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Original Article

Prevalence, Angiographic Findings and Risk Factors for Premature Coronary Artery Disease in Patients Undergoing Coronary Angiography in Kenyatta National Hospital, Nairobi, Kenya

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ABSTRACT

Coronary Artery Disease (CAD) is a leading cause of morbidity and mortality worldwide and poses an emerging challenge in developing countries. While often affecting individuals beyond the sixth decade of life, some populations experience premature CAD (PCAD). However, data on the prevalence, risk factors, and angiographic findings of PCAD in Kenya remains limited. This study aimed to determine the prevalence, angiographic characteristics, and risk factors for PCAD among patients undergoing coronary angiography at Kenyatta National Hospital, Nairobi, Kenya. It was a hospital-based cross-sectional study that included 100 adult patients who underwent invasive coronary angiography. Participants were enrolled consecutively, and data on socio-demographics, risk factors, and angiographic findings were collected from medical records, supplemented with questionnaires when necessary. Angiograms were reviewed with oversight by interventional cardiologists. Data analysis involved descriptive statistics, chi-square/Fisher's exact tests, and multivariable logistic regression using R software (version 4.1.2). The mean age of participants with premature CAD was 49.8 ± 8.5 years, compared to 69.9 ± 8 years for those with mature CAD. Abnormal angiographic findings were observed in 58 patients, with a premature CAD prevalence of 37.9% (95% CI: 25.8%, 51.7%). Bivariate analysis revealed that females had significantly higher odds of premature CAD compared to males (OR: 3.12, 95% CI: 1.04–9.79, p = 0.045). A significant age difference was noted between males and females with premature CAD (47.2 ± 5.8 vs. 51.9 ± 10 years, p = 0.04). Smoking was significantly associated with premature CAD both before and after adjustment (OR: 0.23, 95% CI: 0.04–0.97, p = 0.045). Hypertension and diabetes mellitus were associated with lower odds of premature CAD compared to mature CAD. Most of the patients had multiple- vessel disease with severe stenosis, but no significant associations were found between risk factors and disease severity. The study concluded that premature coronary artery disease is alarmingly prevalent at Kenyatta National Hospital, with females at higher risk and smoking as a key contributing factor. Most patients in the study

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had severe obstructive coronary artery disease. These findings emphasize the need for targeted prevention strategies, particularly smoking cessation, to reduce the burden of PCAD in Kenya.

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INTRODUCTION

Coronary Artery Disease (CAD) is characterized by reduced blood flow to the heart muscle due to plaque build-up (atherosclerosis) in the coronary arteries. Premature Coronary Artery Disease (PCAD) refers to CAD in individuals younger than 55 years in men and 65 years in women, though cut-offs can vary from 45 to 65 years depending on the study (Kimeu & Kariuki, 2016; Waweru & Gatimu, 2021). CAD is the leading cause of morbidity and mortality globally, including in low- and middle-income countries such as Kenya, where cardiovascular diseases (CVDs) account for 25% of hospital admissions and 13% of deaths (World Health Organization, 2021; Chege, 2016; Khoja et al., 2021).

Histological studies reveal subclinical atheromatous plaques in younger individuals, which can progress to significant coronary stenosis later in life (Khoury et al., 2020). Risk factors for PCAD include smoking, dyslipidemia, family history, hypertension, diabetes, obesity, and drug abuse (Mohammad et al., 2015; Osadnik et al., 2018; Shukor et al., 2023). A Kenyan study identified hypertension, diabetes, and dyslipidemia, among the male gender as significant contributors to CAD (Kamotho et al., 2004). Coronary angiography, which uses contrast media to visualize coronary arteries, remains critical for diagnosing and assessing CAD severity, guiding interventions such as revascularization (Bahiru et al., 2018; Feuchtner et al., 2021).

Although CAD typically occurs after age 60, recent studies show an increasing incidence in younger populations (Singh et al., 2019; Meirhaeghe et al., 2020). In Africa, the mean age for myocardial infarction is around 54 years (Steyn & Sliwa, 2016), with approximately 30% of patients presenting under the age of 50 (Ogeng'o et al., 2010). A Kenyan study reported that 27% of patients with Acute Coronary Syndrome (ACS) were under 50, most of whom had STEMI (Kassam et al., 2024). Hypertension continues to be a dominant risk factor, with an average patient age of 57 years (Wambua, 2018). In Tanzania, CAD prevalence is particularly high among older male patients (Meda et al., 2024).

