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Determinants of suboptimal blood pressure control in a multi-ethnic population: The Healthy Life in an Urban Setting (HELIUS) study

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Abstract

Among ethnic minority groups in Europe, blood pressure (BP) control is often suboptimal. We aimed to identify determinants of suboptimal BP control in a multi-ethnic population. We analyzed cross-sectional data of the Healthy Life in an Urban Setting (HELIUS) study, including 3571 participants aged 18-70 with prescribed antihypertensive medication, of various ethnic backgrounds (500 Dutch, 1052 African Surinamese, 656 South-Asian Surinamese, 637 Ghanaian, 433 Turkish, and 293 Moroccan) living in Amsterdam, the Netherlands. 53.3% of the population had suboptimal BP control, defined as BP ≥140/90 mmHg despite prescribed antihypertensives. Using multivariate logistic regression analysis, female sex (OR 0.50, 95%CI 0.43-0.59), being married (0.83, 0.72-0.96), smoking (0.78, 0.65-0.94), alcohol intake (0.80, 0.66-0.96), obesity (1.67, 1.35-2.06), cardiovascular disease (CVD) history (0.56, 0.46-0.68), non-adherence to antihypertensives (1.26, 1.00-1.58), and family history of hypertension (1.19, 1.02-1.38) were identified to be independently associated with suboptimal BP control in the total population. In the ethnic-stratified analysis, factors associated with better BP control were female sex (all ethnic groups), smoking (Turks), and CVD history (Dutch, South-Asian Surinamese, and African Surinamese), whereas factors associated with suboptimal BP control were older age (Turks), obesity (Dutch, African Surinamese, Ghanaian, and Turks), and non-adherence to antihypertensives (Dutch). In conclusion, our analysis identifies several key determinants that are independently associated with suboptimal BP control in a multi-ethnic population, with some important variations between ethnic groups. Targeting these determinants may help to improve BP control.

1 | INTRODUCTION

In Western Europe, less than two-third of the adults with drug-treated hypertension reach the recommended blood pressure (BP) targets,[1] and BP control rates appear to differ between ethnic minority groups and European host populations,[2,3] with lower control rates particularly in African origin populations.[4] These low control rates potentially contribute to the observed ethnic differences in hypertension-mediated complications.[5]

Over the years, multiple studies have found several sociodemographic, lifestyle, health, and health behavioral factors to be associated with (sub-)optimal BP control,[6-8] and studies from the United States of America (USA) suggest a differential contribution of factors associated with suboptimal BP control among populations of different ethnic background.[9] However, it is unknown whether these determinants contribute differently to suboptimal BP control in a multi-ethnic population in a European setting, as studies using a comprehensive approach to assess the impact of a wide range of sociodemographic, lifestyle, and behavioral factors on BP control rates, are lacking. Moreover, findings from the United States are not directly generalizable to a European context, as these world regions differ considerably in terms of ethnic background of the population, culture, and organization of healthcare systems, including treatment targets and health insurance.[9,10]

We therefore aimed to assess determinants of suboptimal BP control among patients who were prescribed BP-lowering medication in a multi-ethnic population in Amsterdam, the Netherlands, and to determine whether the contribution of these factors differs between ethnic groups. In doing so, we hope to inform clinicians on high-risk groups for suboptimal BP control and to indicate potential modifiable risk factors, ultimately aiming to improve BP control and reduce hypertension-mediated complications across different ethnic groups.

2 | METHODS

2.1 | Study population and study design

For the current analysis, baseline data of the prospective Healthy Life in an Urban Setting (HELIUS) cohort were used. The rationale, design, and methodology of HELIUS have been described in detail elsewhere.[11,12] In short, HELIUS aims to assess differences in health and care among the six largest ethnic groups living in Amsterdam, the Netherlands. Baseline data collection was conducted between 2011 and 2015, including participants aged 18-70 years of various ethnic origin. The study protocol was approved by the Medical Ethical Committee of the Academic Medical Center, and all participants provided written informed consent prior to enrollment in the study.

