Ethnic differences in risk factor profiles in subjects with coronary disease attending a state hospital in KwaZulu-Natal

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ABSTRACT

Objectives: This study compares the profile of coronary artery disease (CAD) across different ethnic groups at a tertiary referral hospital in KwaZulu-Natal.
Method: We reviewed the clinical records of 1 104 subjects who underwent coronary angiography at Grey's Hospital for suspected CAD over a 5-year period (2012 - 2016). Uni- and multivariable analysis was used to identify associations of risk factors with CAD.
Results: Coronary artery disease was present in 886 subjects, of whom 69.9% were male. The majority were of Indian ethnicity (60.8%). The mean age of Africans was younger (54.9 ± 10.8 years) compared to Indians (58.0 ± 11.0 years), Coloureds (58.6 ± 12.3 years) and Whites (60.0 ± 10.5 years) (p=0.001). The prevalence of premature CAD (PCAD) (<55 years in males and <65 years in females) was 46% of males and 66,7% in females. Most African females (84,6%, p=0.01) and white females (75,6%, p=0.01) presented with PCAD. ST-elevation myocardial infarction was the most frequent presentation among African subjects (n=99, 66.0%), followed by Whites (n=76, 45.2%) and Indians (n=240, 44.5%), and least common among Coloureds (n=11, 37.9%) (p<0.001). The most prevalent risk factors were dyslipidaemia (95.1%), hypertension (70.3%), smoking (67.4%) and diabetes (57.2%). The prevalence of smoking was lowest in the African group (51.3%) compared to about 66% in the other groups (p<0.001) (Table I). About 80% of Indians and Whites had clustering of 3 or more risk factors compared to 39.3% of Africans (p<0.001). A family history of CAD lowest among African (n=13, 8.7%) and Coloured subjects (n=11, 37.9%) (p<0.001) and a history of previous MI was obtained in 5.3% of African subjects compared to >23% in each of the other ethnic groups (p<0.001). Single vessel disease was commoner among Africans (48.7%), while Indians had more triple vessel disease (47.7%), (p<0.001). Univariate analysis identified risk factors and ethnicity (Indians, p=0.02) and Whites, p=0.02) as being associated with CAD, but on multivariable analysis ethnicity fell away. Age (46 - 65 years: OR: 2.2 [1.5 - 3.3], age >65 years: OR: 4.8 [2.8 - 8.2], male gender (OR: 2.7 [1.9 - 3.9]), history of smoking (OR: 2.0 [1.4 - 3.1] (all p<0.001) as well as diabetes (OR: 1.7 [1.2 - 2.4], p=0.005) and atherogenic dyslipidaemia (OR: 1.7 [1.2 - 2.4], p=0.004) were independent cardiovascular risk factors associated with the presence of CAD.
Conclusion: Major risk factors were associated with CAD at a young age across all race groups. Although Africans had a lower risk factor burden, the low prevalence of a family history of MI and near absence of a previous history of MI indicate that recent environmental and / or lifestyle changes that have contributed to the emergence of CAD, often premature, in this group. SA Heart® 2025;22:12-21

INTRODUCTION

Coronary artery disease (CAD) is the leading cause of morbidity and mortality worldwide across various ethnic and racial groups.[1-7] The distribution of CAD displays socioeconomic disparities with an increasing burden of the disease among low income countries.[2,3,8] Almost 3 decades ago Seedat, et al.[9] proposed that Africans were not developing CAD to the same extent as White or Indian subjects due to cardiovascular protective role conferred by the preserved serum levels of both high density lipoprotein and lower total cholesterol. Other observational studies[10-15] have also confirmed that Africans have lower cholesterol levels and are the least likely to be diagnosed with CAD when compared to other ethnic groups. Steyn, et al.[11] further noted that the African subjects were still at the initial phase of epidemiological transition due to urbanisation and changing lifestyle factors, resulting in an increased prevalence of non-communicable diseases, especially cardiovascular disease. However, other local studies have reported an upsurge in the prevalence of cardiovascular risk factors among Africans.[16-19]

Approximately 2 decades ago the INTERHEART study[3] demonstrated that 90% of risk factors for developing acute myocardial infarction (AMI) were attributable to 9 cardiovascular risk factors (abnormal lipids, smoking, hypertension, diabetes, abdominal obesity, psychosocial factors, consumption of fruits, vegetables, and alcohol, and regular physical activity) worldwide. Subsequently, the INTERHEART Africa study[11] showed that 5 of the 9 cardiovascular risk factors (hypertension, diabetes, abdominal obesity, current history of smoking, and apolipoprotein B to apolipoprotein A1 ratio) were accountable for nearly 90% of the risk associated with first time AMI, consistent with that found in the global INTERHEART study. These studies suggest that the spectrum of CAD is changing rapidly in the developing countries.[16,19-23] In South Africa, White and Indian subjects have a higher prevalence of CAD-related deaths compared to Coloured and African subjects.[9,12,19,24] There are few recent studies of subjects with CAD across different ethnic groups.[25-31] In this study we analysed the cardiovascular risk profile of subjects with CAD admitted for coronary angiography to Grey's Hospital in KwaZulu-Natal and related this to the patterns of CAD across 4 ethnicities.