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Though relatively fewer in number, young CAD patients represent a significant healthcare burden, necessitating focused research and targeted prevention strategies (Kimani et al., 2018; Page et al., 2013).

This study examines the prevalence of PCAD, its associated risk factors, angiographic characteristics, and the relationship between disease severity and risk profile among patients undergoing coronary angiography at Kenyatta National Hospital in Nairobi, Kenya.

MATERIALS AND METHODS

Study design

This was a hospital-based cross-sectional study that utilized hospital records to collect data on risk factors and indications for coronary angiograms. Missing information was supplemented through patient questionnaires. Angiographic characteristics were analyzed from coronary angiogram images under the supervision of interventional cardiologists, while laboratory and imaging data were obtained from medical records. This design enabled a comprehensive evaluation of variables in patients undergoing invasive coronary angiography.

Study setting

The study was conducted at Kenyatta National Hospital (KNH) in Nairobi, Kenya, the largest and oldest referral hospital in the country, with a capacity of 2,400 beds and 6,000 staff. Its cardiac catheterization lab and status as a national cardiology referral centre made it a suitable site for studying CAD diagnoses.

Study population

Study participants were adult patients aged ≥ 18 years, referred for coronary angiography at Kenyatta National Hospital, Nairobi, Kenya for a period of 6 months from June 2024 to November 2024 and meeting eligibility criteria.

Inclusion criteria

Inclusion criteria included all patients aged ≥18 years, who were undergoing invasive coronary angiography and who gave informed consent.

Exclusion criteria

Eligible participants for whom the invasive coronary angiogram was not completed due to unforeseen complications during the procedure were excluded. In addition, eligible participants who transferred to other facilities at the time of the study were excluded.

Sampling Technique and Sample Size Calculation

The researcher employed a consecutive sampling method to enrol patients until the target sample size of 100 was reached. This size was determined based on the estimated number of eligible patients accessible during the six-month study period. According to KNH records (2023), approximately five patients undergo coronary angiography weekly, equating to around 20 patients per month and 120 over six months. The sample size calculation utilized a formula for finite populations appropriate for cross-sectional studies (O'Neill, 2022).

$$\mathbf{n}=\frac{N(z2)P(1-P)}{(d2)(N-1)+(z2)P(1-P)}$$

Where;

n = the desired sample size

N = estimated number of accessible populations = 120 patients

Z = the standard normal deviation, set at 1.96, which corresponds to 95% confidence level

P = expected proportion of angiographic findings in patients undergoing coronary angiography 45% (Bradley et al., 2014).

d= is the desired margin of error, which is 5%

Hence, the sample size was 91 patients. The sample was adjusted by 10% (9 participants); hence a sample size of **100 patients** was arrived at.

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Data collection procedures

The independent variables included prevalence and risk factors, while the dependent variable was Premature Coronary Artery Disease (PCAD). Data were collected using a structured questionnaire to abstract relevant information from enrolled patients. Three research assistants (RAs) with at least a diploma in a medical or health-related field were recruited and trained on study objectives, informed consent, and data collection procedures. They signed confidentiality agreements to ensure data privacy.

Statistical analysis

Statistical analyses were performed using R version 4.1.2. Descriptive statistics were reported as mean ± standard deviation (SD) for continuous variables and numbers, counts, and percentages for categorical variables. The Pearson chi-square test was used to assess associations between independent variables (risk factors for PCAD) and dependent variables (absence or presence of PCAD). Variables demonstrating associations in the Pearson chi-square test and those with p values of 0.25 and below were selected for multivariable logistic regression to derive the adjusted odds ratios (ORs) to determine the level of associations. A p-value at $\alpha \leq 0.05$ was used as the criterion for statistical significance.