Of the total of 22 165 baseline participants for whom questionnaire and physical examination data were available, 3571 participants with prescribed BP-lowering medication were included in the analysis (Figure 1). Suboptimal BP control was defined as systolic BP ≥140 mmHg or diastolic BP ≥90 mmHg among hypertensive participants using BP-lowering medication.[13]

2.2 | Measurements and definitions

Information on sociodemographics, lifestyle, medical history, healthcare use, health behavior, psychosocial health, and family history was obtained through questionnaires. Information on physical health was obtained through physical examination and blood sample collection, using standardized procedures.

Participant's ethnicity was determined based on the country of birth of the participant as well as that of their parents.[12] Based on median split of the age distribution, age was dichotomized into participants 55 years and younger and 56 years and older. Relationship

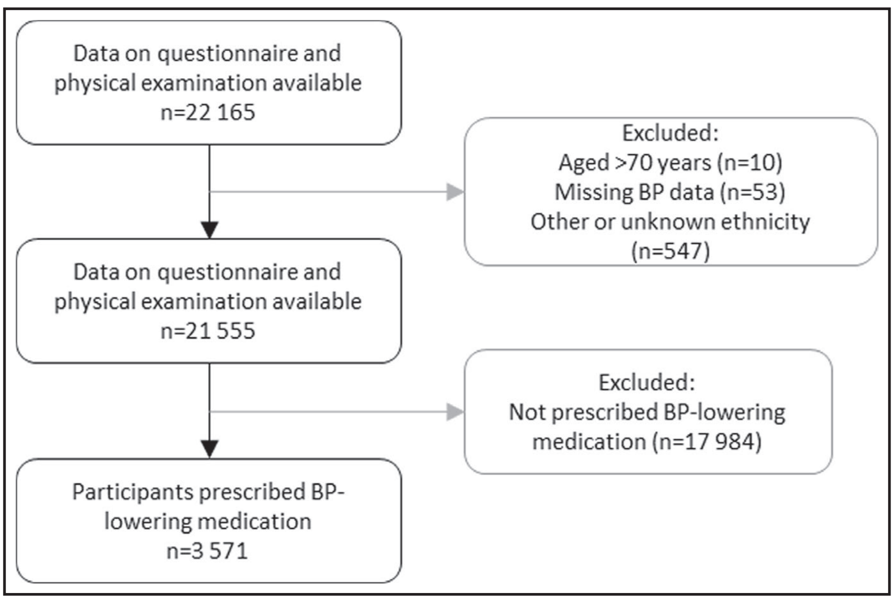

FIGURE 1 Flowchart of participants included in the analysis. BP, blood pressure

status was dichotomized into being married/having a registered partnership/living together, and being single/divorced/widowed. Level of education was based on the highest qualification attained in either the Netherlands or in the country of origin, and grouped into two categories: lower (secondary school or below) and higher education (vocational training and above). Employment status was classified into being employed or being unemployed/retired/student/fulltime home keeper/on social benefits. Smoking was classified into current smoking and never/former smoking. Use of alcohol was based on the reported units of alcohol intake per week and categorized into low (men 0-4 units/week and women 0-2 units/week) or moderate/high (men >4 units/week and women >2 units/week). Physical activity was assessed using the Short Questionnaire to Assess Health-Enhancing Physical Activity questionnaire[14] and was dichotomized into ≥5 days, 30 min/day versus <5 days, 30 min/day. Participants with a self-reported history of stroke, myocardial infarction, or coronary or peripheral revascularization were classified as having a history of cardiovascular disease (CVD). Healthcare use was defined by the last time BP was checked by a healthcare professional and classified into <6 months ago, 6 months to 1 year ago, or >1 year ago. Participants were asked to bring all prescribed medication to the research location. BP-lowering medication was classified according to the Anatomical Therapeutic Chemical (ATC) classification.[15] Adherence to BP-lowering medication was assessed by a previously validated self-report question,[16] where participants were asked how many days of the week they took their prescribed medication. Participants reporting to have taken their medication <7 days per week either during physical examination and/or in the questionnaire were categorized as non-adherent, whereas those reporting to take their medication on 7 days per week on both occasions (physical examination and questionnaire) were considered to be adherent. Depressed mood was defined as having a score of ≥10 on the Patient Health Questionnaire 9, a questionnaire assessing the prevalence of depressive symptoms over the preceding two weeks.[17] Psychological stress was assessed with two single-item questions relating to stress at work and home, derived from the INTERHEART study.[18] Stress at home/work was classified into never/during some period, and during several periods/permanently. Participants were considered as having a family history of hypertension, if they reported a first degree relative to be diagnosed with hypertension.

