditions which interfere with the patient’s ability to exercise.

Patients were selected as per inclusion and exclusion criteria from South Heart Clinic and Diagnostic Centre in Kolkata from October 2018 to June 2021 duration. After taking a detailed clinical history and physical examination, the individuals were performed TMT as per Bruce protocol by standard treadmill machine (NASAN) with NASAN (C) ST-Win standard BL 6.91 software. Maximum target heart rate (THR) can be calculated by $220 - \text{Age}$ of the person. The TMT consists of seven stages each of 3 min duration followed by 8 min period of post-exercise observation. In sub-maximal TMT, THR reached as 90% of the predicted maximal heart rate.⁷

Selective coronary angiography was performed on the TMT-positive patients with the standard Judkins approach at AMRI Hospital, Kolkata. Significant CAD was defined as the presence of >50% luminal diameter narrowing of one or more major epicardial arteries or its major branches. A “diffuse disease” was defined by the presence of significant stenosis in >2 coronary vessels with stenosis in >2 segments of each vessel.

Statistical analysis

All information taken from the study subjects were checked for consistency and completeness and entered into MS Excel spreadsheet. Data were organized and presented using the principles of descriptive statistics. Analysis was done using statistics that is a statistical software suite version 22 software. For analytical statistics, binary logistic regression was applied to get the association between various risk factors with the outcomes of the investigative procedures and diagnosis.

RESULTS

Out of randomly selected 170 patients, 153 patients were male and 17 patients were female. Among all these patients, 42 patients were suffering from dyslipidemia, 44 patients were suffering from Type 2 diabetes, 45 patients were suffering from HTN, and 39 patients were obese. All 170 patients went through TMT. Out of 170 patients, 53 patients (Dyslipidemia-14, HTN -19, Diabetes-9, and Obesity-11) became TMT-positive who went through coronary angiography, and out of these 53 patients, 37 patients (Dyslipidemia-10, HTN -15, Diabetes-6, and Obesity-6) were found to have significant CAD.

All 170 patients with coronary risk factors performed TMT. Out of those patients, 53 were found to be TMT-positive. Binary regression analysis showed among all the selected risk factors, dyslipidemia ($P<0.05$; odds ratio [OR]-2.104), and HTN ($P<0.05$; OR-2.159) were found to be significantly associated with the positive outcome of TMT. Other risk factors such as Type 2 diabetes mellitus (T2DM) and obesity were not statistically significantly associated with TMT-positivity but OR is more than 1 for both the risk factors (Table 1).

All 53 TMT-positive patients were selected for CAG. Out of those patients, 37 were found to be suffering from CAD. Binary regression analysis showed among all the selected risk factors, dyslipidemia ($P<0.05$; OR-1.964) and HTN ($P<0.05$; OR-2.125) were found to be significantly associated with the positive outcome of CAG. Other risk factors such as T2DM and obesity were not statistically significantly associated with causation of CAD but OR is more than 1 for both the risk factors (Table 2).

DISCUSSION

One of the most crucial methods for prompt intervention and mortality prevention is accurate screening and diagnosis of IHD. Many facilities use TMT and/or myocardial perfusion imaging (MPI) scans for screening before moving on to CAG, the gold standard for the diagnosis of CAD.⁸

Table 1: Association between treadmill test positivity and different coronary risk factors

S. No.	Risk factors	Odds ratio	P-value
1.	Dyslipidemia	2.104	0.045
2.	Type 2 DM	1.482	0.368
3.	Hypertension	2.159	0.043
4.	Obesity	1.006	0.972

DM: Diabetes mellitus

Table 2: Association between coronary artery disease and different coronary risk factors

S. No.	Risk factors	Odds ratio	P-value
1.	Dyslipidemia	1.964	0.022
2.	Type 2 DM	1.416	0.414
3.	Hypertension	2.125	0.045
4.	Obesity	1.398	0.864

Type 2 DM: Type 2 diabetes mellitus

In our study, 170 patients with different coronary risk factors performed TMT. Out of those patients, 53 were found to be TMT-positive. Among all the selected risk factors, dyslipidemia ($P<0.05$; OR-2.104) and HTN ($P<0.05$; OR-2.159) were found to be significantly associated with the positive outcome of TMT. Other risk factors such as T2DM and high BMI were not statistically significantly associated with TMT positivity but OR is more than 1 for both the risk factors.

Although TMT has a rather low sensitivity and specificity, while being a cost-effective, conveniently accessible, and generally applicable technique for the early identification of CAD. Although TMT has got few potholes like female patients frequently have false-positive TMT. In 50% of female patients, anemia, ST abnormalities, and T-wave inversion in leads V2-V4 are the most frequent causes, largely due to anemia.⁸

Accurate screening and diagnosis of IHD is one of the most important mechanisms of timely intervention and prevention of mortality. TMT and/or MPI scans are used in many centers for screening to be followed up with CAG, which is used as a gold standard for the diagnosis of CAD.⁸ Therefore, we wanted to study the coronary angiography of the TMT-positive patients to confirm the presence of CAD.

In our study, all 53 TMT-positive patients were selected for CAG. Out of those patients, 37 were found to be suffering from significant CAD. Among all the selected risk factors, like TMT here, dyslipidemia ($P<0.05$; OR-1.964) and HTN ($P<0.05$; OR-2.125) were found to be significantly associated with the positive outcome of CAG. Other risk factors such as T2DM and high BMI were not statistically significantly associated with causation of CAD but OR is more than 1 for both risk factors.

