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DIABETES

A new tool, a better tool? Prevalence and performance of the International Diabetes Federation and the National Cholesterol Education Program criteria for metabolic syndrome in different ethnic groups

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Abstract We used a population based study in the Netherlands of 330 Hindustani Surinamese, 586 African Surinamese, and 486 ethnic Dutch (Dutch) to describe the prevalence of the metabolic syndrome (MS) and the association with differences in cardiovascular disease in and between ethnic groups. Fasting blood samples, blood pressure, and anthropometric measurements were obtained. MS was defined according to the criteria of the International Diabetes Federation (IDF) and the criteria of the National Cholesterol Education Program (NCEP). Cardiovascular disease was assessed by the Rose questionnaire and included questions on previous diagnoses of angina pectoris/myocardial infarction, cerebrovascular accident, intermittent claudication. The prevalence of MS (IDF and NCEP) was highest in Hindustani Surinamese men, followed by Dutch and African Surinamese men: 51.0%, 19.4%, and 31.2% (IDF), respectively. Among women, both the Hindustani and African Surinamese participants had a higher prevalence of MS (IDF and NCEP) than the Dutch. The association between the components, MS and cardiovascular disease differed between ethnic groups, in particular among men; OR for MS (NCEP) = 1.0 (0.4–2.7) among Hindustani Surinamese, OR = 4.9 (1.3–18.3) among African Surinamese, and OR = 2.8 (1.1–7.1) among Dutch. However, the differences in MS could not account for the ethnic differences in cardiovascular disease, regardless of the criteria used. The results suggest that, before the criteria can be used to guide practice, they may need to be changed and refined to take into account the differences between ethnic groups as well as the variations by gender.

Keywords Ehnicity · Metabolic syndrome · Cardiovascular disease

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Introduction

Metabolic syndrome (MS) is characterized by impaired glucose tolerance, central obesity, hypertension and dyslipidemia [1]. Persons with metabolic syndrome are at high risk of developing diabetes mellitus and cardiovascular disease (CVD) [2–3]. Compared with people without the syndrome, people with MS are three times as likely to have a cardiovascular event and twice as likely to die from CVD [4].

In European origin populations, the prevalence of MS is estimated to be 20–25% [5]. However, there is evidence that the prevalence of MS may be higher in other ethnic groups. Some studies have reported a higher prevalence among South Asian and African populations, whereas others did not find an increased prevalence in these groups as compared to European populations [6, 7]. The results have been shown to be dependent on the criteria used to identify MS [7].

Most of these previous studies have either used the criteria set by the National Cholesterol Education Program (NCEP) or the criteria set by the World Health

Organisation (WHO) [8, 9]. However, the problem with use of these criteria is that these have been developed and tested mainly in populations of (white) European descent [4, 10–15]. Little attention has been paid to adjustment of the criteria to groups of other ethnicity or descent. In 2005, the International Diabetes Federation (IDF) developed a new set of criteria which, besides providing a more practice-oriented definition of MS, aimed to incorporate ethnicity specific modifications in order to improve the sensitivity in those populations [16]. More specifically, the IDF criteria take into account a lower cut-off value for central obesity with an ethnicity specific adjustment for South Asians. In addition, the criteria set a lower cut-off value for the fasting plasma glucose and include patients who are receiving (effective) treatments for previously diagnosed events.

We aimed, firstly, to describe the prevalence of MS among Hindustani Surinamese, African Surinamese, and ethnic Dutch (Dutch) according to the NCEP criteria and the newer criteria recommended by the IDF, and to assess the effect of the adjustment of the cut-off values for the different components on the reported prevalence within the ethnic groups.

Secondly, we wished to investigate whether the ethnicity specific IDF criteria better identified persons at high risk for CVD in the different ethnic groups than the previous criteria set by the NCEP. In addition, we determined whether differences in the occurrence of CVD between Hindustani Surinamese, African Surinamese, and Dutch could be accounted for by differences in the prevalence of MS.