Ethical considerations

The research proposal was approved by the Jomo Kenyatta University of Agriculture and Technology School of Graduate Studies, and ethical clearance was granted by the university's Ethical Review Committee. Permissions were also obtained from NACOSTI and the Kenyatta National Hospital administration. The study adhered to ethical principles, including confidentiality, anonymity, informed consent, and voluntary participation. Participants received consent forms and were informed of their right to withdraw at any time or decline specific questions.

RESULTS

Sociodemographic characteristics of the recruited patients.

A total of 100 patients were recruited, with 53% aged 40-64 years, 43% over 64, and the remainder under 40. The sample was 60% male and 57% from rural areas. Forty-two patients had normal angiographic findings, while 58 had confirmed CAD with one or more epicardial vessels involved.

Characteristics of patients with confirmed coronary artery disease (CAD)

Out of the 58 patients with abnormal angiographic findings, 36 (62.1%) were males and the rest were females. Out of the 36 males, 10 (27.8%) had PCAD and the rest had Mature Coronary Artery Disease (MCAD). The mean age of the patients with PCAD was 49.8 years with a standard deviation of 8.5 years while the mean age of the patients with MCAD was 69.9 years with a standard deviation of 8 years.

Of the 10 patients who smoked, 3 had PCAD and the rest had MCAD. A total of 19 (32.8%) with obesity had abnormal angiographic findings of which 7 (36.8%) had PCAD. Of the 44 (75.9%) patients with hypertension, 14 (31.8%) had PCAD while the rest had MCAD. A total of 16 (27.6%) of the patients had diabetes mellitus of which 7 (43.8%) had PCAD and the rest had MCAD. Of the 30 (51.7%) patients with dyslipidemia, 13 (43.3%) had PCAD and the rest had MCAD. The rest of the information is shown in Table 1 below.

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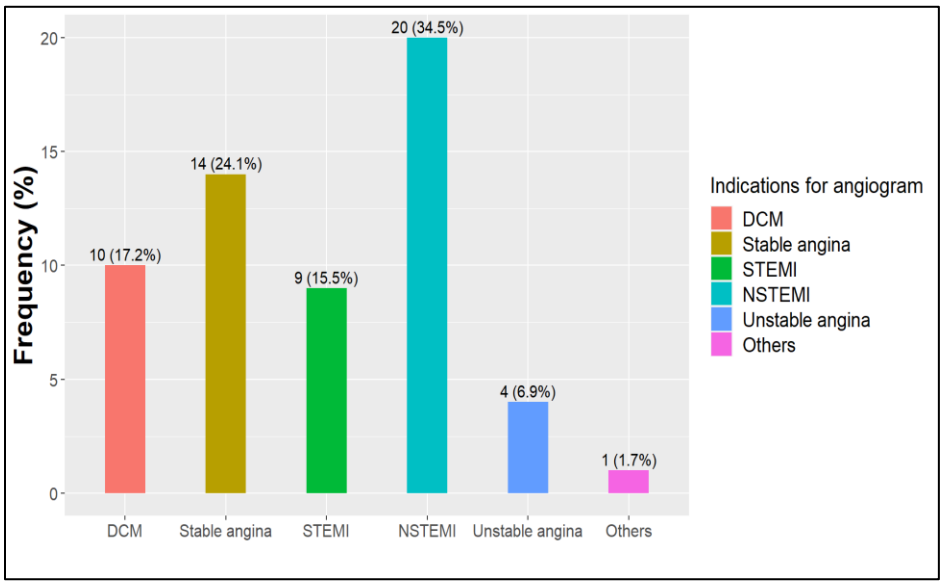
Table 1: Characteristics of patients with confirmed coronary artery disease (CAD)

Factors			
Sociodemographic factors	N = 58	**Premature CAD n = 22**	**Mature CAD n = 36**
Gender			
Female	22 (37.9%)	12 (54.5%)	10 (45.5%)
Male	36 (62.1%)	10 (27.8%)	26 (72.2%)
Age in years			
Mean age ±SD	58 (100%)	49.8±8.5	69.9±8.0
Smoking	10 (17.2%)	3 (30%)	7 (70%)
Alcohol consumption	23 (39.7%)	6 (26.1%)	17 (73.9%)
No regular exercise	34 (58.6%)	13 (38.2%)	21 (61.8%)
Non-heart healthy diet	41 (70.7%)	15 (36.6%)	26 (63.4%)
Residence			
Rural	38 (65.5%)	11 (28.9%)	27 (71.1%)
Urban	20 (34.5%)	11 (55%)	9 (45%)
Clinical characteristics			
Obese	19 (32.8%)	7 (36.8%)	12 (63.2%)
Hypertensive	44 (75.9%)	14 (31.8%)	30 (68.2%)
Diabetic	16 (27.6%)	7 (43.8%)	9 (56.2%)
Dyslipidaemia	30 (51.7%)	13 (43.3%)	17 (56.7%)
Family history of PCAD	5 (8.6%)	3 (60%)	2 (20%)

