Original Article

Impact of Metabolic Syndrome on the Progression of Coronary Artery Disease: An Observational Cohort Study

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ABSTRACT

Objective: The objective of study was to evaluate the impact of MetS on the progression of CAD across diverse patient populations.

Study Design: An observational cohort study

Place and Duration of Study: This study was conducted at the department of Medicine and Cardiology at Nishtar II Medical University and Hospital, Multan, from September 2023 to August 2024.

Methods: Total 424 participants aged between 30 to 75 years diagnosed with MetS according to the International Diabetes Federation criteria. Clinical exams, structured interviews, and reviews of medical records were used to gather data. Important laboratory and anthropometric data were assessed at baseline and after 6, 12, 18, and 24 months of follow-up. Regression models were used in the statistical studies, which were carried out using SPSS version 26, to evaluate the connections between the components of the MetS and the advancement of CAD.

Results: The results showed a significant positive correlation with the progression of CAD between waist circumference, systolic blood pressure, and fasting blood glucose levels ($\beta = 0.15$, $p = 0.002$; $\beta = 0.18$, $p = 0.003$; and $\beta = 0.22$, $p = 0.001$, respectively). Participants showed significant improvements in metabolic parameters during the 24-month follow-up period, including a drop in fasting blood glucose levels to 99.89 mg/dL and a reduction in waist circumference to 87.03 cm and systolic blood pressure to 123.87 mmHg. Furthermore, good improvements were seen in lipid profiles, demonstrating the beneficial effects of focused therapies on cardiovascular health.

Conclusion: This study indicates how crucial MetS is in accelerating CAD development. It also emphasizes how crucial early preventive and sensible risk control are for reducing cardiovascular risk.

Key Words: Metabolic syndrome, coronary artery disease, multicenter study, cardiovascular risk, cohort study.

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INTRODUCTION

A collection of linked risk factors, the metabolic syndrome (MetS) dramatically raises the likelihood of cardiac disorders including coronary artery disease (CAD) [1, 2]. MetS is the condition whereby central obesity, high blood pressure, cholesterol, and insulin resistance all occur concurrently. This is a global health issue particularly in those who lead inactive lives or consume poor diets[3,4].

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Affecting millions of people worldwide, MetS rates have gone crazy and could jeopardize public health services[5]. Among the biochemical events connected to this disease and driving its growth and aggravation are those related to endothelial function, inflammation, and vascular stiffness[6].

When compared to people who did not have MetS, those who did had more serious coronary artery lesions and more bad cardiovascular events. These findings amply illustrate the significance of MetS in aggravating CAD[7]. MetS and CAD are linked in a convoluted fashion. For instance, obesity aggravates insulin resistance and accelerates atherosclerosis by inducing an inflammatory condition[8, 9]. Moreover, a variety of risk factors might hasten the development of CAD, which complicates the execution of therapeutic treatment regimens [10, 11].

To effectively avoid and treat CAD, one must completely comprehend the relationship between MetS and CAD since it is so complex. Though past studies on this subject have been conducted, not enough multicenter studies examining how MetS alters the course of CAD in different groups have been published.

Examining the relationships between these two main health concerns will help us to better understand the elements increasing the risk of heart disease and design treatments catered to the special requirements of MetS patients.

METHODS

This study was carried out between September 2023 to August 2024, it was conducted at Medicine and Cardiology Department of the Nishtar II Medical University Multan, Specifically a cohort study, it was a combined, observational design. The Institutional Review Board (IRB) examined and approved the research protocol. All subjects gave their informed permission before being included in the study, guaranteeing that ethical standards were closely adhered to at every stage of the investigation. The volunteers have to satisfy exactly the criteria established by the International Diabetes Federation for MetS. Among them were being an adult between the ages of 30 and 75 and having a CAD diagnosis derived from angiographic tests. Participants were not permitted to be anyone with acute infections, inflammatory disorders, cancer, or history of heart bypass operations. The World Health Organization (WHO) technique for sample size estimation was applied to ascertain the study's sample size. The study needed at least 385 individuals to provide statistically significant findings with a 95% confidence level (Z = 1.96), a 5% margin of error (E = 0.05), and the knowledge that half of those with CAD had MetS (p = 0.5). One might consider those who could drop out over the two-year research period using a desired sample size of around 424 persons. This would let one examine the relationship between MetS and CAD expansion in great detail. Sample size was calculated by using formula ($n = Z^2 \times p\ (1- p)/E^2$), p = estimated prevalence (you can assume a prevalence of 50% or 0.5 for maximum variability if unknown) with margin of error (0.05 for a 5% margin). Since you can't have a fraction of a participant, round up to the next whole number, resulting in a sample size of 385 participants. If we assume a 10% dropout rate, the target sample size would be: Adjusted sample size = n × (1+ dropout rate) = 385 × 1.10 = 423.5. Rounding gives a target sample size of 424 participants.

