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# Hypertension prevalence, awareness, treatment, and control in Surinamese living in Suriname and The Netherlands: the HELISUR and HELIUS studies

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## Abstract

We studied hypertension prevalence, awareness, treatment, and control among persons living in a middle-income country compared with those of similar ethnicity living in a high-income country. Data from the cross-sectional HELISUR and HELIUS studies were used among 1000 Surinamese and 6971 Surinamese migrants living in The Netherlands (18–70 years), respectively. Groups were formed based on country and self-defined ethnicity, and stratified by sex. Age-adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated for hypertension prevalence, awareness, treatment, and control. Subsequently, we focused on hypertension prevalence and adjusted for risk factors for hypertension: BMI and waist circumference (model 2), educational level, physical activity, and smoking (model 3). After adjustment for age, no significant differences in hypertension prevalence, awareness, treatment, and control between countries were seen in men. However, women in Suriname were more often hypertensive with lower levels of awareness and control than those in The Netherlands (African: OR 1.54 [95% CI 1.19, 2.00]; South-Asian: 1.90 [1.35, 2.67]; awareness: 0.62 [0.43, 0.88] in African women; control: 0.48 [0.28, 0.84] in South-Asian women). Higher hypertension prevalence was explained by differences in BMI and waist circumference in African women (adjusted OR 1.26 [0.96, 1.65]) and by education, physical activity, and smoking in South-Asian women (adjusted OR 1.29 [0.87, 1.89]). Particularly, women in Suriname bear a relatively high hypertension burden with lower levels of awareness and control. As the higher hypertension prevalence was mainly explained by lifestyle-related risk factors, health promotion interventions may reduce the hypertension burden in Suriname.

**Keywords** Hypertension · Prevalence · Awareness · Treatment · Control · Ethnicity

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## Introduction

Hypertension is the leading risk factor for mortality worldwide, and is more common in low- and middle-income countries (LMIC) than in high-income countries (HIC) [1–3]. With many effective and inexpensive treatments available, hypertension control and prevention of subsequent hypertension-related diseases should be achievable [2]. Nevertheless, hypertension control rates are suboptimal in LMIC, and no significant improvements were observed in the past decade [2, 3]. In contrast to LMIC, the prevalence of hypertension slightly decreased and the level of hypertension control substantially increased in HIC [2, 3]. This indicates that there is still considerable room for improvement for LMIC.

Suriname, a middle-income country (MIC) in South America, bears a high burden of hypertension [4–6]. About half of the population migrated to The Netherlands between 1970 and 1990 due to political or economic reasons. This unprecedented mass migration offers a unique opportunity to study differences in the prevalence, awareness, treatment, and control of hypertension between MIC and HIC. This comparison could shed light on where significant improvements can be made and what populations should be targeted to reduce the high hypertension burden in Suriname. Therefore, we compared the Healthy Life in Suriname (HELISUR) study in urban Suriname with the Healthy Life in an Urban Setting (HELIUS) study, which included Surinamese who migrated to The Netherlands; both studies using similar methodology [7–9]. Our main objective was to compare hypertension prevalence, awareness, treatment, and control levels between Surinamese living in Suriname and Surinamese living in The Netherlands.

## Materials and methods

### Study population and study design

We used cross-sectional data from the HELISUR and HELIUS studies, which were conducted in the capitals of Suriname and The Netherlands, respectively. Data from both studies were collected with similar questionnaires and physical and laboratory assessments. Ethical clearance was obtained from the respective ethics committees and participants gave written informed consent prior to the enrolment in the studies.

The full details of both studies have been described elsewhere [7–9]. In short, in Suriname, the HELISUR study was carried out between 2013 and 2015 [7]. The capital Paramaribo is divided into 1200 enumeration areas out of which 18 were randomly selected by the General Bureau of Statistics. In order to include 1800 participants (aged 18–70 years), trained interviewers were sent to the different enumeration areas, visiting every house and all household members until 100 persons were included. To reduce selection bias, if household members were not at home, interviewers revisited the address with a maximum of three times. The participation rate was 72% (those that agreed to participate divided by the total number of participants that were asked to participate). Subsequently, participants were invited for a physical examination at the local Academic Hospital. Of the 1800 participants, 1485 were eligible for physical examination ($n=9$ died; $n=3$ were outside age range after re-evaluation; $n=303$ could not be retrieved [e.g., changed phone number or moved to a different address]). Of the 1485 eligible individuals, 328 declined to participate (participation rate: 78%). A total of 1157 persons participated in the interview as well as the physical examination.