MATERIALS AND METHODOLOGY

The aim of this study was to evaluate the spectrum of CAD over a 5-year period (2012 - 2016) at Grey's Hospital, a tertiary level referral facility in Pietermaritzburg, KwaZulu-Natal, South Africa, servicing the urban and Midlands area of KwaZulu-Natal. This public health care facility provides regional services to lower- and middle-income groups, residing in the uMgungundlovu health district and surrounding areas.

A retrospective chart review of all patients who were referred to Grey's Hospital with a clinical diagnosis of CAD was conducted in order to determine prevalence of atherosclerotic risk factors in adults with CAD, and relate the risk factor profile of to the extent of CAD at angiography. Data extracted from the medical records comprised age, gender, ethnicity, previous medical history for traditional CAD risk factors such as hypertension, diabetes mellitus, dyslipidaemia, previous history of myocardial infarction (MI), family history of premature CAD, and history of smoking. Ethnicity was determined from the admission files and patients were classified accordingly as being of African, Coloured, Indian, and White descent.

Definitions

Coronary artery disease was defined using the criteria from the 2013 American College of Cardiology Foundation / American Heart Association Task Force (ACCF/AHA).[32] Eligible patients were adult males and females, presenting with a diagnosis of stable angina or acute coronary syndrome (ACS). The term ACS as outlined in the Third Universal Classification of Myocardial Infarction encompasses ST-segment elevation MI (STEMI), non-ST-segment elevation MI (NSTEMI), and unstable angina (UA).[33]

Hypertension was defined as blood pressure (BP) ≥140/90mmHg or self-reported use of antihypertensive medication.[34] Diabetes mellitus was diagnosed in patients who were on chronic anti-hyperglycaemic drugs, or self-reported or had documented glycated haemoglobin A1c (HbA1c) ≥6.5%.[35] Dyslipidaemia was diagnosed in patients who were on chronic lipid lowering drugs (e.g. statin), or self-reported, or previously documented diagnosis from medical records or established during the hospital stay by lipogram. The lipid profiles were classified using the criteria from the Third National Cholesterol Education Programme and Adult Treatment Panel III (NCEP-ATP III)[36] guidelines. Total cholesterol (TC) was considered high if >5.17mmol/L, low high-density lipoprotein cholesterol (HDL-C) was defined as <1.3mmol/L for females and <1.03mmol/L for males and hypertriglyceridaemia was defined as triglycerides (TG) >1.7mmol/l. Low-density lipoprotein cholesterol (LDL-C) data was calculated using the Friedewald equation. For TG >4.5mmol/L, the John Hopkins University LDL-C calculator[37] was used to measure LDL (iPhone App Version 1.0.1).

Atherogenic dyslipidaemia was defined in accordance with the criteria used in the NCEP-ATP III[36] guidelines as the combination of elevated levels of triglycerides and low levels of HDL-C. A positive family history of premature CAD[36] was defined as coronary artery disease diagnosed in a first-degree relative before the age of 55 in males and for females before the age of 65. A history of smoking was defined as either current or previous use of tobacco products or cigarettes.

Patient demographic data, past medical history, and presenting diagnosis of CAD were analysed in conjunction with laboratory results and angiographic findings to formulate relevant conclusions about their overall combined contribution to the spectrum of CAD at Grey's Hospital. Data were further analysed according to gender and age groups: (a) those ≤45-years-old, (b) between 46 - 65-years-old, and (c) those >65-years-old. Angiographic obstructive CAD was defined as ≥50% luminal diameter stenosis in ≥1 epicardial coronary artery and multivessel CAD was defined as ≥50% luminal diameter stenosis in ≥2 epicardial coronary arteries. The remaining subjects were classified as normal or non-occlusive coronary disease at coronary angiography. Angiographic findings of obstructive coronary disease were grouped into single-vessel disease (SVD), double-vessel disease (DVD) and triple-vessel disease (TVD). With regards to lesion localisation to a specific coronary artery, patients were further grouped into the left anterior descending coronary artery (LAD), circumflex artery (CxA) and right coronary artery (RCA).

Statistical analysis

Descriptive statistics were used to summarise the clinical and demographic characteristics of the patients. Frequency and percentages were used for categorical variables and means (Standard Deviations [SD]) or medians (interquartile ranges) for numeric variables. Subgroup comparisons of risk factors (diabetes, hypertension, smoking history, family history of CAD, previous MI, and dyslipidaemia) by ethnic group (Africans vs. other ethnic groups) was done using Chi-square tests or Fisher's exact test. The Kruskal-Wallis test was used for comparisons of numeric variables.

A logistic regression model containing cardiovascular risk factors significant at the univariate level was used to identify independent factor differences by gender, ethnic group, age group, cardiovascular risk factors, number of risk factors, and atherogenic dyslipidaemia. Two sets of models were developed: the first model looked at obstructive disease and non-obstructive / normal vessels to determine the predictors of CAD. The second model assessed the severity of CAD, comparing SVD to multivessel disease (DVD and TVD). All data were analysed using Stata V13 and a p-value <0.05 was considered significant.