Subjects and methods

Study population

The study population consisted of participants in the SUNSET study (Surinamese in the Netherlands: Study on health and Ethnicity) [17, 18]. In 1975, almost half the population of the former Dutch colony Surinam migrated to the Netherlands. Approximately 80% of these Surinamese immigrants in the Netherlands are African Surinamese ("Creoles", a mix of African, European, and other ethnic groups) or Hindustani Surinamese (South Asian, originally from the Indian sub-continent). SUNSET is based on a random sample of 2,975 individuals, aged 35–60 years, drawn from the Amsterdam population register (Fig. 1). For the sampling procedure we selected all persons who were born in the Netherlands and whose parents were both born in the Netherlands, persons of whom both parents were born in Surinam, and persons who were born in Surinam and who had at least one parent who was born in Surinam.

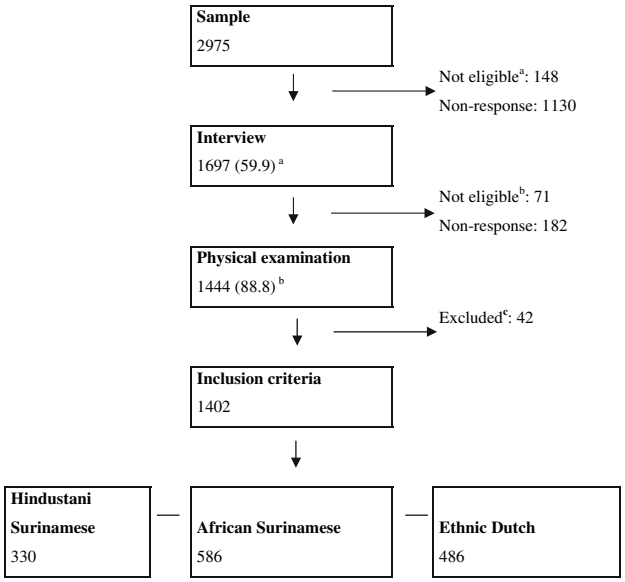

Fig. 1 Flow chart of the inclusion into the study. [a]Persons who had moved were deceased or could not be reached at the registered address were not considered as potential participants. [b]Only persons of Hindustani Surinamese, African Surinamese, and ethnic Dutch origin were invited for the physical examination (n = 1,626). Surinamese participants in the interview who originated from Java or China and persons with missing ethnicity were excluded (n = 71). [c]Persons without a fasting plasma glucose, HDL-cholesterol, or triglyceride value, waist circumference measurement or systolic and diastolic blood pressure reading were excluded (n = 42)

Interview and medical examination

Between 2001 and 2003, all persons in the sample were approached for a structured interview by interviewers who had been matched by sex and presumed ethnicity, based on name-analysis. The interview contained questions on lifestyle, migration history, demographic variables, and general health status. In addition, CVD was assessed by the Rose questionnaire (including questions on previous diagnoses of angina pectoris/myocardial infarction, cerebrovascular accident, intermittent claudication) [19]. Finally, ethnicity was determined based on self-report. If information on the self-reported ethnicity of the individual was lacking, information on the mother, father and mother's ancestors was used to classify participants.

Participants of Hindustani Surinamese, African Surinamese, or Dutch origin were also invited for a medical examination at a local health care center. During the examination, the following characteristics were recorded by trained study physicians: weight in light clothing on an electronic scale to the nearest 200 g and height by wall tape measure to the nearest 0.01 m. Waist circumference midway between the lower rib margin and the iliac crest and hip circumference at the maximum point over the greater trochanters were determined to the nearest 0.01 m

by tape measure. Blood pressure and resting heart rate measurements were obtained from each subject's arm at heart level using an OMRON-M4 semi-automatic sphygmomanometer with an appropriate-sized cuff, after the subjects had emptied their bladder and had been seated for at least 5 min. All anthropometric measurements were obtained twice and the means, rounded off to the nearest integer, were used for analysis. Fasting glucose, high density lipoprotein cholesterol (HDL), and triglyceride levels were determined in serum samples obtained at the time of the medical examination.

The study was approved by the Institutional Review Board of the Academic Medical Centre of the University of Amsterdam. All participants provided a written informed consent.