In The Netherlands, the HELIUS study was conducted from 2011 to 2015 in Amsterdam among six ethnic groups (aged 18–70 years), including people with a Surinamese background [8, 9]. The Dutch municipal registry was used to identify Surinamese subjects according to the country of birth of the participant or their parents [10]. More specifically, a person was defined as Surinamese if he/she fulfilled one of two criteria: (1) he/she was born in Suriname and has at least one parent born in Suriname (first generation), or (2) he/she was born in The Netherlands and both parents were born in Suriname (second generation). Participants were randomly selected from the municipal registers, stratified by ethnicity, and were sent invitation letters to participate in the study. Of those invited, 62% of the Surinamese origin participants were contacted (either by response card or after a home visit by an interviewer). Of them, 51% agreed to participate in the study (participation rate). Overall, 7694 participants with a Surinamese background filled in the HELIUS questionnaire and underwent a physical examination at one of the research locations.

Participants' flow of both studies is depicted in Fig. 1. Participants from both studies were classified as African or South-Asian according to their self-defined ethnicity, to explore potential ethnic differences in the outcome measures. Surinamese of non-African or non-South-Asian ancestry were excluded from the current analysis ($n=151$ in HELISUR; $n=500$ in HELIUS). We additionally excluded participants with missing data on any of the variables ($n=6$ in HELISUR; $n=223$ in HELIUS) and assumed that these data were missing at random, resulting in a complete-case-only analysis with 1000 Surinamese living in Suriname and 6971 Surinamese living in The Netherlands.