Clinical exams, organized patient interviews, and a review of medical records were used to gather data. This procedure collected lifestyle characteristics, medical history, and demographic data. Important anthropometric metrics, including blood pressure and waist circumference, were evaluated during clinical evaluations. Standardized questionnaires were used to evaluate the elements of MetS, and blood samples were examined for lipid profiles and fasting blood glucose levels. At six, twelve, eighteen, and twenty-four months, follow-up evaluations were carried out to track changes in MetS and cardiovascular health. The proper software (e.g., SPSS version 26) was used to conduct statistical analyses. The clinical and demographic features were gathered using descriptive statistics. Regression models were used to examine the connections between the components of the MetS and the development of CAD while controlling for possible confounders. Less than 0.05 was the threshold for statistical significance.

RESULTS

This research consisted of 424 individuals, 210 males (49.53%) and 214 women (50.47%), with a mean age of 55.32 ± 10.41 years. Table 1 shows that 73.11% of the population had a history of hypertension, and 29.48% had diabetes mellitus. In terms of smoking status, 59.91% had never smoked, 18.87% were past smokers, and 21.23% were current smokers. 35.38% of the population was sedentary, 47.17% was moderately active, and 17.45% was actively involved in their physical activity. Regarding eating and exercise routines, 42.45% only focused on food, 11.79% exercised, 18.87% did both, and 26.89% did neither. The average waist circumference was 94.16 ± 12.03 cm, while the diastolic and systolic blood pressure readings were 85.26 ± 10.34 mmHg and 130.52 ± 15.81 mmHg, respectively. Total cholesterol was measured in the lab at 210.59 ± 35.27 mg/dL; LDL cholesterol was measured at 130.88 ± 30.12 mg/dL; HDL cholesterol was measured at 40.54 ± 10.51 mg/dL; fasting blood glucose was measured at 110.23 ± 25.41 mg/dL; and triglycerides were measured at 150.03 ± 45.25 mg/dL.

Table No. 1: Demographic, Clinical, and Laboratory Characteristics of Participants (n = 424)

Variable		Total (n = 424)
Age (years)	Mean ± SD	55.32 ± 10.41
Gender	Men	210 (49.53%)
	Women	214 (50.47%)
Medical History	History of Hypertension	310 (73.11%)
	History of Diabetes Mellitus	125 (29.48%)
Smoking Status	Current Smokers	90 (21.23%)
	Former Smokers	80 (18.87%)
	Never Smokers	254 (59.91%)
Physical Activity Level	Sedentary	150 (35.38%)
	Moderate Activity	200 (47.17%)
	Active	74 (17.45%)
Diet and Exercise	Diet only	180 (42.45%)
	Exercise only	50 (11.79%)
	Both diet and exercise	80 (18.87%)
	No Diet and	114 (26.89%)

	Exercise	
Waist Circumference (cm)	Mean ± SD	94.16 ± 12.03
Blood Pressure	Systolic (mmHg)	130.52 ± 15.81
	Diastolic (mmHg)	85.26 ± 10.34
Laboratory Results	Total Cholesterol (mg/dL)	210.59 ± 35.27
	LDL Cholesterol (mg/dL)	130.88 ± 30.12
	HDL Cholesterol (mg/dL)	40.54 ± 10.51
	Fasting Blood Glucose (mg/dL)	110.23 ± 25.41
	Triglycerides (mg/dL)	150.03 ± 45.25

The results of follow-up evaluations of important health parameters over a 24-month period revealed a noteworthy reduction in waist circumference, with measurements at 6 months being 92.53 ± 11.57 cm, 12 months being 90.45 ± 11.06 cm, 18 months being 88.76 ± 10.53 cm, and 24 months being 87.03 ± 10.21 cm (table 2). The diastolic blood pressure also dropped at the same time, from 83.07 ± 10.17 mmHg to 79.08 ± 8.15 mmHg. The diastolic blood pressure reduced from 128.45 ± 15.03 mmHg at 6 months to 123.87 ± 13.59 mmHg at 24 months. At six months, fasting blood glucose levels were 108.19 ± 24.02 mg/dL; at 24 months, they had decreased to 99.89 ± 21.32 mg/dL. LDL cholesterol readings dropped from 126.53 ± 29.17 mg/dL to 114.52 ± 26.41 mg/dL, while total cholesterol levels dropped from 206.19 ± 34.13 mg/dL to 195.18 ± 31.13 mg/dL. During the same period, triglyceride levels dropped from 146.13 ± 43.19 mg/dL to 133.28 ± 40.67 mg/dL, while HDL cholesterol levels grew progressively from 42.32 ± 10.19 mg/dL at 6 months to 46.19 ± 11.36 mg/dL at 24 months.