Weight and height were measured twice to the nearest decimal place, in light clothing without shoes. The mean of the two readings was used for analysis. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Overweight was defined as a BMI ≥25-30 kg/m^2 and obesity as BMI ≥30 kg/m^2. Waist circumference (WC) was measured at midpoint between the lower margin of the last palpable rib and the top of the iliac crest. Abdominal obesity was defined as a WC ≥102 cm in men and ≥88 cm in women. BP was measured twice, in a sitting position with an appropriate cuff on the participant's left arm, using a semi-automated oscillometric device (Microlife WatchBP Home; Microlife AG), after at least 5 minutes rest. The mean of the two measurements was used in the analyses.

Blood samples were collected after a 10-14 hours fast to determine fasting plasma glucose and creatinine levels. Diabetes was defined as fasting plasma glucose ≥7 mmol/L and/or use of glucose-lowering medication.[19] Estimated glomerular filtration rate (eGFR) was calculated using the Chronic Kidney Disease (CKD) Epidemiology Collaboration creatinine equation taking ethnicity into account; CKD was defined as having an eGFR <60 ml/min/1.73 m^2.[20]

2.3 | Statistical analysis

Data on categorical variables were presented by frequencies and percentages, continuous variables were presented by means and standard deviations. For suboptimal BP control, crude prevalence rates with corresponding 95% confidence intervals were calculated using the Wilson method.

Univariate logistic regression was performed to assess the association between each predictor variable and suboptimal BP control, for the total population and for the ethnic groups separately. Following that, a multivariate logistic regression model was built for the total population, using logistic regression with backwards stepwise selection of the covariates based on the Akaike information criterion, resulting in a subset of predictor variables included in the final model. The model selection process was cross-checked using forward selection and sequential replacement of predictor variables. The final model was fitted to the ethnic subgroups, to assess which variables were independently associated with suboptimal BP control in each group. Multicollinearity between the variables included in the regression analysis was assessed using the variation inflation factor (VIF). As all VIFs were <3, multicollinearity between the independent variables was considered unlikely. All analyses were performed using R Statistics version 3.6.2 (R Core Team (2019), using the "tableone" version 10.0, "MASS" version 51.4, and "car" version 7.0 packages. R Foundation for Statistical Computing).

3 | RESULTS

3.1 | Baseline characteristics

Characteristics of the study population are described in Table 1. Ghanaian, Turkish, and Moroccan participants were younger and had a lower level of education. Smoking prevalence was low in Ghanaian and Moroccan, as was alcohol intake in Turkish and Moroccan participants. A majority of the study population was overweight or obese, with the highest prevalence of obesity in the Turkish population. Nearly half of the South-Asian Surinamese and Moroccan participants had diabetes. Depressed mood and psychosocial stress were reported by nearly one-third of the Turkish participants. More than half (53.3%) of the study population had suboptimal BP control, with a prevalence ranging from 43.9% in Turkish to 62.3% in Ghanaian participants.