Indications for coronary angiography for patients with confirmed CAD

There were six indications for coronary angiography: dilated cardiomyopathy, non-ST elevation myocardial infarction (NSTEMI), ST-elevation myocardial infarction (STEMI), stable angina, unstable angina, and others (e.g., left bundle branch block, left ventricular aneurysm). NSTEMI was the most common (34.5%), followed by stable angina (24.1%). Ten patients (17.2%) had dilated cardiomyopathy, and nine (15.5%) had STEMI. Other indications are shown in Figure 1.

Figure 1: Indication for Coronary Angiogram for patients with Confirmed CAD



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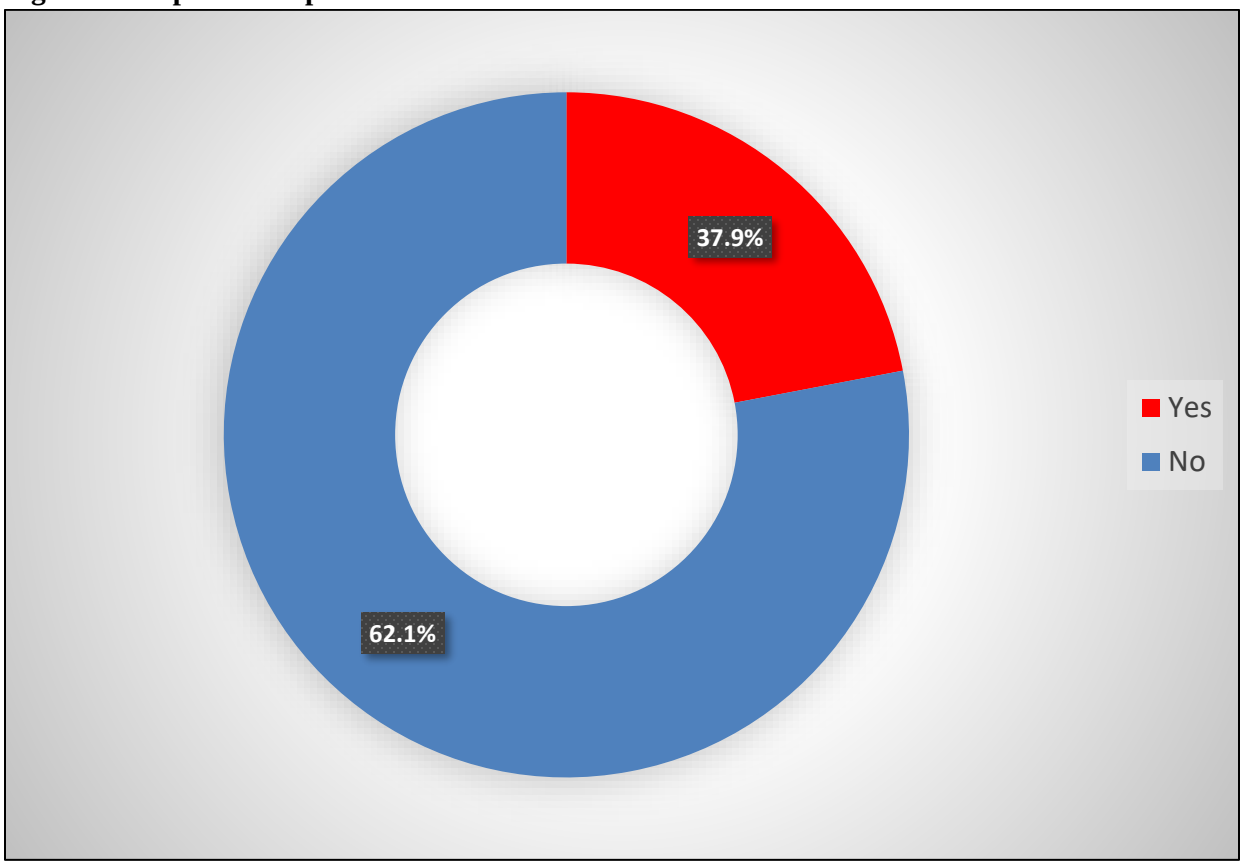
Prevalence of premature coronary artery disease among patients with angiographically confirmed coronary artery disease.