Ethical considerations

The study protocol was approved by the Bioethics Committee of the Faculty of Health Sciences, Nelson R. Mandela School of Medicine, University of KwaZulu-Natal, ethics reference number: BE538/17.

RESULTS

During the 5-year period (January 2012 - December 2016), 1 318 subjects were admitted for evaluation of suspected CAD. Of the 1 318 evaluated subjects, 214 subjects were excluded for reasons of inadequate data (n=202) and declined coronary angiography (n=12). The study population comprised the remaining 1 104 subjects who had undergone coronary angiography. Of these, 886 had angiographically confirmed CAD and comprised the study group, while the remaining 218 subjects had normal angiograms or non-occlusive disease and were used as the comparative group (Table I).

Demographic data

The mean age of the subjects with CAD was 57.9 ± 11.0 years. The youngest were Africans (54.9 ± 10.8 years), followed by Indians (58.0 ± 11.0 years), Coloureds (58.6 ± 12.3 years), and the oldest subjects were Whites (60.0 ± 10.5 years) (p=0.001). There was a predominance of Indian subjects (n=539, 60.8%), followed by Whites (n=168, 19%), Africans (n=150, 16.9%) and Coloureds (n=29, 3.3%) (p=0.001). The majority of the study cohort were male (n=619, 69.9%), with no difference in the male to female ratio across the ethnic groups (p=0.18). One hundred and twenty six subjects (n=126, 14.2%) were under the age of 45; 526 (59.4%) were between 46 - 65-years-old and the remaining 234 (26.4%) subjects were older than 65 (>65) (Table I).

Presenting diagnosis

The commonest diagnosis at presentation was ST-elevation myocardial infarction (STEMI) (n=426, 48.1%) followed by non-ST-elevation myocardial infarction (NSTEMI) (n=243, 27.4%), and the least prevalent were stable (p<0.001) and unstable (p=0.024) angina together making up 24.5% of the CAD subjects. Within the ethnic groups ST-elevation myocardial infarction was most frequent among African subjects (n=99, 66.0%), followed by Whites (n=76, 45.2%) and Indians (n=240, 44.5%), and least common among Coloureds (n=11, 37.9%) (p<0.001). Angina was the least common manifestation among African subjects (n=15, 10.0%) compared to other ethnic groups, Coloureds (n=5, 17.2%), Indians (n=145, 26.9%), and Whites (n=52, 31%). Non-ST-elevation myocardial infarction was equally distributed across all ethnic groups (p=0.089) (Table I).

Premature coronary artery disease (PCAD), defined as CAD in males <55 years and females <65 years, was present in 463 (52.3%) subjects; it was commoner in females (M 46.0%, F 66.7%). There was no difference in males with PCAD across ethnic groups but most of the African females (84.6%, p=0.01) and White females (75.6%, p=0.01) had PCAD. In adults under 45 years, PCAD was commoner among Africans (n=31, 20.7%) and Indians (n=79, 14.7%), compared to Coloureds (n=13, 7.7%) and Whites (n=15, 7.7%) (p<0.001) (Table I).

Risk factor profile

The most prevalent cardiovascular risk factors were dyslipidaemia (n=843, 95.1%), hypertension (n=623, 70.3%), and a history of smoking (n=597, 67.4%) followed by diabetes (n=507, 57.2%) and a family history of CAD (n=410, 46.3%). A history of smoking was present in two thirds of subjects with CAD. About half of the Africans (51.3%) were smokers compared to two-thirds of the Indians (68.1%), and over three quarters of the Whites (77.4%), and Coloureds (79.3%) (p<0.001).

While the majority of all ethnic groups had some form of dyslipidemia, there were significant differences in their risk factor and lipid profiles. Compared to other ethnic groups, Indian subjects had the highest prevalence of dyslipidaemia (97.8%), diabetes (65.9%), a family history of CAD (55.1%) and a history of previous MI (26.7%) (all p<0.001). Almost 80% of Indians and Whites had clustering of 3 or more (≥3) cardiovascular risk factors compared to 39.3% of Africans and 58.6% of Coloureds (p<0.001). The median LDL-C was lowest

TABLE I: Risk factor profile and angiographic findings across ethnic groups.