Response rates, inclusion, and exclusion criteria

The overall response to the interview was 60% (Fig. 1). Participation rates were higher among women than among men. In addition, participants in the interview were more likely than non-participants to be married and living with a partner and/or children, have a higher age at recruitment, have a higher income, and live in a less urban area (address density of 1,500–2,500 addresses/km^2 vs. $\geq$2,500). However, absolute and relative differences between participants and non-participants in these characteristics were small and reported trends were similar across ethnic groups (data not shown). The response to the invitation for the medical examination was 89%.

In the present analysis, we included participants who had participated in both the interview and the medical examination. Of all participants, 71 were excluded due to missing information on self-reported ethnicity. In addition, 182 persons were excluded because they had not undergone a physical exam and 42 persons because of missing measurements for the MS components, leaving 1,402 participants in the study, divided into 330 Hindustani Surinamese, 586 African Surinamese and 486 Dutch (Fig. 1).

Statistical analyses

Participants in different ethnic groups were described by presenting characteristics as means (standard deviation: SD) or proportions (95%-confidence interval: 95%-CI). Multivariate logistic regression analysis was performed in each ethnic group with CVD (yes/no) as the dependent variable and MS (NCEP and IDF criteria: yes/no) as the main independent variable. These analyses were stratified by sex and adjusted for age and smoking (currently yes/no). Interaction terms between were taken into consideration, but only those interaction terms that significantly improved the model ($P \leq 0.05$) were included. Finally, the effect of MS and components of MS on the ethnic differences in CVD were studied by means of logistic regression analyses, adjusted for age and smoking. All analyses were performed using SAS, version 9.1 (Cary, NC).

Results

The characteristics of the study population are shown in Table 1. Hindustani Surinamese and African Surinamese men and women were younger and tended to be congregated at the lower end of the socio-economic structure compared to Dutch men and women. Surinamese men more often smoked than Dutch men, while Surinamese women smoked less frequently than Dutch women. Furthermore, among women, but not men, Hindustani and African Surinamese were less physically active and had a higher mean BMI than the Dutch. Finally, we found a higher prevalence of CVD among Hindustani Surinamese men (15.2%) compared to Dutch men (9.4%), while the prevalence of CVD among African Surinamese men (6.3%) was lower. Among women, both the Hindustani Surinamese and African Surinamese had a higher prevalence of CVD than the Dutch; 15.7%, 10.6%, and 7.4%, respectively.

Table 2 shows the prevalence of MS. In all ethnic groups, the prevalence of MS as defined by the IDF criteria was higher than the prevalence as defined by the NCEP criteria. According to both criteria, Hindustani Surinamese men and women had a higher prevalence of MS (IDF: 51.0% among men and 49.7% among women, NCEP: 33.8% among men and 41.6% among women) than Dutch men and women. In addition, we found a higher prevalence of MS among the African Surinamese women than among the Dutch women. In contrast, the prevalence of MS was lower among African Surinamese men than among Dutch men (IDF: 19.4 vs. 31.2%).

In all ethnic groups, the IDF criteria classified a higher proportion of persons as having central obesity and an elevated fasting plasma glucose than the NCEP criteria, but differences with regard to the other components were smaller (Table 2). For both definitions, the distribution of the components of MS varied across ethnic groups. Hindustani Surinamese had the highest frequency of raised fasting plasma glucose, often accompanied by dyslipidemia (low HDL-cholesterol and high triglycerides) and/or raised blood pressure (Table 2). High triglycerides were also frequently found in Dutch, but not in African Surinamese. African Surinamese women often had central obesity together with an elevated blood pressure, whereas among African Surinamese men central obesity was less prevalent.

Table 1 Characteristics of 35–60 years old men and women of Hindustani Surinamese (n = 330), African Surinamese (n = 586), and ethnic Dutch (n = 486) descent