The overall prevalence of angiographically confirmed coronary artery disease (CAD) was 58%. Of the 58 patients with abnormal angiographic findings, 22 had premature coronary artery disease (PCAD) and 36 had mature coronary artery disease (MCAD). The prevalence of PCAD among confirmed CAD patients was 37.9% (95% CI: 25.8%, 51.7%) (Figure 2).

Figure 2: Proportion of patients with PCAD vs. MCAD



The risk factors of patients with angiographically confirmed Premature Coronary Artery Disease

Bivariate analysis revealed that gender, age, and smoking were significantly associated with the type of coronary artery disease ($p < 0.05$). Female patients were 3.12 times more likely to have PCAD than MCAD (OR 3.12, 95% CI 1.04–9.79). Smoking was associated with a significantly lower likelihood of PCAD, with 82% reduced odds compared to MCAD (OR 0.18, 95% CI 0.04–0.63). After adjustment, smoking remained a significant predictor, showing 77% lower odds for PCAD compared to MCAD (OR 0.23, 95% CI 0.04–0.97), as shown in Table 2.

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Table 2: The risk factors of patients with angiographically confirmed Premature Coronary Artery Disease

Factors						
Sociodemographic factors	**Premature CAD n = 22**	**Mature CAD n = 36**	**Crude OR (95% CI)**	**P-value**	**Adjusted OR (95% CI)**	**P-value**
Gender						
Female	12	10	3.12 (1.04, 9.79)	**0.045**	1.72 (0.49, 6.12)	0.392
Age in years						
Mean age ±SD	49.8±8.5	69.9±8.0	0.56 (0.32, 0.74)	**0.003**		
Smoking	3	17	0.18 (0.04, 0.63)	**0.014**	0.23 (0.04, 0.97)	**0.045**
Alcohol consumption	6	17	0.42 (0.13, 1.27)	0.136		
No regular exercise	13	21	1.03 (0.35, 3.09)	0.955		
Non-heart healthy diet	15	26	0.82 (0.26, 2.69)	0.743		
Clinical characteristics						
Obese	7	12	0.93 (0.29, 2.87)	0.905		
Hypertensive	14	30	0.35 (0.10, 1.19)	0.095		
Diabetic	7	9	0.42 (0.13, 1.24)	0.123		
Family history of PCAD	3	2	2.68 (0.41, 21.77)	0.302		
Dyslipidemia	13	17	0.76 (0.04, 13.41)	0.854		

Angiographic characteristics among patients with confirmed CAD

Out of 100 patients, 58 (58%) had abnormal coronary angiographic findings. The left anterior descending artery (LAD) was the most involved, with 51 patients (87.9%) showing stenosis. Of these, 18 (35.3%) had PCAD and the rest had MCAD. The right coronary artery (RCA) was affected in 40 patients, with 14 (35%) having PCAD. Among the 58 patients, 18 (31%) had single vessel disease, with 10 (55.6%) having PCAD. Twenty-one patients had triple vessel disease, of which 14 (66.7%) had PCAD. Severe stenosis was present in 81 vessels (66.9%), with 29 (35.8%) in PCAD patients. The overall mean stenosis was 69.3% (SD = 25.1%), with PCAD patients showing higher mean stenosis (74.7% ± 29.1%) compared to MCAD patients (63.8% ± 21.0%), as shown in Table 3.