Variables	All n (%) 886 (100)	African n (%) 150 (16.9)	Coloured n (%) 29 (3.3)	Indian n (%) 539 (60.8)	White n (%) 168 (19.0	p-value
Age (years), mean ± SD	57.9 ± 11.0	54.9 ± 10.8	58.6 ± 12.3	58.0 ± 11.0	60.0 ± 10.5	0.001
Age Group n (%)						
≤45 years	126 (14.2)	31 (20.7)	3 (10.3)	79 (14.7)	13 (7.7)	<0.001
46 - 65 years	526 (59.4)	99 (66.0)	20 (69.0)	304 (56.4)	103 (61.3)	
>65 years	234 (26.4)	20 (13.3)	6 (20.7)	156 (28.9)	52 (31.0)	
Gender n (%)						
Males	619 (69.9)	104 (69.3)	22 (75.9)	365 (67.7)	128 (76.2)	0.18
Females	267 (30.1)	46 (30.7)	7 (24.1)	174 (32.3)	40 (23.8)	
Premature CAD n (% of gender)						
Males (<55 years)	285 (46.0)	54 (51.9)	12 (54.5)	171 (46.8)	48 (37.5)	0.11
Females (<65 years)	178 (66.7)	39 (84.8)	3 (42.9)	107 (61.5)	29 (72.5)	0.01
Risk Factor Profile n (%)						
Hypertension	623 (70.3)	108 (72.0)	19 (65.5)	386 (71.6)	110 (65.5)	0.42
Diabetes	507 (57.2)	75 (50.0)	10 (34.5)	355 (65.9)	67 (39.9)	<0.001
Dyslipidaemia	843 (95.1)	132 (88.0)	27 (93.1)	527 (97.8)	157 (93.5)	<0.001
Family history of CAD	410 (46.3)	13 (8.7)	11 (37.9)	297 (55.1)	89 (53.0)	<0.001
History of smoking	597 (67.4)	77 (51.3)	23 (79.3)	367 (68.1)	130 (77.4)	<0.001
Previous MI	199 (22.5)	8 (5.3)	7 (24.1)	144 (26.7)	40 (23.8)	<0.001
Number of Risk Factors n (%)						
0 - 2	249 (28.1)	91 (60.7)	12 (41.4)	113 (21.0)	33 (19.6)	<0.001
≥3	637 (71.9)	59 (39.3)	17 (58.6)	426 (79.0)	135 (80.4)	
Biochemistry, mmol/L						
Total Cholesterol, median (IQR) - mmol/L	4.9 (4-5.7)	4.2 (3.5-5.3)	5.0 (4.1-5.3)	4.9 (4.0-5.9)	5.0 (4.0-6.0)	<0.001
LDL-C, median (IQR) - mmol/L	2.8 (2.1-3.7)	2.5 (1.9-3.3)	2.8 (2.2-3.4)	2.9 (2.2-3.7)	3.1 (2.2-3.7)	0.004
HDL-C, median (IQR)	1.0 (0.8-1.2)	1.0 (0.8-1.3)	1.0 (0.9-1.2)	1.0 (0.8-1.2)	1.0 (0.8-1.2)	0.33
Triglycerides, median (IQR) - mmol/L	1.7 (1.2-2.5)	1.3 (0.8-1.9)	1.9 (1.5-2.5)	1.9 (1.3-2.7)	1.8 (1.2-2.6)	0.001
HbA1c, mean ± SD - %	7.2 ± 2.0	7.4 ± 2.4	6.9 ± 2.1	7.4 ± 2.0	6.5 ± 1.5	0.001
Metabolic syndrome criteria n (%)						
Total cholesterol ≥5.17 mmol/L	338 (38.1)	44 (29.3)	9 (31.0)	208 (38.6)	77 (45.8)	0.02
LDL ≥2.59 mmol/L	507 (57.2)	67 (44.7)	17 (58.6)	318 (59.0)	105 (62.5)	0.006
Triglycerides ≥1.7 mmol/L	445 (50.2)	44 (29.3)	16 (55.2)	298 (55.3)	87 (51.8)	<0.001
HDL-C Male ≤1.03 mmol/L	407 (65.8)	55 (52.9)	15 (68.2)	249 (68.2)	88 (68.8)	0.03
HDL-C Female ≤1.29 mmol/L	188 (70.4)	30 (65.2)	5 (71.4)	131 (75.3)	22 (55.0)	0,07
Glycated haemoglobin A_{1c} ≥6.5%	447 (50.5)	68 (45.3)	10 (34.5)	314 (58.3)	55 (32.7)	<0.001
Blood Pressure ≥130/85 mmHg	169 (19.1)	43 (28.7)	5 (17.2)	94 (17.4)	27 (16.1)	0.01
Atherogenic Dyslipidaemia n (% of gender)						
Males	238 (38.4)	20 (19.2)	10 (45.5)	157 (43.0)	51 (39.8)	<0.001
Females	99 (37.1)	8 (17.4)	4 (57.1)	71 (40.8)	16 (40.0)	0.02
Presenting Diagnosis n (%)						
SA	87 (9.8)	4 (2.7)	0 (0.0)	61 (11.3)	22 (13.1)	<0.001
UA	130 (14.7)	11 (7.3)	5 (17.2)	84 (15.6)	30 (17.9)	0.024
STEMI	426 (48.1)	99 (66.0)	11 (37.9)	240 (44.5)	76 (45.2)	<0.001
NSTEMI	243 (27.4)	36 (24.0)	13 (44.8)	154 (28.6)	40 (23.8)	0.089
Angiographic CAD Findings						
Extent of CAD n (%)						
Single-vessel CAD	260 (29.3)	73 (48.7)	12 (41.4)	116 (21.5)	59 (35.1)	<0.001
Double-vessel CAD	261 (29.5)	38 (25.3)	7 (24.1)	166 (30.8)	50 (29.8)	0.581
Triple-vessel CAD	365 (41.2)	39 (26.0)	10 (34.5)	257 (47.7)	59 (35.1)	<0.001
Epicardial vessel involvement n (%)						
Left anterior descending artery	732 (82.6)	121 (80.7)	19 (65.5)	458 (85.0)	134 (79.8)	0.025
Circumflex artery	521 (58.8)	63 (42.0)	17 (58.6)	360 (66.8)	81 (48.2)	<0.001
Right coronary artery	614 (69.3)	78 (52.0)	20 (69.0)	397 (73.7)	119 (70.8)	<0.001