TABLE 1 Characteristics of study population

	Total	Dutch	South-Asian Surinamese	African Surinamese	Ghanaian	Turkish	Moroccan
N	3571	500	656	1052	637	433	293
Female (%)	2210 (61.9)	251 (50.2)	370 (56.4)	733 (69.7)	394 (61.9)	267 (61.7)	195 (66.6)
Age >55 years (%)	1852 (51.9)	367 (73.4)	396 (60.4)	616 (58.6)	182 (28.6)	162 (37.4)	129 (44.0)
Married, living together (%)	1739 (49.0)	327 (65.5)	328 (50.5)	333 (31.9)	223 (35.3)	318 (73.6)	210 (71.9)
Education, intermediate/higher (%)	1307 (37.0)	280 (56.7)	222 (34.0)	483 (46.4)	172 (27.4)	78 (18.2)	72 (24.8)
Employed (%)	1606 (45.7)	244 (48.9)	302 (46.5)	543 (52.2)	330 (52.8)	120 (28.7)	67 (23.5)
Current smoking (%)	700 (19.7)	128 (25.6)	155 (23.7)	269 (25.8)	27 (4.3)	103 (24.1)	18 (6.2)
Moderate/high alcohol intake (%)	640 (18.1)	291 (58.4)	87 (13.3)	152 (14.7)	87 (13.7)	19 (4.4)	4 (1.4)
Physically active (%)	2094 (58.7)	375 (75.2)	390 (59.5)	651 (62.0)	346 (54.3)	179 (41.3)	153 (52.2)
BMI category (%)							
Normal weight (BMI <25)	585 (16.4)	136 (27.2)	147 (22.4)	170 (16.2)	83 (13.1)	27 (6.2)	22 (7.6)
Overweight (BMI 25-30)	1428 (40.1)	206 (41.2)	314 (47.9)	395 (37.6)	268 (42.1)	134 (31.0)	111 (38.1)
Obesity (BMI ≥30)	1552 (43.5)	158 (31.6)	194 (29.6)	486 (46.2)	285 (44.8)	271 (62.7)	158 (54.3)
Abdominal obesity (%)	2417 (67.8)	323 (64.6)	402 (61.4)	724 (69.0)	408 (64.2)	336 (77.6)	224 (76.7)
Diabetes Mellitus (%)	1072 (30.2)	79 (15.9)	302 (46.2)	290 (27.9)	131 (20.7)	135 (31.4)	135 (46.1)
Chronic kidney disease (%)	164 (4.6)	29 (5.8)	49 (7.5)	41 (4.0)	23 (3.6)	11 (2.6)	11 (3.8)
CVD history (%)	621 (17.7)	109 (21.9)	179 (27.8)	135 (13.0)	54 (8.8)	108 (25.4)	36 (12.7)
Last time BP checked (%)							
<6 months	2899 (81.4)	352 (70.4)	559 (85.2)	868 (82.7)	548 (86.2)	333 (77.6)	239 (81.6)
6 months-1 year	427 (12.0)	96 (19.2)	68 (10.4)	131 (12.5)	55 (8.6)	48 (11.2)	29 (9.9)
>1 year	237 (6.7)	52 (10.4)	29 (4.4)	50 (4.8)	33 (5.2)	48 (11.2)	25 (8.5)
Non-adherent to BP-lowering medication (%)	388 (10.9)	29 (5.8)	69 (10.6)	152 (14.5)	72 (11.4)	41 (9.6)	25 (8.7)
Depressed mood (%)	573 (16.3)	43 (8.6)	135 (20.7)	124 (11.9)	66 (10.6)	136 (32.0)	69 (24.1)
Perceived stress (%)	784 (22.2)	93 (18.6)	159 (24.4)	203 (19.5)	113 (18.1)	138 (32.2)	78 (27.2)
Positive family history for hypertension (%)	2380 (67.1)	286 (57.2)	505 (77.2)	830 (79.3)	332 (52.6)	262 (61.5)	165 (56.9)
Systolic BP (mean (SD))	140.3 (17.9)	136.2 (16.4)	141.1 (17.5)	141.1 (17.5)	144.3 (17.8)	136.8 (18.0)	138.8 (17.4)
Diastolic BP (mean (SD))	84.8 (10.5)	82.3 (10.1)	83.9 (10.0)	85.7 (10.2)	89.1 (10.6)	82.7 (10.7)	81.5 (9.9)
Suboptimal BP control (%)	1902 (53.3)	221 (44.2)	360 (54.9)	597 (56.7)	397 (62.3)	190 (43.9)	137 (46.8)

Note: Abbreviations: BMI, body mass index; BP, blood pressure; CVD, cardiovascular disease; N, number; SD, standard deviation.

3.2 | Factors associated with suboptimal BP control

Results of the univariate logistic regression are presented in Table S1.