	Hindustani Surinamese Mean (SD) or N (%)		African Surinamese Mean (SD) or N (%)		Ethnic Dutch Mean (SD) or N (%)	
	Men	Women	Men	Women	Men	Women
Age (mean, in years)	44.5 (6.7)	45.1 (6.6)	44.0 (6.2)	43.5 (5.8)	48.0 (6.7)*	47.6 (7.0)*
Level of education (higher vocational or more)	17 (11.7)	23 (12.4)	17 (17.8)	88 (22.3)	104 (42.6)*	77 (31.8)*
Grade of employment (routine non-manual employees or higher)	46 (34.6)	95 (59.4)	93 (54.1)	270 (77.6)	156 (64.5)*	157 (66.2)*
Current smoking (yes)	77 (53.1)	41 (22.5)	109 (57.7)	120 (30.9)	110 (45.5)*	106 (43.8)*
Physical activity (30 min 5× per week or more)[a]	86 (63.2)	78 (43.8)	99 (57.2)	212 (55.6)	161 (66.5)	145 (59.9)*
Body mass index (mean, in kg/m^2)	26.4 (5.0)	27.8 (5.3)	26.3 (4.3)	29.4 (5.5)	26.3 (4.4)	26.0 (5.2)*
CVD (yes)[b]	22 (15.2)	29 (15.7)	12 (6.3)	42 (10.6)	23 (9.4)*	18 (7.4)*

CVD = cardiovascular disease, CI = 95%-confidence interval

*Difference between ethnic groups $P < 0.05$ (Chi-square)

[a] Dutch Heart Foundation guideline

[b] Rose questionnaire (including self-reported diagnosis of angina pectoris/myocardial infarction, cerebrovascular accident, intermittent claudication)

The association between MS, the individual components of MS and CVD in each ethnic group is presented in Table 3. Among men, particularly the African Surinamese and Dutch, central obesity showed an association with prevalent CVD. Among Hindustani Surinamese and Dutch men HDL-cholesterol and triglycerides were associated with CVD, while among women in all ethnic groups and among African Surinamese men these associations were not observed. Among the Hindustani, in particular men, individual components classified according to the IDF criteria showed a stronger association, although not always statistically significant, than the components stratified according to the NCEP criteria. In the other ethnic groups this trend was not observed. The strongest association between MS and CVD was observed among African Surinamese (NCEP: OR = 4.9 (1.3–18.3) and Dutch men (IDF: OR = 3.2 (1.3–7.8)).

Table 4 shows that compared to the Dutch, Hindustani men and women and African Surinamese women, but not men, had a higher odds of having CVD. Adjustment for metabolic syndrome did not fully account for differences in CVD between ethnic groups, although due to wider confidence intervals some associations were no longer significant (Table 4). Yet, addition of individual components, particularly classified according to IDF criteria, to the model did reduce the OR among the Hindustani Surinamese; the OR changed from 3.0 (1.5–5.7) to 2.2 (1.1–4.5) among women and 2.0 (1.0–3.8) to 1.3 (0.6–2.6) among men.

Discussion

In our study, we found large differences in prevalence of MS and CVD across different ethnic groups. For both the IDF and NCEP definition, the prevalence of MS and its components was higher in Hindustani Surinamese men and women and among African Surinamese women than among Dutch, while African Surinamese men had a lower prevalence of MS. CVD was also more common among the Hindustani Surinamese men and Hindustani/African Surinamese women than among Dutch men and women. The association of MS and its components with prevalent CVD varied between ethnic groups and different trends were observed between men and women. However, accounting for the differences in MS could not fully account for the differences in the occurrence of CVD between groups.

Previous studies

Our findings on the prevalence of MS defined by the NCEP criteria are consistent with studies in ethnic groups from Canada and the United Kingdom [6, 7]. In agreement with these studies, the prevalence of MS among Hindustani Surinamese and African Surinamese population was two to three times higher than among the ethnic Dutch population. Anand et al. have reported a higher prevalence of MS in South Asians (26%) compared to Europeans (22%). Tillin et al. have found that the prevalence of MS was highest in South Asians (31%), followed by Afro-Caribbeans (20%) and lowest in Europeans (16%). The study also reported a strong dependency of the criteria used to identify persons with MS on the estimated prevalence of MS, particularly in the Afro-Caribbeans population and among the South Asians. Similar to our findings, large differences could be observed between populations in the prevalence of individual components of the syndrome.