CAD: coronary artery disease, SD: standard deviation, MI: myocardial infarction, STEMI: ST-elevation myocardial infarction, NSTEMI: non-ST-elevation myocardial infarction, UA: unstable angina, SA: stable angina, HDL-c, high-density lipoprotein cholesterol, LDL, low-density lipoprotein cholesterol, Hypertension: history of hypertension ***OR*** *self-reported use of anti-hypertensive medication* ***OR*** *BP ≥140/90 mmHg, Diabetes: history of diabetes* ***OR*** *self-reported use of anti-hyperglycaemic medication* ***OR*** *HbAc1 ≥6.5%, Dyslipidaemia: history of dyslipidaemia* ***OR*** *TC ≥5.17* ***OR*** *TG >1.7* ***OR*** *HDL-C ≤1.03 in males* ***OR*** *HDL-C ≤1.29 in females.*

among Africans (2.5mmol/L, IQR 1.9 - 3.3), compared to Whites (3.1mmol/L, IQR 2.2 - 3.7, Indians (2.9mmol/L, IQR 2.2 - 3.7), and Coloureds (2.8mmol/L, IQR 2.2 - 3.4) (p=0.004). There was no difference in the median HDL-C (1.0mmol/L, IQR 0.8 - 1.2) across all ethnic groups (p=0.33). The median TG was lowest among the African subjects (1.3mmol/L, IQR 0.8 - 1.9), compared to ≥1.8mmol/L in the other ethnic groups (p=0.001). Atherogenic dyslipidemia was also least frequent in African males (19.2%, p<0.001) and females (17.4%, p=0.02) compared to over 40% for each gender in the other ethnic groups (Table I).

There was a high prevalence of diabetes (52.8%), which increased to 57.2% when we added the diagnostic criteria using the HbA1c >6.5%. Two thirds of the Indian (n=355, 65.9%) and half of the African (n=75, 50.0%) subjects had diabetes compared to over a third of Whites (n=67, 39.9%) and Coloureds (n=10, 34.5%) (p<0.001). Correspondingly, the mean HbA1c was highest among Africans (7.4% ± 2.4%) and Indians 7.4% (SD ± 2.0%), followed by Coloureds 6.9% (SD ± 2.1%), and Whites 6.5% (SD ± 1.5%) (p<0.001).

A family history of CAD was highest among Indians (n=297, 55.1%) and Whites (n=89, 53.0%) whilst it was lowest among African (n=13, 8.7%) and Coloured subjects (n=11, 37.9%) (p<0.001). A history of previous MI was obtained in 5.3% of African subjects compared to >23% in each of the other ethnic groups (p<0.001). (Table I).

In summary, 50% of Africans had diabetes, and they had a lower prevalence of the other major risk factors compared to other ethnic groups. Clustering of 3 or more cardiovascular risk factors was present in 39.3% of Africans compared to almost 80% in Indians and in Whites. Except for HDL-C, the median serum levels of all the remaining lipid subtypes were lower among the African subjects.

Coronary angiography

This showed that single-vessel disease was most common among Africans (48.7%, p<0.001) and triple-vessel disease most common among Indians (47.7%, p<0.001) (Table I). The left anterior descending artery (LAD) was involved in 80% of all ethnic groups except in Coloureds (65.5%) (p=0.025). Africans had less frequent involvement of the right coronary artery (RCA) (52.0%) (p<0.001) and the circumflex artery (CX) lesions (42.0%) (p<0.001).

Predictors of CAD

On univariate analysis age, male gender, ethnicity, diabetes, history of smoking, 3 or more cardiovascular risk factors and atherogenic dyslipidaemia showed significant associations with CAD (Table II). There was a higher risk of CAD amongst Indians (OR: 1.6 [1.1 - 2.3], p=0.02) and Whites: (OR: 1.8 [1.1 - 2.9], p=0.02) which fell away in the adjusted analysis after the risks were controlled for age, gender, ethnicity, number of cardiovascular risk factors and atherogenic dyslipidaemia. Thus, on multivariable analysis age 46 - 65 years (OR: 2.2 [1.5 - 3.3], p<0.001), age >65 years OR: 4.8 [2.8 - 8.2], p<0.001), male gender (OR: 2.7 [1.9 - 3.9], p<0.001), diabetes (OR: 1.7 [1.2 - 2.4], p=0.005), history of smoking (OR: 2.0 [1.4 - 3.1], p=0.001) and atherogenic dyslipidaemia (OR: 1.7 [1.2 - 2.4], p=0.004) remained as independent cardiovascular risk factors associated with the presence of CAD. With regard to extent of disease, multivariate analysis revealed Indian ethnicity (OR: 2.6 [1.6 - 4.0], p<0.001), age (46 - 65 years OR: 1.6 [1.1 - 2.5], p=0.024), age >65 years (OR: 4.1 [2.3 - 7.2], p<0.001), hypertension (OR: 2.1 [1.4 - 3.1], p=0.002), and previous MI (OR: 2.1 [1.3 - 3.4], p=0.002) as independent predictors of multivessel disease (Table III).