Table 3: Patients with abnormal angiographic findings

Angiography findings	N (%)	Premature CAD n (%)	Mature CAD n (%)
Abnormal	58 (%)	22 (37.9%)	36 (62.1%)
Vessels involved			
LAD	51 (87.9%)	18 (35.3%)	33 (64.7%)
LCX	32 (55.2%)	11 (34.4%)	21 (65.6%)
RCA	40 (69%)	14 (35%)	26 (65%)
LMCA	4 (6.9%)	2 (50%)	2 (50%)
Number of vessels involved			
Single vessel disease	18 (31%)	10 (55.6%)	8 (44.4%)
Double vessel disease	16 (27.6%)	3 (18.8%)	13 (81.2%)
Triple vessel disease	21 (36.2%)	7 (33.3%)	14 (66.7%)
Left main coronary artery disease	3 (5.2%)	2 (66.7%)	1 (33.3%)
Severity of Stenosis (n = 121)			
Mild (<50%)	28 (23.1%)	12 (42.9%)	16 (57.1%)
Moderate (50-70%)	12 (9.9%)	4 (33.3%)	8 (66.7%)
Severe (>70%)	81 (66.9%)	29 (35.8%)	52 (64.2%)
Mean stenosis	69.3%±25.1%	**74.7%±29.1**	**63.8%±21.0**

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Association between risk factors and the number of vessels involved

This section examines the relationship between the number of risk factors (hypertension, diabetes, lack of exercise, and poor diet) and vessel involvement. Fisher's exact test showed no significant association between the number of risk factors or specific factors and the number of vessels involved in PCAD patients ($p > 0.05$), as shown in Table 4.

Table 4: Association between the risk factors and the number of vessels involved

		Number of vessels involved			
Risk factor	**N**	**Single vessel**	**Double vessel**	**Tripple vessel**	**P-value**
Number of risk factors					
0-2	12	4 (33.3%)	2 (16.7%)	6 (50%)	0.509
≥3	10	6 (60%)	1 (10%)	3 (30%)	
Hypertension					
Yes	14	7	2	5	0.835[f]
No	8	3	1	4	
Diabetes					
Yes	7	2	1	4	0.586[f]
No	15	8	2	5	
Obesity					
Ye	8	4	1	6	0.840[f]
No	15	6	2	3	
Smoking					
Ye	3	2	0	6	0.322[f]
No	19	8	3	3	

[F]Fisher's exact test

Association between risk factors and severity of stenosis

This section examines the association between risk factors (hypertension, diabetes, lack of exercise, and poor diet) and stenosis severity. Fisher's exact test found no significant correlation between the number or type of risk factors and stenosis severity in PCAD patients ($p > 0.05$), as shown in Table 5.

Table 5: Association between risk factors and the severity of stenosis

Risk factor		**Severity of stenosis**			
Number of risk factors	**N**	**<50%**	**50 to 70%**	**>70%**	**P-value**
0-2	27	6 (22.2%)	1 (3.7%)	20 (74.1%)	0.159
≥3	18	6 (33.3%)	3 (16.7%)	9 (50%)	
Hypertension					
Yes	18	5	0	13	
0.590f				16	0.590[f]
0.590f					
No	24	7	4	21	0.0997[f]
Diabetes				8	
Yes	28	6	1		
No	18	6	3	17	0.901[f]
Obesity				12	
Yes	12	3	0		
No	23	9	4	20	0.228[f]
Smoking				9	

[F]Fisher's exact test

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DISCUSSION

The overall prevalence of coronary artery disease was high at 58% (95% CI 47.7%, 67.7%). In 2022, coronary artery disease (CAD) affected 315 million people worldwide, with the highest prevalence observed in Central Europe, Eastern Europe, and Central Asia, while South Asia had the lowest prevalence. A CAD prevalence of 90% has been reported in the urban populations of the United States (Stark et al., 2024). This shows that coronary artery disease is prevalent, especially among the at-risk population. The high prevalence in this study reflects the at-risk nature of the sampled population, all of whom presented with cardiovascular symptoms, highlighting the substantial burden of CAD.

The prevalence of premature coronary artery disease among the patients with confirmed CAD in this study was high at 37.9% with a 95% confidence interval of between 25.8% and 51.7%. Similar prevalence rates have been reported in studies conducted in India and Northern Iraq (Mohammad et al., 2015; Sharma et al., 2022). For instance, comparable rates were observed in an Indian cohort (Sharma et al., 2022), and similar findings were documented among patients in Northern Iraq (Mohammad et al., 2015), further validating the consistency of PCAD prevalence in diverse populations.