Table 2 The prevalence of the metabolic syndrome and the individual components among Hindustani Surinamese (n = 330), African Surinamese (n = 586) and ethnic Dutch (n = 486)

	Hindustani Surinamese *N* (%)		African Surinamese *N* (%)		Ethnic Dutch *N* (%)	
	Men	Women	Men	Women	Men	Women
Prevalence of metabolic syndrome according to NCEP criteria	49 (33.8)	77 (41.6)	20 (10.5)	100 (25.3)	42 (17.2)*	40 (16.5)*
Three or more of the following five risk factors						
Central obesity: waist circumference >102 cm in men and >88 cm in women	36 (24.8)	127 (68.7)	30 (15.7)	265 (67.1)	62 (25.4)*	98 (40.5)*
Raised triglycerides: ≥150 mg/dl (1.7 mmol/l)	49 (33.8)	41 (22.2)	25 (13.1)	37 (9.4)	73 (29.9)*	40 (16.5)*
Reduced HDL-cholesterol: <40 mg/dl (1.03 mmol/l) in men and <50 mg/dl (1.29 mmol/l) in women	54 (37.2)	88 (47.6)	30 (15.7)	121 (30.6)	39 (16.0)*	50 (20.7)*
Raised blood pressure: ≥130/≥ 85 mm Hg	75 (51.7)	78 (42.2)	113 (59.2)	168 (42.5)	114 (46.7)*	66 (27.3)*
Raised fasting glucose: ≥110 mg/dl (6.1 mmol/l)	47 (32.4)	54 (29.2)	34 (17.8)	66 (16.7)	41 (16.8)*	23 (9.5)*
Prevalence of metabolic syndrome according to IDF criteria	74 (51.0)	92 (49.7)	37 (19.4)	136 (34.4)	76 (31.2)*	64 (26.5)*
Central obesity: waist circumference ≥94 cm in men (South Asian men: ≥90 cm) and ≥80 cm in women	95 (65.5)	161 (87.0)	64 (33.5)	329 (83.3)	124 (50.8)*	156 (64.5)*
PLUS two or more of the following four risk factors						
Raised triglycerides: ≥150 mg/dl (1.7 mmol/l), or specific treatment for this lipid abnormality	55 (37.9)	48 (26.0)	27 (14.1)	41 (10.4)	78 (32.0)*	45 (18.6)*
Reduced HDL-cholesterol: <40 mg/dl (1.03 mmol/l) in men and <50 mg/dl (1.29 mmol/l) in women, or specific treatment for this lipid abnormality	62 (42.8)	93 (50.3)	31 (16.2)	126 (31.9)	48 (19.7)*	56 (23.1)*
Raised blood pressure: ≥130/ ≥85 mmHg, or treatment of previously diagnosed hypertension	78 (53.8)	88 (47.6)	116 (60.7)	177 (44.8)	119 (48.8)*	70 (28.9)*
Raised fasting plasma glucose: ≥100 mg/dl (5.6 mmol/l), or previously diagnosed type 2 diabetes	87 (60.0)	86 (46.5)	73 (38.2)	132 (33.4)	95 (38.9)*	59 (24.4)*

CI = 95%-confidence interval, NCEP = National Cholesterol Education Program, IDF = International Diabetes Federation, HDL = high density lipoprotein

*Difference between ethnic groups $P < 0.05$ (Chi-square)

Unlike our study, the studies by Tillin and Anand did not evaluate the newer IDF criteria. However, one study did include the criteria of the WHO criteria besides those of the NCEP. We could not take the WHO criteria into account in our evaluations as the required measure of the impaired glucose tolerance (OGTT) was not available.

The prevalence of CVD in previous studies was also comparable to the prevalence found in our study. As in previous studies the disparity in the occurrence of CVD among South Asian origin (e.g., Hindustani Surinamese) and African origin (e.g., African Surinamese) populations as compared to European populations (e.g., Dutch) could not be accounted for by the presence of the MS as defined the NCEP criteria. The IDF criteria have not been previously used to identify persons with MS among these ethnic groups and to study the association with prevalent CVD.