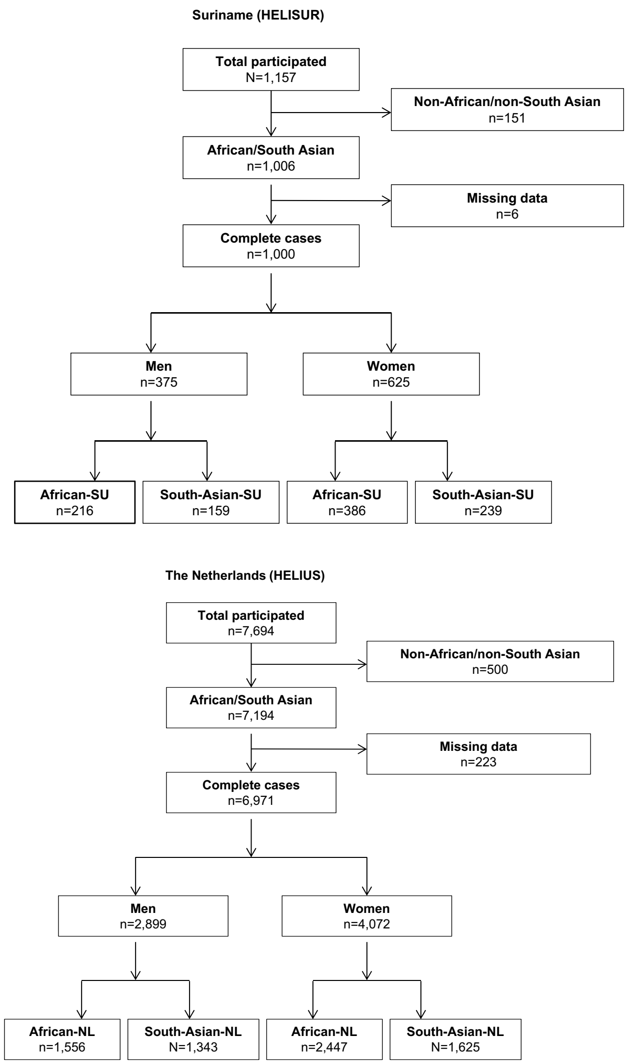



**Fig. 1** Flowchart of both study populations

## Measurements

Educational level was based on the highest qualification obtained. Those with no education or primary school only were considered as low educational level. Smoking status (yes vs no or ex-smoker) was also obtained by questionnaires. Physical activity was estimated using the International Physical Activity Questionnaire-long form (IPAQ-LF) in HELISUR, and the Short Questionnaire to Assess Health-Enhancing (SQUASH) physical activity questionnaire in HELIUS [11, 12]. The duration (min/week physically active) of the total study population was divided into quartiles, and the first quartile (least physically active) was classified as low physical activity. All participants were asked to bring their prescribed medications to the research locations and antihypertensive agents were identified using Anatomical Therapeutic Chemical (ATC) classification system, i.e., ATC codes C02 (antihypertensive agents), C03 (diuretics), C07 (beta-blocker), C08 (calcium antagonists), and C09 (ACE inhibitors or angiotensin antagonists) were considered antihypertensive medication.

Height, weight, and waist circumference (WC) were measured in duplicate to the nearest 0.1 cm or 0.1 kg, with participants wearing no shoes and light clothing only. A third measurement was made if the difference between the first two readings was more than 0.5 cm (for height), 0.5 kg (for weight), or 1.0 cm (for WC). Mean height, weight, and WC were calculated by taking the mean of the two measurements (the two closest values if a third measurement was obtained). Body mass index (BMI) was computed as weight in kilograms/height in meters squared. For the definition of obesity and abdominal obesity, we used the respective ethnic-specific BMI and WC cut-off values that correspond to a high cardiovascular risk [13, 14]. Obesity was defined as BMI $\geq$ 30 kg/m$^2$ for persons of African ancestry, and as BMI $\geq$ 27.5 kg/m$^2$ for those of South-Asian ancestry [13, 14]. Abdominal obesity was defined as WC $\geq$ 94 cm in African men, $\geq$ 90 cm in South-Asian men, and $\geq$ 80 cm in women [13, 14].

Blood pressure (BP) was measured twice in the sitting position after a 5 min rest with an automated oscillometric device (WatchBP Office; Microlife AG, Widnau, Switzerland [15]), using an appropriately adjusted cuff size on the left upper arm supported at heart level. Hypertension was defined as a systolic BP $\geq$ 140 mm Hg, or a diastolic BP $\geq$ 90 mm Hg, or being on antihypertensive medication [1]. Awareness of hypertension was defined as the proportion of hypertensive individuals who self-reported any prior diagnosis of hypertension by a health care professional. Treatment of hypertension was defined as the proportion of hypertensive individuals who were receiving prescribed antihypertensive medication for high BP management. BP control was defined as the proportion of hypertensive individuals on antihypertensive medication with systolic BP < 140 mm Hg and diastolic BP < 90 mm Hg [1].

## Statistical analysis

Characteristics of the study population were expressed as proportions or means with standard deviations (SD) with differences tested using Chi-square tests (dichotomous) and Student's *t* tests (continuous). Because of significant interaction between sex and ethnicity ($p < 0.05$), we stratified our analyses by sex. To assess potential differences in the age distribution of hypertension across the subgroups, the following age categories were formed: 20–29, 30–39, 40–49, 50–59, and 60–69 years, and HT prevalence was studied within these categories. To study differences in the prevalence, awareness, treatment, and control of hypertension, we calculated age-adjusted odds ratios (OR) with 95% confidence intervals (CI) by means of logistic regression analysis, using hypertension prevalence, level of awareness, treatment, and control as outcome variables and age, BMI, WC, educational level, physical activity, and smoking as covariates. Subsequently, we explored differences between countries in the prevalence of hypertension by ethnic group and, additionally, adjusted the analyses for other important risk factors of hypertension, including BMI and WC (model 2) and educational level, physical activity, and smoking (model 3). Model fit was assessed with the Hosmer–Lemeshow goodness-of-fit test for logistic regression models and collinearity checks were performed for the independent variables entered in the models (variance inflation factor > 1 and < 4 indicates no collinearity). Statistical analysis of the data was carried out using the SPSS version 20.0 (SPSS, Inc., Chicago, IL, USA) software for Windows. Graphical presentation was based on GraphPad Prism version 7.0 (GraphPad Software, Inc., San Diego, CA).