DISCUSSION

This study shows a high prevalence of major cardiovascular risk factors in subjects presenting with diagnosis of acute coronary syndrome or stable angina at a tertiary referral centre in KwaZulu-Natal. In keeping with other studies[10,13,14,38] Indians constituted the majority ethnic group and there was a predominance of males[3,5,25,27,28,39-45] with a similar male to female ratio (7:3) across the ethnic groups. The mean age amongst Indians (58 ± 11 years) in our study is similar to that in the Chennai Urban Population Study (58 ± 12 years)[39] and the Kerala ACS Registry (60 ± 12.1 years)(45) in India. The mean age of our African subjects (54.9 ± 10.8 years), is also strikingly similar to reports from Cameroon and Kenya,[41] the INTERHEART Africa study (54.3 ± 11.3 years),[11] as well as study at the Chris Hani Baragwanath Hospital, Soweto (55 [51 - 61] years)[18] and the R.K. Khan Hospital, Durban (54.3 ± 11.0 years).[27] The mean age of African subjects in these studies is about 5 years younger compared to African Americans with CAD.[46]

Most of the subjects in our study were in the age group 45 - 65 years and were male, which we have documented previously at the R.K. Khan Hospital in Durban.[47,48] The age predominance was present across all the ethnic groups, unlike the stepwise increase in CAD prevalence documented in African Americans and Whites from the age of <55 years to >65 years documented by Whittle, et al.[49,50] About half the males and two thirds of the females had PCAD. It has been suggested that the loss of ovarian protection in women may account for the high prevalence of hypertension, diabetes, and dyslipidaemia in females which placed them at a higher risk for cardiovascular events at an earlier stage of their lives.[51] The INTERHEART study[3] showed that men from Africa (10.9%) and South Asia (9.7%) comprised the highest proportion of cases with first AMI

TABLE II: Statistical association of CAD with major risk factors.

Variables	No CAD [x] 218 (%)	CAD [y] 886 (%)	Total 1 104	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Gender							
Female	118 (30.6)	267 (69.4)	385	Reference			
Male	100 (13.9)	619 (86.1)	719	2.7 (2.0 - 3.7)	<0.001	2.7 (1.9 - 3.9)	<0.001
Ethnic Group							
African	52 (25.7)	150 (74.3)	202	Reference			
Coloureds	15 (34.1)	29 (65.9)	44	0.7 (0.3 - 1.3)	0.3	0.5 (0.2 - 1.1)	0.09
Indian	118 (18.0)	539 (82.0)	657	1.6 (1.1 - 2.3)	0.02	1.1 (0.7 - 1.7)	0.68
White	33 (16.4)	168 (83.6)	201	1.8 (1.1 - 2.9)	0.02	1.2 (0.7 - 2.0)	0.61
Age Group							
≤45 years	59 (31.9)	126 (68.1)	185	Reference			
46 - 65 years	124 (19.1)	526 (80.9)	650	2.0 (1.4 - 2.9)	<0.001	2.2 (1.5 - 3.3)	<0.001
>65 years	35 (13.0)	234 (87.0)	269	3.1 (2.0 - 5.0)	<0.001	4.8 (2.8 - 8.2)	<0.001
Hypertension							
No	62 (19.1)	263 (80.9)	325	Reference			
Yes	156 (20.0)	623 (80.0)	779	0.9 (0.7 - 1.3)	0.718		Excluded‡
Diabetes							
No	119 (23.9)	379 (76.1)	498	Reference			
Yes	99 (16.3)	507 (83.7)	606	1.6 (1.2 - 2.2)	0.002	1.7 (1.2 - 2.4)	0.005
Dyslipidaemia							
No	15 (25.9)	43 (74.1)	58	Reference			
Yes	203 (19.4)	843 (80.6)	1 046	1.4 (0.8 - 2.7)	0.232	1.3 (0.7 - 2.7)	0.41
History of Smoking							
No	113 (28.1)	289 (71.9)	402	Reference			
Yes	105 (15.0)	597 (85.0)	702	2.2 (1.6 - 3.0)	<0.001	2.0 (1.4 - 3.1)	0.001
Previous MI							
No	184 (21.1)	687 (78.9)	871	Reference			
Yes	34 (14.6)	199 (85.4)	233	1.6 (1.1 - 2.3)	0.03	1.1 (0.7 - 1.8)	0.63
Family History of CAD							
No	115 (19.5)	476 (80.5)	591	Reference			
Yes	103 (20.1)	410 (79.9)	513	0.90 (0.7 - 1.3)	0.8		Excluded‡
Number of Risk Factors							
0 - 2	96 (27.8)	249 (72.2)	345	Reference			
≥3	122 (16.1)	637 (83.9)	759	2.0 (1.5 - 2.7)	<0.001	0.9 (0.6 - 1.5)	0.77
Atherogenic Dyslipidaemia							
No	161 (22.7)	549 (77.3)	710	Reference			
Yes	57 (14.5)	337 (85.5)	394	1.7 (1.2 - 2.4)	0.001	1.7 (1.2 - 2.4)	0.004