The results of the stepwise multivariate logistic regression analysis (Figure 2) showed female sex, being married/living together, current smoking, moderate/high alcohol intake, and CVD history were associated with lower odds of suboptimal BP control, whereas obesity, non-adherence to BP-lowering medication, and a family history for hypertension were associated with higher odds of suboptimal BP control.

In the ethnic-stratified analysis (Figure 3), female sex was independently associated with lower odds of suboptimal BP control in all groups with the association in Moroccans being borderline significant. Smoking was associated with lower odds for suboptimal control in Turks and to a lesser extent in Moroccans. Additionally, CVD history was associated with lower odds of suboptimal BP control in Dutch,

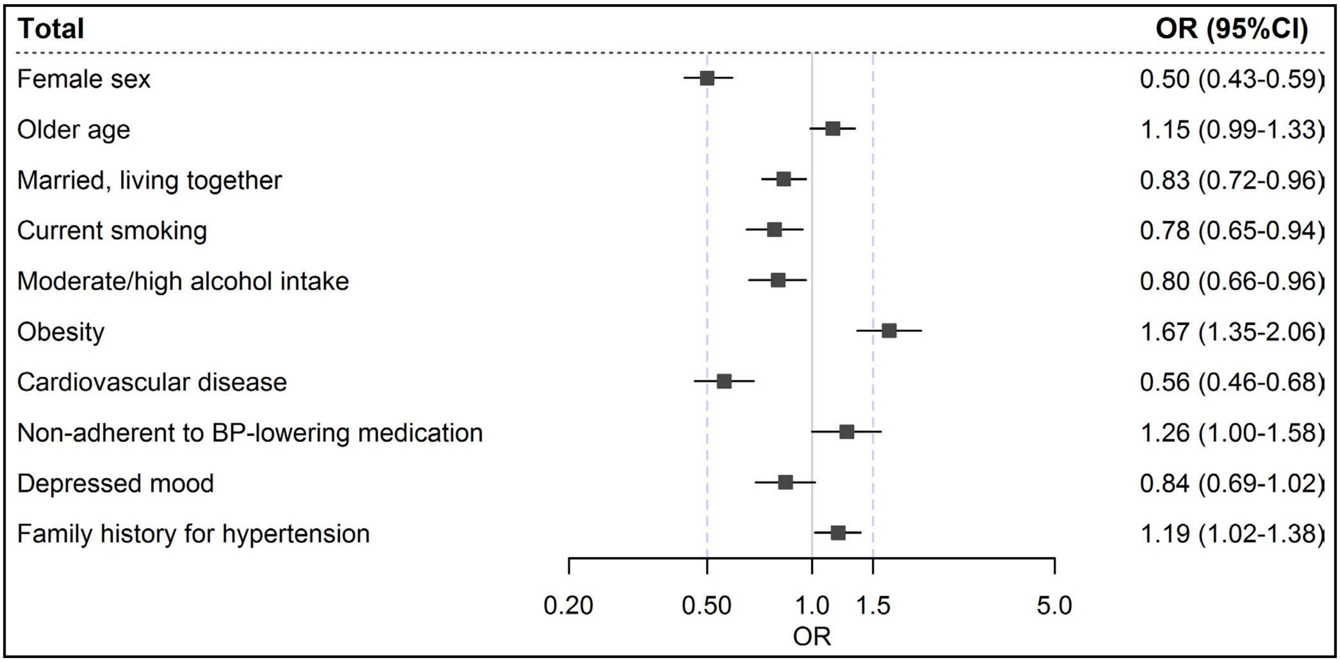

FIGURE 2 Determinants of suboptimal blood pressure control for the total population, derived from multivariate regression analysis. Error bars are 95% confidence intervals; OR, odds ratio; CI, confidence interval; BP, blood pressure

South-Asian, and African Surinamese, but not in the other groups. Older age was associated with higher odds of suboptimal BP control in the Turkish population only. Obesity was associated with higher odds of suboptimal BP control in all groups except for the Moroccan and South-Asian Surinamese groups, with the latter showing borderline significance. In Dutch, non-adherence to BP-lowering medication was associated with higher odds for suboptimal BP control.

