The association between socioeconomic status and prevalence, awareness, treatment and control of hypertension in different ethnic groups: the Healthy Life in an Urban Setting study

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Background: Socioeconomic status (SES) and ethnicity are both important determinants of hypertension prevalence and control rates but their separate contribution is unknown. We assessed the association of SES with hypertension prevalence, awareness, treatment and control, and whether this differs between ethnic groups.

Methods: We used baseline data from the Healthy Life in an Urban Setting (HELIUS) study, a multiethnic population-based cohort study, including 18,106 participants (84% of the total cohort) of Dutch (n = 4,262), African Surinamese (n = 3,732), Moroccan (n = 2,902), Turkish (n = 2,604), South-Asian Surinamese (n = 2,664) and Ghanaian (n = 1,947) descent with data on SES and hypertension status.

Results: Regardless of ethnicity, lower SES was associated with higher hypertension prevalence, especially in participants with no education compared with those with higher levels of education [OR 2.29 (2.05–2.56)]. There was an inverse association between SES and hypertension treatment with the strongest association for lower compared with higher educated participants [OR 1.63 (1.39–1.90)]. In addition, lower SES was associated with lower hypertension control with the strongest association for participants with the lowest compared with the highest occupational level [OR 0.76 (0.60–0.95)]. The association between educational level and treatment but not the other SES- or hypertension-indicators, was influenced by ethnicity, with lower educated Dutch and African Surinamese having higher ORs for hypertensive treatment [Dutch OR 1.98 (1.43–2.76); African Surinamese OR 1.44 (1.10–1.89)].

Conclusion: SES, in particular education, impacts hypertension treatment in the Netherlands, whereas the association of specific SES parameters with hypertension indicators differ across ethnic groups. Further exploration is needed on how sociocultural beliefs and behaviours may differentially affect blood pressure control across ethnic minority populations.

Keywords: education level, ethnicity, Healthy Life in an Urban Setting study, hypertension, occupation, socioeconomic status

Abbreviations: AHA, American Heart Association; BP, blood pressure; CI, confidence interval; CVD, cardiovascular disease; CVRM, cardiovascular risk management; ESC, European Society of Cardiology; ESH, European Society of Hypertension; HELIUS, Healthy Life in an Urban Setting; IQR, interquartile range; OR, odds ratio; SD, standard deviation; SES, socioeconomic status

INTRODUCTION

Worldwide around 17 million deaths are caused by cardiovascular disease (CVD) each year [1]. Early detection, treatment and control of hypertension significantly reduces the risk of CVD, but despite the availability of guidelines and cheap and effective treatment, in a large number of patients hypertension remains undetected, untreated or inadequately controlled [2,3]. In high-income countries, socioeconomic status (SES) is positively associated with health [4]. It is hypothesized that socioeconomic disadvantage leads to lower access to care,
lower health literacy or diminished ability to pursue a healthy lifestyle [2,3]. For migrant populations from low-income and middle-income countries residing in high-income countries, the association of SES with hypertension has not been well established [5]. Limited evidence is available about the association of SES with awareness, treatment and control of hypertension especially for migrant groups [3]. It has been shown that prevalence of hypertension is higher in ethnic minority groups in Europe [5–8], and that hypertension is more frequently uncontrolled compared with the host European populations [5,9,10]. This implies that ethnicity is an important factor to consider in hypertension management. The reasons for inequalities in hypertension prevalence among people with different ethnicities are still unclear, although migration-related lifestyle changes, aging and genetic predispositions have been suggested as potential underlying factors [5,10]. As ethnic minority groups in high-income countries mostly have lower SES [11], this may contribute to previously reported higher hypertension prevalence rates and lower control rates. Therefore, our aim was to investigate the association of SES with hypertension prevalence, awareness, treatment and control in a multiethnic population and assess whether this association is similar for different ethnic groups.

DATA AND METHODS

Study population
For this research, baseline data from the Healthy Life in an Urban Setting (HELIUS) study was used. The rationale, conceptual framework, design and methodology of the HELIUS study have been described elsewhere [12,13]. In brief, HELIUS is a multiethnic population-based cohort study that has been set up to investigate health and healthcare utilization among the six major ethnic groups in Amsterdam, The Netherlands. Participants were randomly selected from the municipal registers of Amsterdam, with stratified sampling for different ethnic groups to allow for comparable group sizes. Baseline data collection took place between January 2011 and June 2015. Participants were aged 18–70 years at examination and were from African Surinamese; South-Asian Surinamese; Turkish, Moroccan, Ghananian and Dutch ethnic origin. The study protocols were approved by the Institutional Review Board of the Amsterdam University Medical Centre at the University of Amsterdam. All participants provided written informed consent prior to study enrolment.

Definitions and measurements
The data were collected by standardized questionnaires and physical examination. During physical examination, biological samples were obtained.