Table No. 2: Follow-Up Assessments of Key Health Metrics at 6, 12, 18, and 24 Months

Variable	6 Months	12 Months	18 Months	24 Months
Waist Circumference (cm)	92.53 ± 11.57	90.45 ± 11.06	88.76 ± 10.53	87.03 ± 10.21
Systolic Blood Pressure (mmHg)	128.45 ± 15.03	126.67 ± 14.51	125.03 ± 14.17	123.87 ± 13.59
Diastolic Blood Pressure (mmHg)	83.07 ± 10.17	81.89 ± 9.56	80.16 ± 9.03	79.08 ± 8.15
Fasting Blood Glucose (mg/dL)	108.19 ± 24.02	105.34 ± 23.67	102.17 ± 22.45	99.89 ± 21.32
Total Cholesterol (mg/dL)	206.19 ± 34.13	202.21 ± 33.41	198.03 ± 32.21	195.18 ± 31.13
LDL Cholesterol (mg/dL)	126.53 ± 29.17	122.19 ± 28.43	118.56 ± 27.87	114.52 ± 26.41
HDL Cholesterol (mg/dL)	42.32 ± 10.19	43.89± 10.52	44.95 ± 11.09	46.19 ± 11.36
Triglycerides (mg/dL)	146.13 ± 43.19	141.07 ± 42.17	137.14 ± 41.34	133.28 ± 40.67

The regression analysis of the MetS components and how they relate to the development of CAD is shown in Table 3. A significant correlation between waist circumference and the development of CAD was found, resulting in a regression coefficient (β) of 0.15 (SE = 0.05, p = 0.002). Similar positive correlations were seen for diastolic and systolic blood pressure (β = 0.12, SE = 0.06, p = 0.028) and systolic blood pressure (β = 0.18, SE = 0.07, p = 0.003). The highest positive connection was found for fasting blood glucose (β = 0.22, SE = 0.09, p = 0.001), suggesting that it plays a crucial role in the advancement of CAD. Significant positive associations were also shown by LDL cholesterol (β = 0.20, SE = 0.08, p = 0.002) and total cholesterol (β = 0.14, SE = 0.05, p = 0.004). On the other hand, triglycerides exhibited a positive link (β = 0.17, SE = 0.06, p = 0.005) with CAD development, but HDL cholesterol was adversely related (β = -0.16, SE = 0.07, p = 0.007).

Table No. 3: Regression Analysis of Metabolic Syndrome Components on Coronary Artery Disease Progression

Metabolic Syndrome Component	Regression Coefficient (β)	Standard Error (SE)	p-value
Waist Circumference (cm)	0.15	0.05	0.002
Systolic Blood Pressure (mmHg)	0.18	0.07	0.003
Diastolic Blood Pressure (mmHg)	0.12	0.06	0.028
Fasting Blood Glucose (mg/dL)	0.22	0.09	0.001
Total Cholesterol (mg/dL)	0.14	0.05	0.004
LDL Cholesterol (mg/dL)	0.20	0.08	0.002
HDL Cholesterol	-0.16	0.07	0.007

(mg/dL)			
Triglycerides (mg/dL)	0.17	0.06	0.005

DISCUSSION

The results of this study provide us with significant fresh insights on how MetS influences the course of CAD in a large spectrum of individuals. Older persons with CAD had comparable waist circumferences according to other research[12, 13]. According to our data, the mean waist circumference of the individuals was 94.16 ± 12.03 cm. This implies that, in many individuals, belly obesity—a major component of MetS—remains a significant risk factor for the course of CAD.

In our group, 73.11% of individuals had prior high blood pressure, hence hypertension was very prevalent. This rate corresponds with recent research showing that elevated blood pressure aggravates cardiovascular disease[14, 15]. In our study, the mean systolic blood pressure was 130.52 ± 15.81 mmHg and the mean diastolic blood pressure was 85.26 ± 10.34 mmHg. These values help to explain why high blood pressure is a main cause of CAD. These findings make it abundantly evident how crucial it is for individuals with MetS to monitor and regulate their blood pressure so as to avoid CAD.

With a mean fasting blood glucose level of 110.23 ± 25.41 mg/dL, our findings revealed a clear correlation between metabolic elements and how CAD developed. This result aligns with another study showing those with uncontrolled diabetes had higher risk of major cardiovascular events[16]. In our regression investigation, we identified a strong, significant connection ($\beta = 0.22$, $p = 0.001$) between fasting blood glucose and CAD development. This indicates that those with MetS have to learn diabetic control techniques.

With a range of 30.12 mg/dL to 210.59 mg/dL, our investigation also revealed total cholesterol was 210.59 mg/dL and LDL cholesterol was 130.89 mg/dL. As with other research showing a considerably increased risk of CAD among those with MetS when their cholesterol levels are high[17, 18]. Furthermore, our investigation revealed that the development of CAD was adversely correlated with HDL cholesterol levels (40.54 ± 10.51 mg/dL) ($\beta = -0.16$, $p = 0.007$). This indicates that HDL cholesterol can assist avoid heart disease and is in accordance with research by Zou Y et al [19] that persons with MetS can profit from greater HDL levels for their heart health.

CONCLUSION

Examining blood pressure, waist circumference, and fasting blood glucose levels, this study spanning several sites reveals that MetS significantly influences the development of CAD and looks at risk variables. Our study reveals that persons with MetS experience quicker heart difficulties, which emphasizes the need of using focused therapy to reduce these risks. This study provides crucial knowledge on how MetS and CAD interact that might support clinical treatment and public health initiatives aiming at reduced cardiovascular disease and mortality.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Ghulam Hussain, Muhammad Farooq
Drafting or Revising Critically:	Usman Sadiq, Gohar Ali, Muhammad Shahid Nawaz Khan, Muhammad Tahir
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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