Limitations and strengths

First, like in many surveys, the plasma glucose level, HDL-cholesterol, and triglyceride levels were based on a single measurement of a fasting plasma sample obtained at the time of the medical examination. Similarly, the blood pressure, although measured twice according to a strict protocol, was only measured on one occasion. This may

Table 3 The association of metabolic syndrome and its components with cardiovascular disease among Hindustani Surinamese (n = 330), African Surinamese (n = 586) and ethnic Dutch (n = 486) participants

Adjusted for age and smoking	Hindustani Surinamese OR (CI)		African Surinamese OR (CI)		Ethnic Dutch OR (CI)	
	Men	Women	Men	Women	Men	Women
Central obesity						
(According to NCEP criteria)	1.3 (0.5–3.6)	2.3 (0.7–7.4)	**4.8 (1.4–16.9)**	1.4 (0.6–2.9)	**3.0 (1.2–7.2)**	1.1 (0.4–3.0)
(According to IDF criteria)	3.3 (0.9–12.3)	1.3 (0.3–6.2)	2.1 (0.6–6.8)	2.0 (0.7–6.0)	**3.2 (1.2–8.6)**	1.5 (0.4–4.9)
Reduced HDL-cholesterol						
(According to NCEP criteria)	0.9 (0.3–2.4)	1.3 (0.6–3.0)	1.0 (0.2–5.1)	0.9 (0.4–1.8)	0.8 (0.2–2.9)	1.0 (0.3–3.2)
(According to IDF criteria)	**3.1 (1.2–8.2)**	1.7 (0.7–3.8)	1.0 (0.2–4.8)	1.1 (0.5–2.1)	2.0 (0.8–5.4)	1.1 (0.4–3.4)
Raised triglycerides						
(According to NCEP criteria)	0.7 (0.3–2.0)	1.4 (0.6–3.5)	–	1.4 (0.5–3.8)	2.2 (0.9–5.3)	0.8 (0.2–3.0)
(According to IDF criteria)	2.3 (0.9–5.8)	1.7 (0.7–4.1)	–	1.2 (0.4–3.3)	**3.0 (1.2–7.2)**	1.4 (0.5–4.3)
Raised blood pressure						
(According to NCEP criteria)	0.8 (0.3–2.2)	2.3 (0.9–5.6)	0.9 (0.2–3.2)	1.4 (0.7–2.9)	1.0 (0.4–2.4)	0.4 (0.1–1.3)
(According to IDF criteria)	1.5 (0.6–4.5)	**3.3 (1.2–8.8)**	1.3 (0.3–4.8)	1.5 (0.7–2.9)	1.1 (0.4–2.7)	0.5 (0.1 1.6)
Raised fasting plasma glucose						
(According to NCEP criteria)	1.8 (0.7–4.7)	1.3 (0.5–3.1)	2.3 (0.6–8.4)	1.8 (0.8–4.1)	2.2 (0.8–5.9)	3.1 (0.9–10.8)
(According to IDF criteria)	**3.1 (1.0–9.8)**	1.3 (0.5–2.9)	1.5 (0.5–5.1)	1.7 (0.9–3.5)	**2.5 (1.0–6.2)**	1.4 (0.5–4.3)
Metabolic syndrome						
(According to NCEP criteria)	1.0 (0.4–2.7)	2.1 (0.9–5.0)	**4.9 (1.3–18.3)**	1.9 (1.0–4.0)	**2.8 (1.1–7.1)**	0.7 (0.2–2.5)
(According to IDF criteria)	2.6 (0.9–7.2)	2.0 (0.8–4.9)	3.2 (0.9–11.1)	1.5 (0.7–2.9)	**3.2 (1.3–7.8)**	1.7 (0.6–5.0)

CVD = cardiovascular disease (Rose questionnaire, including diagnosis of angina pectoris/myocardial infarction, cerebrovascular accident, intermittent claudication), OR = odds ratio, CI = 95%-confidence interval, MS = metabolic syndrome, NCEP = National Cholesterol Education Program, IDF = International Diabetes Federation, bold = $P < 0.05$

Table 4 The effect of metabolic syndrome on differences in cardiovascular disease between Hindustani Surinamese (n = 330), African Surinamese (n = 586) and ethnic Dutch (n = 486)