Note: This table shows all patients during the study period who underwent coronary angiography. All percentages add up horizontally to 100%.
No CAD [x]: if normal or non-occlusive coronary disease was identified at coronary angiography. CAD [y]: if any obstructive lesion was identified at coronary angiography.
Excluded‡: if p-value >0.5 under unadjusted column. OR: odds ratio, CI: confidence interval.

under the age of 40 years and the authors[11] suggested that the HIV / AIDS pandemic with shortened life expectancy probably explains the skew towards younger age at presentation.

While the current study shows a high prevalence of cardio-vascular risk factors in subjects with CAD across different ethnic groups, there were significant differences in the prevalence of diabetes, dyslipidaemia, family history of CAD, history of smoking and previous MI which could have accounted for differences in disease severity across ethnic groups.[52] A history of smoking was present in half the African subjects and in over two thirds of the other ethnic groups. This is much higher than

TABLE III: Association of risk factors to extent of disease (single vs. multivessel disease).

Variables	SVD 260 (%)	DVD/TVD 626 (%)	Total 886	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Gender							
Female	71 (26.6)	196 (73.4)	267	Reference			
Male	189 (30.5)	430 (69.5)	619	0.8 (0.6 - 1.1)	0.24	1.1 (0.8 - 1.6)	0.61
Ethnic Group							
African	73 (48.7)	77 (51.3)	150	Reference			
Coloureds	12 (41.4)	17 (58.6)	29	1.3 (0.6 - 3.0)	0.5	1.1 (0.5 - 2.7)	0.79
Indian	116 (21.5)	423 (78.5)	539	3.5 (2.4 - 5.1)	<0.001	2.6 (1.6 - 4.0)	<0.001
White	59 (35.1)	109 (64.9)	168	1.8 (1.1 - 2.7)	0.02	1.3 (0.8 - 2.2)	0.37
Age Group							
≤45 years	59 (46.8)	67 (53.2)	126	Reference			
46 - 65 years	168 (31.9)	358 (68.1)	526	1.9 (1.3 - 2.8)	0.002	1.6 (1.1 - 2.5)	0.024
>65 years	33 (14.1)	201 (85.9)	234	5.4 (3.2 - 8.9)	<0.001	4.1 (2.3 - 7.2)	<0.001
Hypertension							
No	113 (43.0)	150 (57.0)	263	Reference			
Yes	147 (23.6)	476 (76.4)	623	2.4 (1.8 - 3.3)	<0.001	2.1 (1.4 - 3.1)	0.002
Diabetes							
No	140 (36.9)	239 (63.1)	379	Reference			
Yes	120 (23.7)	387 (76.3)	507	1.9 (1.4 - 2.5)	<0.001	1.1 (0.8 - 1.7)	0.51
Dyslipidaemia							
No	15 (34.9)	28 (65.1)	43	Reference			
Yes	245 (29.1)	598 (70.9)	843	1.3 (0.7 - 2.5)	0.82		Excluded‡
History of Smoking							
No	76 (26.3)	213 (73.7)	289	Reference			
Yes	184 (30.8)	413 (69.2)	597	0.8 (0.6 - 1.1)	0.2	0.8 (0.5 - 1.3)	0.41
Previous MI							
No	232 (33.8)	455 (66.2)	687	Reference			
Yes	28 (14.1)	171 (85.9)	199	3.1 (2.0 - 4.8)	<0.001	2.1 (1.3 - 3.4)	0.002
Family History of CAD							
No	156 (32.8)	320 (67.2)	476	Reference			
Yes	104 (25.4)	306 (74.6)	410	1.43 (1.1 - 1.9)	0.02	1.1 (0.7 - 1.6)	0.64
Number of Risk Factors							
0 - 2	85 (34.1)	164 (65.9)	249	Reference			
≥3	175 (27.5)	462 (72.5)	637	1.4 (1.0 - 1.9)	0.051	1.2 (0.7 - 2.1)	0.52
Atherogenic Dyslipidaemia							
No	169 (30.8)	380 (69.2)	549	Reference			
Yes	91 (27.0)	246 (73.0)	337	1.2 (0.9 - 1.6)	0.23	1.1 (0.8 - 1.5)	0.60