Females in this study exhibited higher odds of PCAD compared to males before adjusting for confounders, a finding supported by prior research (Nazli et al., 2024). While CAD remains a leading cause of mortality in both genders, women often experience worse outcomes following myocardial infarction or coronary artery bypass grafting (Lawton, 2011). Although the gender difference in PCAD odds was not statistically significant after adjustment, the trend aligns with existing literature, suggesting underlying biological and sociocultural factors.

Surprisingly, smoking was associated with lower odds of PCAD in this study, a finding contrary to most literature. Previous studies have consistently identified smoking as a significant risk factor for PCAD, with smokers at higher risk for CAD-related complications (Nazli et al., 2024; Mohammad et al., 2015). Variability in findings may stem from differences in participant demographics, smoking patterns, and unmeasured confounding factors.

Patients with diabetes mellitus and hypertension also showed lower odds of PCAD compared to CAD, though these associations lacked statistical significance. This aligns with findings from other studies, which have reported mixed associations between these conditions and PCAD (Nazli et al., 2024). Obesity and abnormal low-density lipoprotein (LDL) levels were similarly associated with reduced odds of PCAD, contrary to prior studies that identified these factors as significant contributors (Mohammad et al., 2015; Nazli et al., 2024). Differences in study populations, age distributions, and lifestyle factors likely explain these discrepancies. For example, obesity often increases with age, potentially shifting its impact on younger CAD populations.

Family history emerged as an important factor, with participants reporting positive family history showing increased odds of PCAD, although this association was not statistically significant. Previous studies have highlighted the role of familial predisposition in CAD risk, particularly among first-degree relatives (Rubin & Borden, 2012; Bajaj et al., 2011). A family history of PCAD, especially early myocardial infarction, significantly elevates the risk of atherosclerosis and related conditions (Lloyd-Jones et al., 2004; Sivapalaratnam et al., 2010).

This study identified the left anterior descending artery as the most frequently affected coronary artery, followed by the right coronary artery. These findings align with prior research indicating that larger coronary arteries are more susceptible to atherosclerosis (National Heart, Lung, and Blood

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Institute, 2023). More than half of the patients had multi-vessel disease, with the majority presenting with triple-vessel disease. This is consistent with studies reporting a high prevalence of multi-vessel involvement in CAD (Meda et al., 2024). However, other studies have noted single-vessel disease as more common in PCAD, likely reflecting differences in lifestyle and behavioural factors such as smoking.

Among PCAD patients, most had significant stenosis exceeding 70%, similar to findings from other studies reporting mean stenosis levels around 75% (Meda et al., 2024; Maroszyńska-Dmoch & Wożakowska-Kapłon, 2016). However, this study did not find significant associations between risk factors and either the number of vessels involved or the severity of stenosis. Existing research has demonstrated strong links between risk profiles and CAD severity, with hypertension and diabetes mellitus playing prominent roles in plaque development and vessel obstruction (Morgan et al., 2004).

CONCLUSION

The prevalence of PCAD among patients with confirmed CAD at Kenyatta National Hospital was high, as indicated by this study. Smoking was the only factor significantly associated with PCAD, demonstrating a protective association both before and after adjustment. Patients with hypertension and diabetes mellitus exhibited lower odds of PCAD compared to other forms of CAD. The majority of patients had multi-vessel disease, with significant stenosis observed in most cases. Notably, risk factors for CAD did not significantly influence the number of vessels involved or the severity of stenosis in this cohort.

Recommendations

- Conduct multi-centre studies to enhance the generalizability of findings to larger populations and improve the statistical power of future research.
- Prioritize the management of cardiovascular risk factors, implement screening programs for high-risk populations, and expand interventional cardiology services to mitigate the prevalence and impact of PCAD.
- Investigate gender disparities in CAD more comprehensively, focusing on differences in risk profiles and outcomes. Developing gender-specific preventive and therapeutic strategies may improve clinical outcomes for both men and women.

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