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CLINICAL RESEARCH

Distribution of coronary artery disease severity and risk factors in Afro-Caribbeans

Association entre facteurs de risque cardiovasculaire et sévérité des lésions coronaires chez les sujets afro-caribéens

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Summary
Background. — Traditional risk factors are strong predictors of the incidence of coronary artery disease (CAD), but their association with disease severity remains controversial and could differ across ethnic groups.
Aims. — In this study, we assessed the prevalence of cardiovascular risk factors (CRFs) in Afro-Caribbean patients with documented CAD, and sought to identify which of these factors are related to disease severity.
Methods. — We retrospectively studied 420 consecutive patients with CAD. Disease severity was determined from the results of invasive coronary angiography, based on the presence or absence of multiple (two or three) diseased vessels and the myocardial jeopardy (MJ) score.
Results. — In the studied population (mean age 64.7 ± 12.4 years), hypertension, diabetes and dyslipidaemia were the most frequent modifiable CRFs, present in 75.9, 47.8 and 37.8% of patients, respectively. Multiple logistic regression analysis showed that diabetes, male sex and

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Abbreviations: CAD, coronary artery disease; CI, confidence interval; CRF, cardiovascular risk factor; BMI, body mass index; MJ, myocardial jeopardy; OR, odds ratio.
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personal cardiovascular history significantly increased the risk of multivessel CAD: odds ratios (ORs) of 1.53 (1.01−2.33; $P = 0.048$), 1.61 (1.02−2.55; $P = 0.043$) and 1.68 (1.11−2.56; $P = 0.015$), respectively. Obesity was an independent negative predictor, with an OR of 0.48 (0.29−0.79; $P = 0.004$). Other traditional CRFs (hypertension, dyslipidaemia, smoking, age and family history of vascular disease) were not associated with CAD severity. For high-risk lesions (MJ score ≥ 8), both diabetes and hypertension were independent predictors of disease severity, whereas obesity was no longer a protective factor.

Conclusion. — Diabetes emerged as the strongest modifiable risk factor predictor of multivessel disease in Afro-Caribbean patients, whereas obesity was an independent protective factor. The underlying mechanisms of these associations should be relevant to disease prevention.

Résumé
Contexte. — Les facteurs de risque cardiovasculaire (FDRCV) classiques sont de puissants prédicteurs d'une coronaropathie mais leur lien avec la sévérité des lésions coronaires est controversé et pourrait varier selon les groupes ethniques.
Objectifs. — Évaluer la prévalence des FDRCV chez des sujets afro-caribéens et rechercher les facteurs associés à la sévérité des lésions coronaires.
Méthodes. — Nous avons analysé rétrospectivement 420 dossiers consécutifs de patients coronariens. La sévérité des lésions a été appréciée à la coronarographie selon l'existence ou non de lésions pluritronculaires (2 ou 3 vaisseaux atteints) et selon un score de risque myocardique (*myocardial jeopardy score*).
Résultats. — Dans la population étudiée (d'âge moyen $64,7 \pm 12,4$ ans), l'hypertension, le diabète et une dyslipidémie étaient les FDRCV modifiables les plus fréquemment observés avec une prévalence respective de 75,9, 47,8 et 37,8 %. Dans l'analyse de régression logistique multivariée seuls le diabète, le sexe masculin et les antécédents coronariens étaient prédictifs de lésions pluritronculaires avec des *odds ratio* (OR) de 1,53 (1,01−2,33 ; $p = 0,048$), 1,61 (1,02−2,55 ; $p = 0,043$) et 1,68 (1,11−2,56 ; $p = 0,015$), respectivement. L'obésité était un facteur prédictif négatif avec un OR de 0,48 (0,29−0,79 ; $p = 0,004$). En considérant les lésions coronaires à haut risque (score de risque myocardique ≥ 8), seuls le diabète et l'hypertension étaient des facteurs prédictifs indépendants de sévérité.
Conclusion. — Le diabète est apparu comme le facteur de risque modifiable le plus fortement lié aux lésions pluritronculaires chez les sujets afro-caribéens alors que l'obésité était un facteur protecteur indépendant. La connaissance des mécanismes sous-jacents à ces associations revêt un intérêt majeur pour la prévention des coronaropathies.

Background

Among cardiovascular diseases, coronary artery disease (CAD) is one of the leading causes of mortality and morbidity. The association between conventional risk factors (such as advanced age, male sex, family history of CAD, hypertension, dyslipidaemia, diabetes, smoking and obesity) and the presence of CAD and adverse clinical events is universal and well established [1,2]. However, the correlation between these risk factors and the severity of coronary atherosclerosis, assessed by angiography, is less consistent, with studies reporting conflicting results [3−10]. Several studies have also suggested that the distribution and relative effects of risk factors, as well as disease presentation and prognosis, may differ across ethnic groups [11−15].