## Results

### Characteristics of the study population

For both sexes and ethnicities, participants living in Suriname were generally younger, had more often a low educational level and were less physically active than those living in The Netherlands (Table 1). In men, no large differences were observed in the prevalence of smoking, obesity, and abdominal obesity between the two countries (smoking: 39.7% vs 41.4%; obesity: 22.1% vs 22.1%; abdominal obesity: 49.9% vs 50.5%, for Suriname vs The Netherlands, respectively). In women, however, the prevalence of smoking was significantly lower (8.3% vs 22.2%, $p < 0.01$), and the prevalence of obesity and abdominal obesity was significantly higher in Suriname compared to The Netherlands (46.4% vs 38.0%, $p < 0.01$; 87.4% vs 79.4%, $p < 0.01$).

No significant differences in crude BP levels were seen between the two countries, except for a higher diastolic BP in South-Asian women living in Suriname compared to their counterparts living in The Netherlands (Table 1). Regarding ethnic differences in BP within The Netherlands, we found significantly higher mean systolic and diastolic BP levels in African men and women compared to South-Asian men and women (men: 134.3/84.5 mm Hg vs 130.5/82.5 mm Hg; women: 129.9/80.2 mm Hg vs 126.4/77.5 mm Hg, for, respectively, African-NL vs South-Asian-NL, all $p < 0.01$). In Suriname, only African men had higher crude systolic BP levels than South-Asian men (133.9 vs 129.5 mm Hg, $p = 0.03$).

### Prevalence of hypertension

The age distribution of hypertension in men and women is depicted in Fig. 2. In women below the age of 50 years, hypertension was more prevalent in participants living in Suriname than in those living in The Netherlands.

Crude hypertension prevalence in both men and women did not vary substantially between the two countries (42.2% in Suriname vs 42.4% in The Netherlands, $p = 0.89$; Table 2). In The Netherlands, crude hypertension prevalence was higher in African ancestry men and women than in, respectively, South-Asian ancestry men and women (men: 46.5% vs 40.9%; women: 45.2% vs 35.6%, in, respectively, African-NL vs South-Asian-NL participants, both $p < 0.01$). This ethnic difference in the prevalence of hypertension was not seen in Suriname. After adjustment for age, no differences were seen in the prevalence of hypertension in men from Suriname vs The Netherlands (OR 1.30 [95% CI 0.94–1.80] for African-SU vs African-NL men; 1.29 [0.88–1.98] for South-Asian-SU vs South-Asian-NL men). In women, the prevalence of hypertension was still significantly higher in Suriname than in The Netherlands (age-adjusted OR 1.54 [95% CI 1.19–2.00] for African-SU vs African-NL women vs 1.90 [1.35–2.67] for South-Asian-SU vs South-Asian-NL women). This could be explained by the fact that women of African ancestry in Suriname were more (abdominally) obese: after adjustment for BMI and WC, the difference in hypertension prevalence in women across both countries disappeared (Table 3). In women of South-Asian ancestry, the risk of hypertension was no longer increased after educational level, physical activity, and smoking had been adjusted for (Table 3).

### Awareness, treatment, and control of hypertension

In men, hypertension awareness, treatment, and control did not vary substantially between the two countries (Table 2). This was seen both in African and South-Asian men. African ancestry women living in Suriname were significantly less often aware of their high BP than their counterparts living in The Netherlands (54.9% vs 70.0%, $p < 0.01$). This lower awareness persisted after adjustment for age (OR 0.62 [95% CI 0.43–0.88] for African-SU vs African-NL women). Treatment and control levels in African women were similar between the two countries. Among South-Asian women, awareness did not differ between the two countries. However, compared to their counterparts living in The Netherlands, South-Asian ancestry women living in Suriname were substantially more often treated, but less often controlled (treatment: 75.8% vs 62.8%; control: 34.7% vs 48.7% in South-Asian-SU vs South-Asian-NL women, both $p < 0.01$). After adjusting for age, these differences in treatment and control remained (treatment: OR 2.50 [95% CI