To test the robustness of the final model built in the total population, we performed a backwards stepwise model building process in each ethnic group separately. There were no relevant differences between the models built in the total population and for each ethnic group separately, suggesting the model built in the total population included the most important determinants of suboptimal BP control. Because of the strong association between sex and suboptimal BP control, we performed sex-stratified analysis for the total population. In both males and females, CVD history was associated with lower odds, and obesity was associated with higher odds of suboptimal BP control (Table S2). Additionally, in males, smoking was associated with lower odds, and medication non-adherence and positive family history were associated with higher odds of suboptimal BP control. In females, however, older age was associated with higher odds of suboptimal BP control.

4 | DISCUSSION

4.1 | Key findings

We found that in this multi-ethnic population, obesity, non-adherence to BP-lowering medication, and a family history for hypertension were independently associated with higher odds of suboptimal BP control. Female sex, being married or living together, smoking, moderate to high alcohol intake, and CVD history were all associated with lower odds of suboptimal BP control. The most consistent determinants of suboptimal BP control across all ethnic groups were female sex and obesity, but the other determinants showed distinctive difference between the groups, with older age and current smoking being associated in Turkish, CVD history in Dutch, South-Asian Surinamese, and African Surinamese, and non-adherence to BP-lowering medication in Dutch population only.

4.2 | Discussion of the key findings

Female sex and obesity were the main drivers of suboptimal BP control and showed to be consistent between the different ethnic groups. The finding of other determinants being ethnic-dependent is in line with previous literature from the United States,[9] where, for instance, heavy alcohol drinking and low physical activity were associated with suboptimal BP control in African Americans but not in Whites or Mexican Americans.[7] A previous study from the Netherlands including Dutch, African, and South-Asian Surinamese participants also found differences in determinants between the ethnic groups, with educational level and physical activity being associated with suboptimal BP control in Dutch but not in the other ethnic groups, and older age being associated in South-Asian Surinamese only.[21] These findings imply that ethnic differences in determinants of suboptimal BP control do also exist in a European setting, and clinicians should be aware of these differences when treating patients with hypertension. However, more research should be conducted to replicate these findings in other ethnic minority populations and different settings in Europe.