The Guadeloupian population comprises about 80% Afro-Caribbeans, 10% Indians, 5% Caucasians and 5% other ethnic groups. Cardiovascular diseases are responsible for one third of all deaths in Guadeloupe, where a high prevalence of cardiovascular risk factors (CRFs) has been described in the population, including hypertension, diabetes and obesity [16−19]. However, very few data are available about the distribution of CRFs in patients with CAD in this population, and their impact on the severity of the disease has never been evaluated.

Therefore, the aims of our study were to investigate the prevalence of CRFs in Afro-Caribbean patients with documented CAD, and to determine which of these factors are associated with the extent of atherosclerosis, assessed by coronary angiography.

Methods

Study population

We reviewed the medical records of 543 consecutive Afro-Caribbean patients who had undergone coronary

Table 1 Characteristics of patients and logistic regression for multivessel coronary artery disease.

	All (n = 420)	Two- or three-vessel disease			Multivariable logistic regression		
		Yes (n = 222)	No (n = 198)	P	Odds ratio	95 % CI	P
Age (years)	64.7 ± 12.4	65.2 ± 12.0	64.2 ± 12.8	0.42	—	—	—
Male sex	284 (67.8)	159 (71.6)	125 (63.1)	0.07	1.61	(1.02—2.55)	0.043
Obesity	89 (21.5)	35 (15.8)	54 (28.0)	0.003	0.48	(0.29—0.79)	0.004
Hypertension	318 (75.9)	169 (76.1)	149 (75.6)	0.90	—	—	—
Diabetes	200 (47.8)	116 (52.5)	84 (42.6)	0.04	1.53	(1.01—2.33)	0.048
Dyslipidaemia	158 (37.8)	84 (38.0)	74 (37.6)	0.93	—	—	—
Smoking	52 (14.2)	28 (14.2)	24 (14.3)	0.98	—	—	—
Personal cardiovascular history	170 (40.5)	104 (46.8)	66 (33.3)	0.005	1.68	(1.11—2.56)	0.015
Family cardiovascular history	35 (8.5)	16 (7.3)	19 (9.8)	0.37	—	—	—

Data are mean ± standard deviation or number (%). CI: confidence interval.

angiography for suspected CAD between January 2009 and May 2012 at the University Hospital of Pointe-à-Pitre. The medical records were standardized and were in the form of a detailed questionnaire on risk factors that makes it possible to distinguish missing data from absence of a given factor. The same paper form was used for all patients. Based on the coronary angiography results, 81 patients with normal coronarography were excluded, as were 42 patients with incomplete data on major CRFs.

Area of investigation

Guadeloupe is a 1628 km^2 island situated in the eastern Caribbean; it is a French overseas department of approximately 402,000 inhabitants, with wide availability of health services and easy access to hospital. The University Hospital of Pointe-à-Pitre is the only coronarography centre on the island.

Sociodemographic and clinical data, including age, sex, weight, height, history of hypertension, diabetes, dyslipidaemia, current smoking status, previous cardiovascular disease and family history of early atherosclerotic CAD, were collected. Body mass index (BMI) was calculated as weight/height^2 (kg/m^2). Obesity was defined as BMI ≥ 30 kg/m^2.

Afro-Caribbean ethnic origin was determined when the patient defined him/herself and his/her first-degree relative as Afro-Caribbean. The final study population consisted of 420 patients.

Coronary angiography

Selective coronary angiographies were performed with the Judkins technique, using a femoral or radial approach. At least four positions on the left coronary artery and two positions on the right coronary artery were considered.

Significant vessel disease was defined as ≥ 50% narrowing of the diameter of at least one major (≥ 2.5 mm diameter) epicardial vessel. The vessel diameter and degree of lumen narrowing were calculated by quantitative coronary angiography. All images were calibrated to the lumen

of a guide catheter (5—6 F). CAD severity was measured as: the presence of multiple (two or three) diseased vessels; or one diseased vessel or insignificant stenosis. For a more precise measure of the lesion burden and its potential functional and prognostic impacts, we used the myocardial jeopardy (MJ) score system described by Dash et al., which is a validated tool with which to estimate the amount of myocardium at ischaemic risk [20,21]. For this score, the coronary arterial circulation is considered to involve six-vessel segments: left anterior descending artery, diagonal branches, septal branches, circumflex coronary artery, obtuse marginal branches and posterior descending artery. Each vessel involved directly or indirectly in a lesion (>70% diameter narrowing) proximal to its origin is assigned 2 points. Thus, in our study population, this score ranged from 0 to 12, based on the number of segments involved. Patients with a previous coronary artery bypass were excluded from the evaluation of the MJ score because this method has not been validated in these patients.