Ethnicity was defined according to the registered country of birth as well as that of the participants’ parents. Participants were considered as non-Dutch ethnic originated if either of the following criteria were fulfilled: being born outside of the Netherlands with at least one of his/her parents born abroad (first generation migrant); or being born in the Netherlands, but both parents were born abroad (second generation migrants). The selected ethnicities were chosen as they constitute the largest ethnic minority groups in Amsterdam, where 35% of inhabitants have a non-Western origin [14]. On the basis of their migration background, which traces back to West-Africa (Ghanaians and African-Surinamese), Northern India (South-Asian Surinamese), Morocco and Turkey they are among the main ethnic minority groups in Europe originating from outside of the European Union. Participants of Surinamese ethnic origin were further classified according to self-reported ethnic origin (obtained by questionnaire) into ‘African’, ‘South-Asian’ or ‘other’ [13].

Individuals were classified as hypertensive if their SBP was at least 140 mmHg or DBP was at least 90 mmHg at time of physical examination [15], or if they reported use of antihypertensive medication. Blood pressure (BP) was measured in duplicate using a validated automated digital BP device (Microlife WatchBP Home, Microlife AG, Heerbrugg, Switzerland) on the left arm in a seated position after the participant had been seated for at least 5 min, and the mean of the two measurements was used in the analyses [5]. Following previous research, we defined awareness of hypertension as all participants with hypertension during physical examination that self-reported any prior diagnosis of hypertension by a health-care professional [5]. Treatment of hypertension was defined as the proportion of hypertensive participants that reported receiving prescribed antihypertensive medication for management of elevated blood pressure at time of the interview. Hypertension control was defined as the proportion of hypertensive patients on self-reported antihypertensive medication with SBP less than 140 mmHg and DBP less than 90 mmHg at the time of physical examination. Cardiovascular disease was defined as self-reported hospital admission for stroke, myocardial infarction, percutaneous coronary intervention or coronary artery bypass graft.

We used educational level, occupational level as indicators of SES. Educational level was based on the highest qualification attained in the Netherlands or in the country of origin and was classified into four categories: never been to school or elementary school; lower vocational schooling or lower secondary schooling; intermediate vocational schooling or intermediate or higher secondary schooling; higher vocational schooling or university (e.g. postsecondary schooling or university of applied sciences). Occupational status was chosen to be one of the indicators, to compare people in and outside the working environment. Occupational status was classified into the following four categories: employed; not in working population (retirees, housemaker, students or schooling people); unemployed; and unfit for work (incapacitated). Occupational level was classified according to the Dutch Standard Occupational Classification system [16], which provides an extensive systematic list of all professions in the Netherlands, and consisted of five categories, based on job title and job description, including a question on fulfilling an executive role. The categories were classified as follows: elementary occupations; lower occupations; middle or secondary occupations; higher occupations; scientific occupations. In this study, because of small number of participants in the latter two groups, we combined the categories higher and scientific occupations to form one category.
Selection of participants
For the present study, we used the data of all individuals with available information on SBP and DBP and antihypertensive medication at time of physical examination (n = 22 112). We excluded all participants with unknown or other ethnic origin (n = 547) and excluded an additional 3459 participants with missing data on SES indicators, leaving 18106 participants for analysis (Fig. 1). We chose to perform analysis on this smaller dataset to prevent indistinctive comparisons, and the remaining number of participants in each subgroup in the cohort was still large. Compared with those with complete cases, participants with missing SES data were comparable in age and sex, and prevalence of hypertension but were more frequently of Ghanaian, Turkish or Moroccan origin and were more likely to have a lower level of education (Supplemental File 1, http://links.lww.com/HJH/B858). This resulting dataset consisted of 4262 Dutch, 3732 African Surinamese, 2802 Moroccans, 2699 Turkish, 2664 South-Asian Surinamese, and 1947 Ghanaians. For the analysis on occupational status, we excluded participants outside of the working population (e.g. retirees, homemakers and students) because of large heterogeneity in age in this subgroup (n = 2082). An overview of characteristics of all participants stratified by occupational status are described in Supplemental File 2, http://links.lww.com/HJH/B858. Compared with those employed, unemployed and unfit for work, participants not in the working population were more likely women, had a median higher age and had previously worked on a lower occupational level.