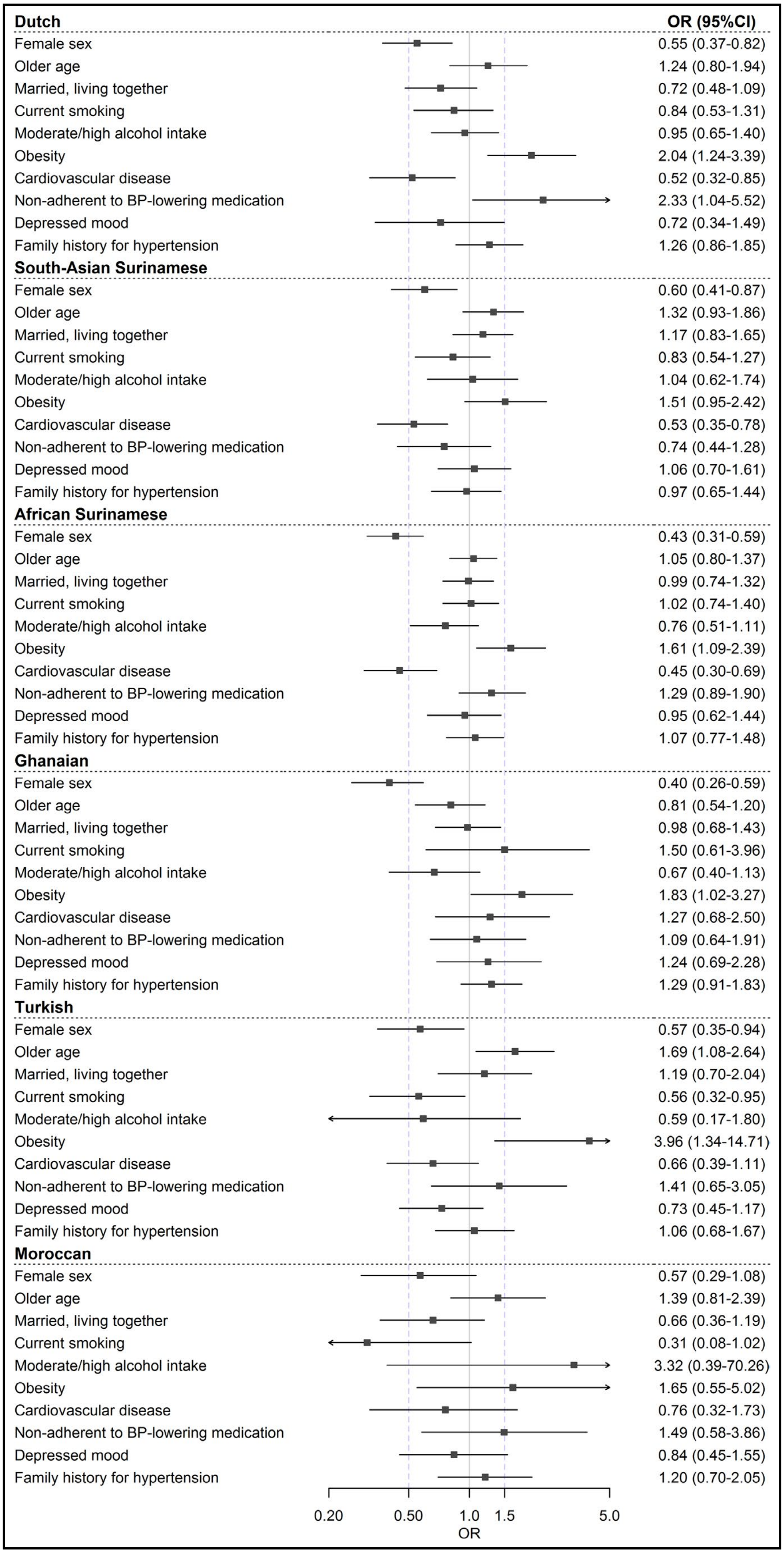

FIGURE 3 Determinants of suboptimal blood pressure control derived from ethnic-stratified multivariate regression analysis. Error bars are 95% confidence intervals; OR, odds ratio; CI, confidence interval; BP, blood pressure

Our finding that female sex is associated with lower odds of suboptimal BP control is in line with previous literature from multi-ethnic populations in the United States and Europe.[2,22] The association with female sex was independent of other determinants that are known to impact hypertension control rates, including educational level, BMI, and regular BP checks. We found this association to be consistent and substantial in the various ethnic groups. In sex-stratified analysis, obesity and CVD history were important determinants of suboptimal BP control in both sexes, but medication non-adherence and positive family history seemed to be more important in males than in females, providing insight into the potential mechanism linking sex to BP control. However, as our sample size did not allow for combined sex- and ethnic-stratified analysis, we were not able to assess sex-specific risk factors for suboptimal BP control within each ethnic group.

Obesity was positively associated with suboptimal BP control in almost all ethnic groups, and in both males and females. BMI is an important BP determinant and obesity is a well-known risk factor for hypertension and resistant hypertension, thereby increasing the risk of suboptimal BP control. Additionally, obesity might be a reflection of other factors such as socioeconomic status and health behavior, further impacting BP control.[23] The strong association between obesity and suboptimal BP control highlights the importance of weight reduction in addition to the pharmacological treatment in order to achieve BP control.[24]

Generally, older age is known to be associated with higher levels of suboptimal BP control rates; however, in our study, older age was associated in the Turkish population only. Health literacy potentially plays a role in this observation. Previous research has shown Turkish populations in the Netherlands to have a lower level of health literacy compared to the Dutch host population, whereas this was not observed for Moroccan or Surinamese populations.[25] Adequate health literacy is a prerequisite to appropriate health decision-making and has previously been associated with better hypertension control.[26] It is conceivable that health literacy is lower among older Turkish migrants, as they more often have a low level of education and limited proficiency in Dutch,[27] hereby affecting rates of suboptimal BP control.