According to the Framingham study from 1984, the onset of CAD may be influenced by a rise in the ratio of total to high-density lipoprotein cholesterol, HTN, smoking, being overweight or diabetic, not exercising enough, stress, and other factors.^{9,10}

CAD, which affects 70–80% of diabetic people, is a significant cause of death (CAD).¹¹ CAD progresses over time in diabetic individuals, generally goes untreated, and ends up becoming the tip of a clinical iceberg. DM is an independent risk factor for coronary heart disease that is also controllable. Compared to non-diabetics, the mortality from cardiac disorders is doubled for diabetic males and quadrupled for diabetes women.¹²

Limitations of the study

Although in our study, we were not able to perform coronary angiography for all the selected patients because it was not technically feasible to perform an invasive procedure like CAG to the TMT-negative patients. The association between diabetes mellitus or high BMI and CAG might have been significant if all the study population performed CAG or the sample size was larger than what we selected.

CONCLUSION

The following conclusions were derived from our study:

- Dyslipidemia and HTN were found to be significantly associated with the TMT positivity as well as significant CAD. Other risk factors such as T2DM and obesity were not statistically significant, though OR was more than 1 for both these risk factors
- Magnitude of significant CAD among the asymptomatic patients with coronary risk factors is 21.76%
- Patients with long-term coronary risk factors (HTN, Dyslipidemia, T2DM, and Obesity) can undergo stress TMT and followed by coronary angiography if TMT is positive for early detection of CAD.

Compliance with ethical standard

Ethical clearance obtained from the institute ethical clearance committee before the study and appropriate consent taken from all the participants of this study.

ACKNOWLEDGMENT

Completion of our study could not have been possible without the active participation and assistance of the study

population. Their contribution is sincerely appreciated and greatly acknowledged. We are also thankful to South Heart Clinic and Diagnostic Centre and AMRI Hospital for providing us the platform.

REFERENCES

1. World Health Organization. Global Health Estimates 2015: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2015. Geneva: WHO; 2016. Available from: <https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/gho-leading-causes-of-death> [Last accessed on 2022 Dec 04].
2. Prabhakaran D, Jeemon P and Roy A. Cardiovascular diseases in India: Current epidemiology and future directions. *Circulation*. 2016;133(16):1605-1620. <https://doi.org/10.1161/CIRCULATIONAHA.114.008729>
3. Libby P. The pathogenesis, prevention and treatment of atherosclerosis. In: Kasper DL, Fauci AS, Hauser SL, Longo DL, Jameson JL and Loscalzo J, editors. *Harrison's Principles of Internal Medicine*. 19th ed. New York: McGraw-Hill Education; 2015. p. 291e1-291e10.
4. Gibbons RJ, Balady GJ, Beasley JW, Bricker JT, Duvernoy WF, Froelicher VF, et al. ACC/AHA guidelines for exercise testing. A report of the American College of Cardiology/American Heart Association task force on practice guidelines (committee on exercise testing). *J Am Coll Cardiol*. 1997;30(1):260-311. [https://doi.org/10.1016/s0735-1097\(97\)00150-2](https://doi.org/10.1016/s0735-1097(97)00150-2)
5. Libby P, Mann DL, Bonow RO, Tomaselli GF, Bhatt DL and Solomon SD. *Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine*. 12th ed. Philadelphia, PA: Elsevier, Saunders; 2022.
6. Forssmann W. Sounding of the right heart. *Klin weekly magazine*. 1929;8(45):2085-2087. <https://doi.org/10.1007/BF01875120>
7. Chadha SL, Gopinath N and Shekhawat S. Urban-rural differences in the prevalence of coronary heart disease and its risk factors in Delhi. *Bull World Health Organ*. 1997;75(1):31-38.
8. Kumar BL and Bhuvaneshwari E. Correlation of treadmill stress test with coronary angiography to predict coronary artery disease in males versus females. *Indian J Cardiovasc Dis Women WINCARS*. 2017;2(03):25-28. <https://doi.org/10.1055/s-0037-1607032>
9. Goldman L and Ausiello DA, editors. *Cecil Medicine*. Philadelphia, PA: Saunders Elsevier; 2008.
10. Castelli WP. Epidemiology of coronary heart disease: The Framingham study. *Am J Med*. 1984;76(2):4-12. [https://doi.org/10.1016/0002-9343\(84\)90952-5](https://doi.org/10.1016/0002-9343(84)90952-5)
11. Bonow RO, Bohannon N and Hazzard W. Risk stratification in coronary artery disease and special populations. *Am J Med*. 1996;101(4A):4A17S-4A22S. [https://doi.org/10.1016/s0002-9343\(96\)00312-9](https://doi.org/10.1016/s0002-9343(96)00312-9)
12. King H, Aubert RE and Herman WH. Global burden of diabetes, 1995-2025: Prevalence, numerical estimates, and projections. *Diabetes Care*. 1998;21(9):1414-1431. <https://doi.org/10.2337/diacare.21.9.1414>

Authors' Contributions:


MSP- Definition of intellectual contents, literature survey, prepared first draft of manuscript, planning, and programming of study protocol; **SM**- Implementation of study protocol, data collection, manuscript preparation, and submission; **UKS**- Implementation of study protocol, clinical assessment, and cardiological interventions; and **SS**- Data analysis and interpretation, manuscript revision, and coordination.

Work attributed to:

R. G. Kar Medical College and Hospital, Kolkata, West Bengal, India.

Orcid ID:

Dr. Moumita Saha Paul -  <https://orcid.org/0000-0001-6509-5491>

Dr. Sovan Mitra -  <https://orcid.org/0009-0009-4547-8909>

Dr. Uttam Kumar Saha -  <https://orcid.org/0009-0000-8447-7364>

Dr. Swapnodeep Sarkar -  <https://orcid.org/0009-0004-2882-2804>

Source of Support: Nil, **Conflicts of Interest:** None declared.