Adjusted for	Hindustani Surinamese vs. Dutch OR (CI)		African Surinamese vs. Dutch OR (CI)	
	Men	Women	Men	Women
Age	**1.9 (1.0–3.8)**	**2.7 (1.4–5.0)**	0.8 (0.4–1.6)	**1.8 (1.0–3.3)**
Age and smoking	**2.0 (1.0–3.8)**	**3.0 (1.5–5.7)**	0.8 (0.4–1.6)	**1.9 (1.0–3.8)**
Age, smoking, and				
Components of MS (classified according to NCEP criteria)	**1.9 (1.0–3.9)**	**2.3 (1.2–4.7)**	0.9 (0.4–2.0)	1.6 (0.8–3.0)
Components of MS (classified according to IDF criteria)	1.3 (0.6–2.6)	**2.2 (1.1–4.5)**	0.9 (0.4–2.0)	1.6 (0.8–3.0)
Age, smoking, and				
MS (according to NCEP criteria)	1.7 (0.9–3.3)	**2.5 (1.3–4.9)**	0.8 (0.4–1.7)	1.7 (0.9–3.2)
MS (according to IDF criteria)	1.5 (0.8–2.9)	**2.6 (1.3–5.0)**	0.8 (0.4–1.7)	1.8 (0.9–3.3)
Age, smoking and waist circumference, systolic blood pressure, HDL-cholesterol, triglycerides, and fasting plasma glucose	1.7 (0.9–3.4)	**2.1 (1.1–4.2)**	0.8 (0.4–1.8)	1.4 (0.7–2.7)

CVD = cardiovascular disease (Rose questionnaire, including self-reported diagnosis of angina pectoris/myocardial infarction, cerebrovascular accident, intermittent claudication), OR = odds ratio, CI = 95%-confidence interval, MS = metabolic syndrome, NCEP = National Cholesterol Education Program, IDF = International Diabetes Federation, bold = $P < 0.05$

have overestimated the true values for these parameters. Nevertheless, we do not expect that these limitations affect the comparability of the ethnic groups as they apply equally to all groups.

Secondly, due to the cross-sectional nature of the study, the associations between the presence of CVD and smoking, obesity, and other risk factors for CVD have to be interpreted with caution, and no conclusions may be draws about causality. The associations may be biased if persons with CVD have selectively, as a result of the treatment for CVD, changed their lifestyle. If true, this would imply an underestimation of the true association between the parameters and CVD. Moreover, the associations may have been affected if, despite the relatively young age of the populations, the persons with the greatest risk of disease have not responded or have already died prior to the study.

Thirdly, we used a self-reported measure of CVD in our analyses. The first problem with this approach is that use of a self-reported measure may have led to an incorrect estimation of the prevalence of CVD. On the one hand, the true prevalence may have been overestimated as self-reported events could not be verified by information retrieved from patient files. On the other hand, the true prevalence of CVD in our population may have been underestimated, because individuals may have unnoticed cardiovascular events. Silent ischemia is thought to occur more often in persons with diabetes, which was particularly prevalent among the Surinamese population [20, 21]. The second problem is that a questionnaire used, the Rose angina questionnaire, was not validated in the Surinamese population, although a study in the UK has suggested that the cross-cultural validity may be compromised [22].

A clear strength of our study is that it was carried out in a setting that enables a comparison of different ethnic groups with a similar (recent) migration history, living in comparable socio-economic conditions. Another major strength of our study is the fact that it was population-based, which reduces the possibility of bias due to preselection according to attendance at a certain clinic or employment at a certain factory. In addition, the recruitment strategy included specific measures to increase the participation among the various ethnic groups, such as endorsement by key figures in the community and matching of participants and interviewers by ethnicity.

In conclusion, we found a high prevalence of MS, particularly among Hindustani Surinamese and African Surinamese. The association of (individual components of) MS with CVD varied across groups, and according to the definition used. Differences between groups could not be explained. Additional research is needed in multiethnic populations to determine whether further ethnicity specific adjustments of the existing criteria or addition of additional parameters for some or all ethnic groups could perhaps enhance the ability of the criteria to identify people with prevalent CVD and, ideally, people with a high risk of incident CVD. Only then can the criteria serve as a guide for prioritizing treatment among individuals with different ethnic backgrounds and to focus prevention efforts on the specific characteristics of the various ethnic groups.

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