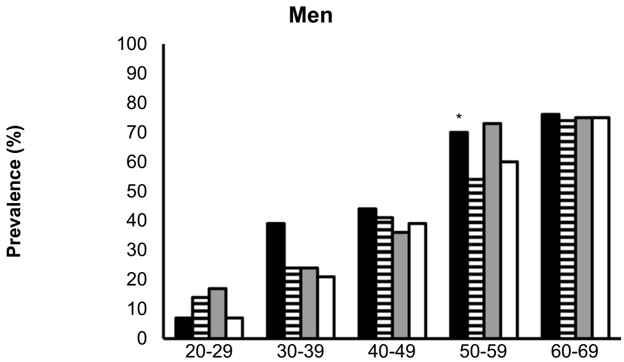
**Table 1** Characteristics of both study populations by sex

| Men | African-SU $n=216$ | African-NL $n=1556$ | $p$ value country difference | South-Asian-SU $n=159$ | South-Asian-NL $n=1,343$ | $p$ value country difference | $p$ value interaction ethnicity*country |
|---|---|---|---|---|---|---|---|
| Age, mean (SD) | 43.0 (15.1) | 48.0 (12.9) | <0.01 | 43.4 (13.5) | 44.7 (13.6) | 0.23 | <0.01 |
| Low educational level, % | 28.2 | 6.4 | <0.01 | 40.3 | 12.6 | <0.01 | <0.01 |
| Tobacco smoking, % | 38.0 | 42.8 | 0.18 | 42.1 | 39.8 | 0.56 | 0.40 |
| Physical activity, % | | | | | | | |
| <1140 min/week (Q1) | 56.3 | 20.2 | <0.01* | 56.0 | 24.8 | <0.01* | <0.01* |
| 1140–2340 min/week (Q2) | 20.9 | 21.1 | | 21.4 | 21.8 | | |
| 2340–3420 min/week (Q3) | 12.6 | 28.3 | | 8.8 | 28.5 | | |
| >3420 min/week (Q4) | 10.2 | 30.3 | | 13.8 | 24.9 | | |
| Body mass index, mean (SD) | 25.5 (5.0) | 26.3 (4.4) | 0.02 | 25.7 (5.0) | 25.8 (4.1) | 0.78 | 0.05 |
| Obesity, % | 17.6 | 17.2 | 0.89 | 28.3 | 27.7 | 0.87 | 0.45 |
| Waist circumference, mean (SD) | 90.3 (14.2) | 92.2 (12.5) | 0.04 | 95.3 (14.1) | 93.8 (12.1) | 0.16 | 0.06 |
| Abdominal obesity, % | 37.5 | 40.6 | 0.38 | 66.7 | 62.0 | 0.25 | 0.05 |
| Systolic BP, mean (SD) | 133.9 (20.0) | 134.3 (17.3) | 0.74 | 129.5 (16.6) | 130.5 (16.3) | 0.43 | 0.84 |
| Diastolic BP, mean (SD) | 83.7 (12.8) | 84.5 (10.7) | 0.29 | 83.1 (11.0) | 82.5 (10.1) | 0.53 | 0.91 |
| **Women** | **African-SU $n=386$** | **African-NL $n=2447$** | **$p$ value country difference** | **South-Asian-SU $n=239$** | **South-Asian-NL $n=1625$** | **$p$ value country difference** | **$p$ value interaction ethnicity*country** |
| Age, mean (SD) | 42.3 (13.7) | 47.8 (12.2) | <0.01 | 43.4 (13.0) | 46.0 (13.3) | 0.01 | <0.01 |
| Low educational level, % | 34.2 | 4.7 | <0.01 | 46.4 | 15.3 | <0.01 | <0.01 |
| Tobacco smoking, % | 9.1 | 24.4 | <0.01 | 7.1 | 19.0 | <0.01 | <0.01 |
| Physical activity, % | | | | | | | |
| <1140 min/week (Q1) | 68.5 | 18.5 | <0.01* | 50.8 | 18.8 | <0.01* | <0.01* |
| 1140–2340 min/week (Q2) | 20.5 | 27.0 | | 33.2 | 28.8 | | |
| 2340–3420 min/week (Q3) | 5.8 | 27.0 | | 9.2 | 27.0 | | |
| >3420 min/week (Q4) | 5.2 | 27.5 | | 6.7 | 25.5 | | |
| Body mass index, mean (SD) | 29.9 (7.0) | 28.8 (5.9) | <0.01 | 28.2 (5.7) | 26.7 (5.3) | <0.01 | <0.01 |
| Obesity, % | 46.1 | 37.4 | <0.01 | 46.9 | 39.0 | 0.02 | <0.01 |
| Waist circumference, mean (SD) | 98.2 (16.9) | 93.4 (14.8) | <0.01 | 97.1 (14.5) | 90.0 (13.5) | <0.01 | <0.01 |
| Abdominal obesity, % | 85.2 | 81.0 | 0.05 | 90.8 | 76.9 | <0.01 | <0.01 |
| Systolic BP, mean (SD) | 129.6 (21.2) | 129.9 (18.4) | 0.78 | 127.9 (20.4) | 126.4 (19.6) | 0.29 | 0.40 |
| Diastolic BP, mean (SD) | 80.6 (11.6) | 80.2 (10.6) | 0.50 | 80.2 (10.8) | 77.5 (10.2) | <0.01 | <0.01 |