Statistical analysis

Quantitative data are presented as means ± standard deviations and qualitative data as numbers (percentages). For comparisons, the patients were categorized into two groups according to the presence of none or one diseased vessels or multiple (two or three) diseased vessels.

The distributions of the data were tested for normality to determine the use of parametric or non-parametric tests. For univariate analyses, differences in the means were detected using Student's or the Wilcoxon test, as appropriate, and differences in proportions with the χ^2 test.

We used logistic regression analysis to study the associations between CRFs and the severity of CAD as the dependent variable. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. The risk factors studied were age, sex, obesity, hypertension, diabetes, dyslipidaemia, family cardiovascular history and personal cardiovascular history. Adjustments were made by age and all the significant covariates at the level of P < 0.2 in the univariate analysis. A multiple logistic regression was also performed for high MJ

Table 2 Distribution of patients according to multivessel coronary artery disease and the myocardial jeopardy score.

Multivessel disease (n = 420)	
Three diseased vessels	97 (23.1)
Two diseased vessels	125 (29.8)
One diseased vessel	176 (41.9)
Non-significant stenosis	22 (5.2)
Myocardial jeopardy score (n = 395)	
0	23 (5.8)
2	85 (21.5)
4	86 (21.8)
6	83 (21.0)
8	47 (11.9)
10	47 (11.9)
12	24 (6.1)

Data are number (%).

scores (defined as a score value higher than the 75th percentile).

IBM SPSS Statistics software, version 19, was used for the data analysis. All tests were two-sided and a P-value <0.05 was deemed to be statistically significant.

Results

In all, 420 patients were included in the study. These patients, who had undergone pathological coronarography, were mainly men (67.8%) and had a mean age of 64.7 ± 12.4 years. The characteristics of the patients are presented in Table 1.

Isolated non-significant stenoses (<50% luminal narrowing) were found in 22 (5.2%) patients, one-vessel CAD in 176 (41.9%) patients, two-vessel CAD in 125 (29.8%) patients and three-vessel CAD in 97 (23.1%) patients (Table 2). The mean MJ score was 5.6 ± 3.4 and was higher in patients with multivessel disease than in the others (7.8 ± 2.7 versus 3.2 ± 2.3, respectively; $P < 0.001$). The MJ score was ≥ 8 (corresponding to the 75th percentile) in 118 patients. Comparison of the groups showed that multivessel CAD lesions were significantly associated with obesity, diabetes and personal cardiovascular history. Diabetes was more frequent in patients with multivessel CAD than in patients with one-vessel CAD or non-significant disease (52.5% versus 42.6%, respectively; $P = 0.04$). Conversely, obesity was less frequent in patients with multivessel CAD (15.8% versus 28.0%, respectively; $P = 0.003$; Table 1).

There were no significant differences between obese patients and non-obese patients in their mean ages (65.5 years versus 64.4 years, respectively; $P = 0.46$), frequency of smoking or personal or family cardiovascular histories. Obese patients were less frequently male than non-obese patients (56.2% versus 70.7%, respectively; $P = 0.010$), more frequently displayed hypertension (84.3% versus 73.1%, respectively; $P = 0.031$), diabetes (58.4% versus 41.6%, respectively; $P = 0.027$), and dyslipidaemia (48.9% versus

34.6%, respectively; $P = 0.014$) and had a lower mean MJ score (4.9 versus 5.9, respectively; $P = 0.014$) (Table 3).

After subdivision of the population into four groups according to BMI, we noted a significant and inverse linear relationship between BMI and frequencies of multivessel CAD, with 60% for BMI <25 kg/m^2, 54% for BMI 25—29.9 kg/m^2, 41% for BMI 30—34.9 kg/m^2 and 33% for BMI $\geq$35 kg/m^2 ($P = 0.002$) (data not shown).

A logistic regression, including sex, obesity, diabetes and personal cardiovascular history as independent variables, showed that diabetes, male sex and a personal cardiovascular history significantly increased the risk of multivessel damage by 1.53 (1.01—2.33; $P = 0.048$), 1.61 (1.02—2.55; $P = 0.043$) and 1.68 (1.11—2.56; $P = 0.015$), respectively. Obesity was an independent protective factor, with an OR of 0.48 (0.29—0.78; $P = 0.004$; Table 1).