Note: This table shows all subjects diagnosed with CAD at angiography. Angiographic findings were subdivided into two groups: single vessel disease (SVD) and multivessel disease (DVD and TVD). The varying patient numbers under each characteristic heading (second column) add up vertically to 260 for SVD, 626 for DVD/TVD (third column) and the total adds up to 886 (fourth column). All percentages add up horizontally to 100%.
Excluded‡: if p-value >0.5 under unadjusted column. OR: odds ratio, CI: confidence interval.
Diabetes: history of diabetes ***OR*** *self-reported use of anti-hyperglycaemic medication* ***OR*** *HbAc1 ≥6.5%, Dyslipidaemia: history of dyslipidaemia* ***OR*** *TC ≥5.17* ***OR*** *TG >1.7* ***OR*** *HDL-C ≤1.03 in males* ***OR*** *HDL-C ≤1.29 in females, Hypertension: history of hypertension* ***OR*** *self-reported use of anti-hypertensive medication* ***OR*** *BP ≥140/90 mmHg.*

that reported the Mozambican Africans (13,9%).[13] In contrast to studies showing a higher prevalence of hypertension among African subjects,[3,46,53,54] compared to other ethnic groups, in our study hypertension and diabetes was highly prevalent (70%) across all ethnic groups and predictive of multivessel disease. Compared to the INTERHEART studies[3,11] and other African studies,[27,41] the 2-fold higher prevalence of diabetes in Africans in our study, together with cigarette smoking, point to a rapidly

changing cardiovascular risk factor profile leading to the emergence of CAD, often premature, in this group.[27] Smoking compounded by the sheer stress from hypertension probably served as the trigger for plaque rupture and the premature development of acute cardiovascular events.[55]

Similarly, dyslipidaemia was present in 88% of our African subjects with CAD, quite different from the 10% prevalence reported among Africans in Mozambique 15 years ago.[13] The levels of HDL-cholesterol was similarly low across all ethnic groups, including the African subjects. The low HDL-C levels among the African subjects are very similar to the findings by Nethononda, et al.[10] and Sliwa, et al.[15] among Africans in Soweto, which, coupled with the high prevalence of diabetes in this group may explain the loss of the presumed protective role afforded by higher HDL-C levels against CAD that has been proposed in early studies.[11,15,56,57]

In keeping with previous studies,[25,27,38,44,47,48] STEMI was the most frequent diagnosis at admission. Two thirds of Africans presented with STEMI (about half of the Indian and White subjects), almost all of whom had a first time presentation with myocardial infarction since they had no history of previous MI. Furthermore, we found a positive family history of CAD in under 10% of African subjects with CAD, similar to reports from Cameroon[31] (2.78%) and Kenya[28] (8%). These findings point to recent environmental influences in the last generation that have led to the emergence of CAD among Africans and may explain why triple-vessel disease was least common among Africans, who had more single-vessel disease compared to the other ethnic groups. This pattern is similar to reports from sub-Saharan Africa,[13,31] and is thought to reflect the lower atherogenic burden amongst Africans who had lower levels of smoking, elevated LDL-C and atherogenic dyslipidemia, as well as a lower prevalence of cardiovascular risk factor clustering compared to the other ethnic groups in our study.

Consistent with previous studies[3,5,31,52] multivariable analysis identified male gender, age, diabetes, smoking, and atherogenic dyslipidaemia as independent predictors of CAD in our study. Of note, Table II shows that the unadjusted higher risk of CAD in Indians and Whites compared to the Africans fell away after adjusting for risk factors in the multivariable analysis. With the exception of the family history, the data show that the risk profile of the African group shows characteristics of people who are past the early stages of the epidemiological transition, not dissimilar to the other ethnic groups in our cohort. Age, hypertension, previous MI, and Indian ethnicity were associated with multivessel CAD.[57] Our study confirms the findings of the INTERHEART study and also suggests that variations in risk factor prevalence explains the differences in disease severity across ethnic groups.[11]

LIMITATIONS

Our study had several limitations due to its retrospective nature, affecting the quality and completeness of data collection. Certain factors raise into question the generalisability of the findings. Firstly, the study was conducted at a single urban public referral hospital, so that the sample was limited to subjects from the lower income groups attending state hospitals, and did not include subjects in the private sector. This may also have resulted in subjects with a high risk factor profile being selected out (referral bias). Secondly, we could not determine the true prevalence of the metabolic syndrome across ethnic groups because datasets were not complete for waist circumference and fasting plasma glucose; nor did we analyse clinical characteristics and outcomes of those with CAD. Thirdly, angiographic analysis was limited to the epicardial vessels with obstructive lesions and did not include an estimate of the severity of stenoses using a scoring system. However, a strength of our sample was that it included subjects who underwent both nuclear scans and angiography in order to detect subjects with angiographic stenoses and functional ischaemia. The study sample represents an important segment of the population of subjects with chest pain that has not been adequately studied, and addresses a gap in our knowledge about the relationships between risk factors and CAD among ethnically diverse subjects.

CONCLUSION

This study reaffirms previous reports showing a high prevalence of cardiovascular risk factors in subjects with CAD in KwaZulu-Natal.[11,27,47,48] Across ethnic groups the predictors of CAD were to a large extent, modifiable risk factors, emphasising the importance of these parameters as targets for secondary prevention.[42] While our findings show a lower atherogenic burden amongst the Africans compared to the other ethnic groups, their lipid and glycaemic risk factor profiles clearly show marked changes compared to early studies at the turn of the century. This, together with the near absence of a family history of MI, confirm that environmental influences and lifestyle changes have contributed to emergence of CAD at a younger age in African men and women compared to the other ethnic groups.[21] The observations indicate the need for urgent population interventions to reduce the impact of chronic diseases of lifestyle, which should include intensive educational primary prevention measures at school-going age.

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