Differences in perceived risk of CVD could explain the inverse association between current smoking and alcohol intake and suboptimal BP control in the total population. This inverse association has been previously described.[22] Potentially, participants who smoke or have high alcohol intake have a higher perceived CVD risk and are therefore more likely to adhere to BP-lowering medication, hereby increasing their likelihood of reaching BP control. However, why this association was only observed in the Turkish and to a lesser extent in the Moroccan population, but not in the other groups, is unknown.

Participants with a positive history of CVD had lower odds of suboptimal BP control, possibly due to a higher awareness among both patients and clinicians of the importance of tight BP control as part of secondary prevention of CVD.[28] However, this association was only observed in Dutch, South-Asian, and African Surinamese subgroups. This suggests there might be insufficient understanding of health information among ethnic minority groups, namely Ghanaian, Turkish, and Moroccan populations, who may have relatively low Dutch language proficiency. In addition, the absence of association between CVD history and BP control in these groups might be related to the accuracy of self-reported CVD history among these populations, as equivalent translations of the questions to their mother tongue could have been difficult, or the disease labeling might differ across ethnic backgrounds.[29] Alternatively, lower odds of suboptimal BP control among participants with CVD history could be a result of reduced BP because of heart failure or other CVD medication influencing BP (eg, beta blockers).[30]

Medication non-adherence is generally considered to be an important determinant of suboptimal BP control, which was reflected by our findings. However, when stratified by ethnicity, only in the Dutch population non-adherence to BP-lowering medication was independently associated with suboptimal BP control. Although self-reported medication adherence questionnaires have been widely used in epidemiological research and have shown to be correlated to objective measures of medication adherence, studies have consistently shown an overestimation of medication adherence rates when self-report was compared to objective measures.[31] This would imply that the contrast between those being adherent and non-adherent to BP-lowering medication might be altered, masking the association with suboptimal BP control in the ethnic minority groups. Furthermore, the difference in association between the Dutch and ethnic minority groups might be attributable to the potential limited validity of self-reported adherence in ethnic minority groups. For instance, cultural standards, values, and expectations within some migrant communities might lead to social desirable answers.[29] Lastly, self-reported medication adherence might be only an indicator of medication initiation, not reflecting long-term medication adherence. For instance, previous research among patients with hypertension from Surinamese and Ghanaian origin reported to take their antihypertensive medication only when they perceive to have symptoms, or to take a "medication holiday" when they travel abroad to their country of origin.[32] Thus, efforts should be made to develop cultural-adapted, validated instruments to assess medication adherence in epidemiological research.

4.3 | Strengths and limitations

A strength of the HELIUS study is the inclusion of a large number of participants from various ethnic origins, as well as the extensive, highly standardized data collection. This allowed us to assess a broad range of potential determinants of suboptimal BP control and to stratify our results by ethnicity, hereby assessing ethnic-specific factors. With European populations becoming increasingly ethnically diverse, the findings of our study are of interest to healthcare professionals working in other multi-ethnic metropolises in Europe.

However, as cross-sectional data were analyzed, assumptions with regard to causality should be made with caution. Also, we were not able to assess the potential impact of access to health care to suboptimal BP control as data on these indicators were not collected. Moreover, the rates of suboptimal BP control could have been overestimated, as BP was measured on a single occasion, potentially reducing the strength of the associations. Moreover, the strength of the associations could have been impacted by the self-reported nature of many of the included factors, and the reliability of these assessments may be different for participants with and without suboptimal BP control. In addition, the smaller sample size of especially the Moroccan group could have resulted in lower statistical power to detect factors significantly associated with suboptimal BP control, which is supported by the observed similar trend in association of female sex and suboptimal BP control.

In conclusion, this study identified several sociodemographic, lifestyle, health, and psychosocial determinants of suboptimal BP control in a multi-ethnic population, with distinct differences in associated determinants between ethnic groups. Knowledge about these key determinants may provide further opportunities to mitigate the excess risk observed in most ethnic minority groups and inform clinicians that focussing on high-risk factors and modifiable determinants of suboptimal BP control is worthwhile in order to improve BP control rates in a multi-ethnic patient population. Further research is needed to replicate these findings and to develop interventions that are culturally appropriate to decrease the observed ethnic disparities in rates of suboptimal BP control rates.

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CONFLICT OF INTEREST

Nothing to declare.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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