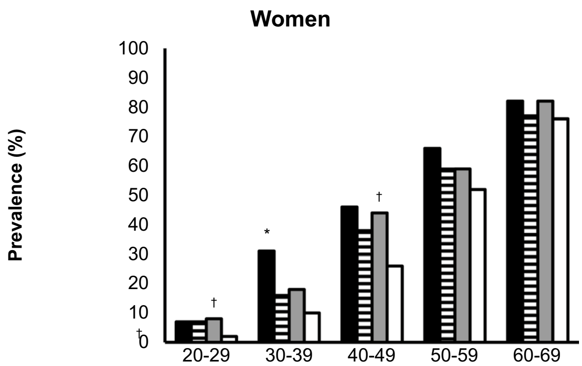
Values are mean with standard deviations (SD) or proportions (%)

*BP* blood pressure

*Physical activity: Q1 versus Q2-4, Q1–4, quartile 1 to 4




| | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 |
|---|---|---|---|---|---|
| African-SU | 7 | 39 | 44 | 70 | 76 |
| African-NL | 14 | 24 | 41 | 54 | 74 |
| South-Asian-SU | 17 | 24 | 36 | 73 | 75 |
| South-Asian-NL | 7 | 21 | 39 | 60 | 75 |




| | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 |
|---|---|---|---|---|---|
| African-SU | 7 | 31 | 46 | 66 | 82 |
| African-NL | 7 | 16 | 38 | 59 | 77 |
| South-Asian-SU | 8 | 18 | 44 | 59 | 82 |
| South-Asian-NL | 2 | 10 | 26 | 52 | 76 |

**Fig. 2** Hypertension by 10-year age groups in men and women. Prevalence rates are rounded to zero decimal places. *Significantly higher than African-NL; †significantly higher than South-Asian-NL

1.47–4.24]; control: 0.48 [0.28–0.84] in South-Asian-SU vs South-Asian-NL women).

## Discussion

### Key findings

Our findings show that hypertension was highly prevalent in men and women living in Suriname, with suboptimal levels of awareness, treatment, and control. While in men these estimates were similar to their counterparts living in The Netherlands, in women, the age-adjusted hypertension prevalence in Suriname was substantially higher and started at an earlier age compared to their counterparts living in The Netherlands. The increased risk of hypertension in women from Suriname was predominantly explained by lifestyle-related risk factors [i.e., (abdominal) obesity in women of African ancestry and physical activity and smoking in women of South-Asian ancestry] and educational level (women of South-Asian ancestry). In addition, the levels of awareness and control were lower in women in Suriname compared to those in The Netherlands.

### Limitations of the study

Several limitations need to be addressed. First, although similar methods were used in both countries, the sampling procedure had to be adapted to the local situation. In Suriname, it was not feasible to randomly select persons using the municipal register. However, we randomly selected enumeration areas and minimized selection bias (i.e., persons who were not at home were less likely to be included than those who were at home) by revisiting every address to a maximum of three times until all household members were included or stated a refusal. Second, there were differences in sample size, with a smaller sample size in Suriname. This might have resulted in fewer significant associations between the determinants and hypertension. Nevertheless, the smallest group was still large enough to detect significant associations, and the distribution between ethnic-sex groups across both countries was similar. As in many epidemiological studies, the definition of hypertension was based on BP measurements within one visit, which might have overestimated the prevalence estimates. In addition, antihypertensive treatment was based on the medication that participants brought with them to the research location. Persons who forgot to bring their medication and had normal blood pressures were misclassified as normotensives. However, it is unlikely that these limitations modify the comparability between the subgroups, as these limitations apply to all groups. Another limitation is the use of different measures to assess physical activity, i.e., with the IPAQ questionnaire in HELISUR and with the SQUASH questionnaire in HELIUS. To improve the comparability between the two questionnaires, we used the overall duration of physical activity and divided it into quartiles to define those least physically active. However, we cannot state with confidence that inter-country differences in physical activity are attributed to the use of different measures or are, in fact, true differences. Finally, we could not measure the association between hypertension and several important determinants of hypertension such as diet, salt intake, and psychosocial stress due to the absence of the data in the study.