The results of the logistic regression for a high MJ score indicated that diabetes and hypertension were independently associated with the most severe CAD lesions, with ORs of 1.63 (1.08—2.46; $p = 0.02$) and 2.26 (1.09—4.67; $p = 0.03$), respectively (Table 4).

Discussion

In this study, we evaluated the association between CRFs and the severity of CAD in an Afro-Caribbean population referred for coronary angiography. We found that diabetes, obesity, male sex and a personal cardiovascular history were significantly associated with extensive coronary lesions. Compared with non-diabetic patients, diabetic patients more frequently had multivessel disease and had a higher burden of lesions, attested by high MJ scores, which confers a worse prognostic value [20]. This association persisted after adjustment was made for other risk factors. In contrast, obesity was a negative and independent predictor of multivessel disease. Other traditional risk factors (hypertension, dyslipidaemia, smoking, age and family history of vascular disease) were not associated with the angiographic severity of CAD.

Our findings are consistent with those of a previous study by Veeranna et al., who reported that diabetes mellitus was the only predictor of CAD burden in an elderly population (631 patients, mean age 73 years) in the USA [22]. The importance of diabetes as a risk factor for the progression of angiographic CAD has been noted in former studies [23—25]. Numerous metabolic, vascular and coagulation abnormalities may contribute to the high prevalence and severity of CAD among diabetic patients [26]. Some authors have reported that even impaired glucose tolerance and an impaired fasting glucose status are independently associated with the extent of CAD [27—29].

Age, smoking and a history of dyslipidaemia were not significantly associated with the most severe CAD. A low frequency of smokers (14%) was noted in this sample of CAD patients. However, this frequency is similar to that previously reported in the general population (15%) and in patients with hypertension [17,18]. Smoking was not associated with the presence of severe CAD.

Our results strengthen the notion that traditional risk factors for the prevalence of CAD and its outcomes may not have the same value in predicting the severity of angiographic lesions or the progression of the disease. In fact,

Table 3 Comparison between obese and non-obese patients.

	Obese (BMI >30 kg/m^2)		P
	Yes (n = 89)	No (n = 325)	
Age (year)	65.5 ± 11.8	64.4 ± 12.6	0.461
Male sex	50 (56.2)	229 (70.7)	0.010
Hypertension	75 (84.3)	237 (73.1)	0.031
Diabetes	52 (58.4)	37 (41.6)	0.027
Dyslipidaemia	43 (48.9)	112 (34.6)	0.014
Smoking	7 (8.8)	45 (16.1)	0.100
Personal cardiovascular history	33 (37.1)	134 (41.2)	0.479
Familial cardiovascular history	6 (6.8)	28 (8.8)	0.556
Myocardial jeopardy score	4.9 ± 3.4	5.9 ± 3.3	0.014

Data are mean ± standard deviation or number (%). BMI: body mass index.

several studies have reported inconsistent results for this question: some authors have found that most of the traditional factors are also good predictors of the severity of angiographic CAD [7,10,30], whereas others have found that only few of these factors are effective predictors of CAD severity [3,5,6,8,23,25]. Differences in study designs and ethnic characteristics may explain these conflicting results.

The present study included 420 patients referred to the only coronarography unit of Guadeloupe, a French overseas island territory with widely available and accessible health services. Therefore, we can hypothesize that our population is representative of the whole population of CAD. Many studies have reported ethnic differences in the prevalence of CRFs and their relative impacts on CAD [3,31]. It has also been demonstrated that the prevalence of CAD, its presentation and prognosis may differ across ethnic groups [13,15]. Standardized mortality from ischaemic heart disease has been found to be significantly lower (by up to 60%) in Afro-Caribbeans born in England than in other ethnic groups [12,13], whereas a high prevalence of diabetes is reported in this population [32]. Moreover, the authors of the United Kingdom Prospective Diabetes Study 32 reported that diabetic patients of Afro-Caribbean origin had a lower risk (0.4, 95% CI 0.2—0.9) of myocardial infarction than diabetic white or South Asian patients [11]. This finding may appear inconsistent with the fact that in our study, diabetes emerged as the strongest modifiable risk factor positively associated with severe and diffuse angiographic lesions in Afro-Caribbean patients. However, the severity of angiographic lesions is not the only variable related to clinical cardiac events, and other conditions, such as coagulation factors and plaque stability, must be considered. Comparative angiographic data from other ethnic groups are required to further this discussion.