### Discussion of the key findings

#### Prevalence of hypertension

We found a higher prevalence of hypertension in women living in Suriname compared to their counterparts living in The Netherlands. This is consistent with earlier studies,

**Table 2** Crude and age-adjusted hypertension prevalence, awareness, treatment, and control in Suriname and in Surinamese living in The Netherlands, stratified by sex

| | *n*/*N* | | Age-adjusted OR (95% CI) |
|---|---|---|---|
| | SU | NL | SU vs NL (reference) |
| Men | | | |
| African | | | |
| Hypertension | 95/216 (44.0) | 724/1556 (46.5) | 1.30 (0.94–1.80) |
| Awareness | 51/95 (53.7) | 366/724 (50.6) | 1.24 (0.79–1.94) |
| Treatment | 41/95 (43.2) | 303/724 (41.9) | 1.18 (0.74–1.89) |
| Control | 14/41 (34.1) | 102/303 (33.7) | 1.08 (0.54–2.16) |
| South-Asian | | | |
| Hypertension | 68/159 (42.8) | 549/1343 (40.9) | 1.29 (0.88–1.89) |
| Awareness | 40/68 (58.8) | 284/549 (51.7) | 1.58 (0.92–2.71) |
| Treatment | 39/68 (57.4) | 278/549 (50.6) | 1.77 (1.00–3.15) |
| Control | 18/39 (46.2) | 112/278 (40.3) | 1.24 (0.63–2.46) |
| Women | | | |
| African | | | |
| Hypertension | 164/386 (42.5) | 1,107/2447 (45.2) | **1.54 (1.19–2.00)** |
| Awareness | 90/164 (54.9) | 775/1107 (70.0) | **0.62 (0.43–0.88)** |
| Treatment | 102/164 (62.2) | 706/1107 (63.8) | 1.18 (0.82–1.69) |
| Control | 45/102 (44.1) | 333/706 (47.2) | 0.87 (0.57–1.32) |
| South-Asian | | | |
| Hypertension | 95/239 (39.7) | 578/1625 (35.6) | **1.90 (1.35–2.67)** |
| Awareness | 56/95 (58.9) | 360/578 (62.3) | 1.07 (0.67–1.70) |
| Treatment | 72/95 (75.8) | 363/578 (62.8) | **2.50 (1.47–4.24)** |
| Control | 25/72 (34.7) | 177/363 (48.7) | **0.48 (0.28–0.84)** |

Significant ($p < 0.05$) differences are depicted in bold

**Table 3** Adjusted differences in prevalence of hypertension in Suriname vs The Netherlands (reference group)

| | African-NL | African-SU OR (95% CI) | South-Asian-NL | South-Asian-SU OR (95% CI) |
|---|---|---|---|---|
| Men | | | | |
| Model 1: age | 1.0 (reference) | 1.30 (0.94–1.80) | 1.0 (reference) | 1.29 (0.88–1.89) |
| Model 2: model 1 + BMI, WC | 1.0 (reference) | 1.33 (0.95–1.86) | 1.0 (reference) | 1.18 (0.79–1.76) |
| Model 3: model 2 + educational level, physical activity, smoking | 1.0 (reference) | 1.22 (0.85–1.76) | 1.0 (reference) | 1.24 (0.96–1.67) |
| Women | | | | |
| Model 1: age | 1.0 (reference) | **1.54 (1.19–2.00)** | 1.0 (reference) | **1.90 (1.35–2.67)** |
| Model 2: model 1 + BMI, WC | 1.0 (reference) | 1.26 (0.96–1.65) | 1.0 (reference) | **1.45 (1.01–2.09)** |
| Model 3: model 2 + educational level, physical activity, smoking | 1.0 (reference) | 1.19 (0.87–1.62) | 1.0 (reference) | 1.29 (0.87–1.89) |

Values are odds ratios (OR) with 95% confidence intervals (CI)

Significant ($p < 0.05$) differences are depicted in bold

*BMI* body mass index, *WC* waist circumference

observing a higher prevalence of hypertension in LMIC than HIC. However, these studies were conducted among heterogeneous populations in terms of ethnicity. Studies among homogenous groups that migrated from an LMIC to an HIC show different results with regard to hypertension prevalence. For example, a recent study among African migrants (Ghanaians) living in Western Europe and non-migrants living in rural and urban Ghana found a clear gradient in the prevalence of hypertension [16]. Hypertension prevalence increased from rural through urban Ghana to Europe [16]. In our comparison between Surinamese living in an LMIC versus HIC, we found that this gradient of hypertension from LMIC to HIC does not seem to apply. In fact, it was the opposite for some groups, particularly women. In addition, hypertension was more prevalent at earlier ages in Suriname. The presence of hypertension in relatively young people might play a role in the high premature mortality rates observed in LMIC, where people often die in their most productive years [17]. Importantly, differences in hypertension between Surinamese living in Suriname vs The Netherlands disappeared after adjustment for age (in men) and risk factors accompanied by westernization, including an unhealthy diet, smoking, and sedentary lifestyle (in women). This underscores the importance of lifestyle modification to reduce the high hypertension burden in urban regions of MIC.

### Awareness, treatment, and control of hypertension

Awareness, treatment, and control rates were suboptimal in both countries. The lowest control levels were seen in African men (34% of those treated, 15% of those with hypertension; both in African-SU men as well as African-NL men). Interestingly, men in Suriname had similar awareness, treatment, and control levels as Surinamese men in The Netherlands, suggesting that for men the access and quality of the health care system of Suriname are similar to that of their counterparts in The Netherlands. In contrast, women living in Suriname were less aware and, despite higher treatment levels, still less controlled for hypertension than their counterparts living in The Netherlands. Reasons behind this pattern remain unclear, but might relate to gender inequalities that women in LMIC are still facing to date [18]. Gender inequalities in education, income, or employment may limit the ability of women from LMIC to protect their health [18]. In Suriname, for example, women have substantially lower health literacy levels than men [19]. Consequently, they may have more difficulties navigating the health care system, understanding medical instructions, and being compliant to their medication regime, putting them at risk for adverse (cardiovascular) health outcomes [20–22]. Focusing on patient education is, therefore, recommended to improve awareness of hypertension and adherence to antihypertensive treatment. However, it is important to recognize culturally and ethnically different perspectives on hypertension and antihypertensive treatment. A study in The Netherlands showed that particularly patients with a migration background, including those with a Surinamese background, reported lowering or leaving off their prescribed antihypertensive dosage [23]. Explanations for altering prescribed dosage were: disliking chemical medications, fear of side effects, preference for alternative treatment and, in Surinamese men, worries about the negative effects on their sexual performance [23]. Future studies should focus on how cultural and ethnic factors influence hypertension management in Suriname, but culturally appropriate health education may be beneficial for Surinamese patients with hypertension.

Both in Surinamese living in an MIC and in an HIC, hypertension is highly prevalent and BP levels are poorly controlled. Yet, those living in MIC Suriname, particularly women, bear a higher burden of hypertension with lower levels of control. Major efforts are needed to reduce the high burden of hypertension and concomitant diseases in urban regions of MIC. As the higher hypertension prevalence was predominantly explained by a higher prevalence of lifestyle-related risk factors in Suriname vs The Netherlands, interventions aimed at health promotion are vital to reduce the high hypertension burden in this middle-income population.

In conclusion, we compared hypertension prevalence, awareness, treatment, control, and determinants related to hypertension in an MIC with an HIC within populations with the same ethnicity. We found that those living in MIC Suriname, particularly women, bore the highest burden of hypertension with lower levels of control compared to their counterparts living in The Netherlands. As this was mainly explained by differences in lifestyle-related risk factors, interventions aimed at promoting a healthy lifestyle are urgently needed to reduce the high burden of hypertension in urban regions in this MIC.

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**Author contributions** FSD drafted the manuscript. MBS, KS, and LMB made substantial contributions in the interpretation of the data and in revising the manuscript. All authors critically reviewed the manuscript.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Statement of human and animal rights** The study protocols were approved by the respective ethic committees of both research institutes and in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent** All participants gave written informed consent prior to the enrolment in the studies.

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