The second major finding of this study was that obese patients with CAD less frequently had multivessel lesions, so obesity appeared to be an independent protective factor against severe CAD in Afro-Caribbean patients. This paradoxical association has also been reported by Rubinshtein et al. in 928 patients from Israel [33] and by Niraj et al. in 770 patients from the USA, including 428 African-Americans and 212 Caucasians [34]. In both studies, the obese patients were significantly younger than the non-obese patients, leading to the conclusion that this association could be partly or completely explained by the greater likelihood that physicians will refer obese patients for coronarography and therefore

Table 4 Characteristics of patients and logistic regression for the myocardial jeopardy score.

	All (n = 395)	MJ score			Multivariable logistic regression		
		MJ ≥8 (n = 118)	MJ <8 (n = 277)	P	Odds ratio	95% CI	P
Age (years)	64.4 ± 12.6	66.6 ± 11.7	63.6 ± 12.7	0.026	1.01	(0.99—1.03)	0.21
Male sex	128 (32.5)	42 (35.6)	86 (31.2)	0.39	—	—	—
Obesity	84 (21.6)	22 (18.6)	62 (22.9)	0.35	—	—	—
Hypertension	299 (75.9)	101 (85.6)	198 (71.7)	0.003	2.26	(1.09—4.67)	0.028
Diabetes	186 (47.3)	71 (60.2)	115 (41.8)	0.01	1.63	(1.08—2.46)	0.020
Dyslipidaemia	150 (38.2)	50 (42.7)	100 (36.2)	0.22	—	—	—
Smoking	51 (14.9)	11 (10.9)	40 (16.4)	0.18	1.21	(0.54—2.70)	0.64
Personal cardiovascular history	145 (36.7)	53 (44.9)	92 (33.2)	0.03	1.23	(0.75—2.01)	0.41
Family cardiovascular history	32 (8.2)	7 (6)	25 (9.2)	0.37	—	—	—

Data are mean ± standard deviation or number (%). CI: confidence interval; MJ: myocardial jeopardy.

at an earlier stage of CAD. In our study, we found no difference in the mean ages of the obese and non-obese patients. This new finding confirms and emphasizes the results of another study by Afonso et al., who found an independent inverse relationship between BMI and angiographic severity, assessed by the MJ score, only in the subgroup of African-American women [35].

When an MJ score threshold of 8 was used, diabetes was still a high-risk factor for severe lesions, but a highly significant association with hypertension was also found, whereas obesity was no longer a protective factor. The prognostic value of the MJ score has been demonstrated. In a study by Califf et al., the authors found an association between the MJ score and 5-year survival. The 5-year survival was 97% in patients with an MJ score of 2 and 95, 85, 78, 75 and 56% for patients with MJ scores of 4, 6, 8, 10 and 12, respectively [20]. Furthermore, the prognostic value of the MJ score was superior to that of the number of diseased vessels. Thus, patients with an MJ score ≥ 8 (corresponding to the 75th percentile) represent a different and more selective anatomically high-risk population (118 patients) than the multivessel CAD population (222 patients), leading to a different relationship between the risk factors and CAD severity. This observation highlights the fact that the relative impact of traditional risk factors on CAD severity may vary, depending on the population selected and the criteria evaluated. This should be taken into consideration when comparing the results of different studies.

Study limitations

The first limitation of our study was its retrospective nature. Second, the risk factors were recorded based solely on the medical records because the biological values were not always available. Therefore, we cannot exclude the possibility that the role of dyslipidaemia was underestimated. However, it is difficult to analyse the effects of blood lipid variables because many patients, especially those with diabetes or with multiple risk factors, are receiving treatment with statin agents, regardless of their cholesterol levels. Moreover, lesion extent was assessed by selective coronary angiography, which predominantly supplies information on the arterial lumen and not directly on the vessel wall or plaque volume, which can be better evaluated with ultrasound.

Nevertheless, to the best of our knowledge, an angiographic evaluation of CAD severity and the impact of risk factors in Afro-Caribbeans have not previously been reported, and the association found in our representative population is highly significant.

Conclusion

Diabetes emerged as the strongest independent risk factor positively associated with lesion severity in an Afro-Caribbean population referred for coronarography. Conversely, obesity — paradoxically — appeared to be a protective factor against multivessel CAD. For the most severely anatomically high-risk patients, both diabetes and hypertension were independent predictors of disease severity, whereas obesity was no longer a protective factor. This study provides new information about the distribution of conventional risk factors and their association with the extent of CAD in this population, in which the high prevalence of diabetes, obesity and hypertension constitutes a major public health challenge. The underlying mechanisms of these associations require further investigation and could be relevant to the prevention of CAD and the management of its risk factors in all populations.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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