Statistical analysis
Baseline characteristics of the study populations were presented separately for each ethnic group with mean and standard deviation for normally and median with interquartile range nonnormally distributed continuous variables, and as number with percentage for categorical variables. Logistic regression analyses were performed to study associations between every SES indicator and hypertension prevalence, awareness, treatment and control, with and without adjustment for covariates with known association to hypertension. Throughout all analyses, we adjusted for age and sex in model 1. In model 2, we adjusted for age, sex and ethnicity. In model 3, we additionally adjusted for BMI [weight in kilograms divided by length in meters squared (kg/m²)] and diabetes (defined by a fasting plasma glucose level ≥7 mmol/l, self-reported diabetes, or treatment with glucose-lowering medication). In the final model (model 4), we additionally adjusted for history of cardiovascular disease. To study the effect of sex on the associations found, interaction analyses were performed. To assess the impact of ethnicity on the association between SES indicators and hypertension measures, we performed logistic regression analyses including interaction terms for each SES indicator/ethnicity. Comparisons were made between the model with and without the interaction term using an analysis of variance (ANOVA) analysis. We tested for interaction only in cases where the association between a specific SES indicator and hypertension measure was statistically significant. Logistic regression outcomes were expressed in terms of odds ratios (OR) with corresponding 95% confidence intervals (CIs). Analyses with two-sided P values of less than 0.05 were considered statistically significant. Statistical analyses were performed using the computing environment R (Version 4.0.0, The R Foundation for Statistical Computing).
RESULTS

Characteristics of the population

Baseline characteristics of the study population stratified by ethnicity are shown in Table 1. Overall, 9936 participants (54.9%) were women, among all six ethnicities, this was evenly distributed. The median age of the cohort was 46 years (IQR 41–54). Turks and Moroccans tended to be younger compared with other ethnic groups. The mean BMI of the cohort was 26.86 (SD 5.07). Ghanaians and Turks had significant higher mean BMI (28.55 and 28.04) compared with the Dutch host populations (24.79). Diabetes mellitus was present in 1550 participants (8.6%) and was most prevalent among Ghanaians (36.6%) and African Surinamese (43%).

Most migrants had a low or intermediate educational level, whereas the proportion of individuals having a higher level of education was larger in individuals of Dutch origin.

Overall, 68.1% of participants were employed, whereas only 7.6% was unfit for work. Greatest number of unemployment was seen in Ghanaians (21.1%), whereas the lowest (5.5%) was observed in the host population.

The proportion of individuals working on a higher occupational level was larger in the Dutch population compared with the ethnic minority groups.

Socioeconomic status and hypertension prevalence

Lower education levels were associated with higher hypertension prevalence rates (Fig. 2a). This effect remained significant after adjustment for ethnicity, BMI and diabetes [OR 1.45 (1.26–1.66)] for the lowest education level (Table 2a). Furthermore, regression analysis showed a significant association between hypertension prevalence and the other two SES indicators, when adjusting for age and sex (Fig. 2a). In an age-sex adjusted model, being unemployed was associated with 1.39 (1.25–1.54) times higher odds for hypertension compared with being employed.
FIGURE 2 Hypertension prevalence, awareness, treatment and control and socioeconomic status indicators education, occupational level and occupational status (adjusted for sex and age). CI, confidence interval; OR, odds ratio; ref: reference; \( P \) value less than 0.05 is significant; *statistically significant for overall association. (a) Hypertension prevalence, \( P \) value is less than 0.001 in all three logistic regression analyses. (b) Hypertension awareness, \( P \) value is only significant in the association between occupational status and awareness. (c) Hypertension treatment, \( P \) value is less than 0.001 in all three regression analyses. (d) Hypertension control, \( P \) value is only significant (\(<0.001\)) in the association between occupational status and control.
### TABLE 2. Logistic regression analysis results for each adjustment model

#### (a) Hypertension prevalence and SES indicators (education, occupational status and occupational level)

|                                | Model 2 OR (95% CI)     | P value | Model 3 OR (95% CI)     | P value | Model 4 OR (95% CI)     | P value |
|--------------------------------|-------------------------|---------|-------------------------|---------|-------------------------|---------|
| **Education (n = 18 106)**     |                         |         |                         |         |                         |         |
| Higher                         | ref                     | ref     | ref                     | ref     | ref                     | ref     |
| Intermediate                   | 1.48 (1.33–1.66)        | <0.001  | 1.32 (1.18–1.47)        | <0.001  | 1.31 (1.17–1.46)        | <0.001  |
| Lower                          | 1.46 (1.31–1.63)        | <0.001  | 1.25 (1.12–1.39)        | <0.001  | 1.23 (1.10–1.37)        | <0.001  |
| Never been to school/elementary| 1.87 (1.63–2.15)        | <0.001  | 1.45 (1.26–1.66)        | <0.001  | 1.41 (1.22–1.61)        | <0.001  |

**P value for overall association:** <0.001

#### (b) Hypertension awareness and SES indicators (education, occupational status and occupational level)

|                                | Model 2 OR (95% CI)     | P value | Model 3 OR (95% CI)     | P value | Model 4 OR (95% CI)     | P value |
|--------------------------------|-------------------------|---------|-------------------------|---------|-------------------------|---------|
| **Education (n = 5963)**       |                         |         |                         |         |                         |         |
| Higher                         | ref                     | ref     | ref                     | ref     | ref                     | ref     |
| Intermediate                   | 1.06 (0.90–1.25)        | 0.489   | 1.04 (0.88–1.23)        | 0.683   | 1.02 (0.86–1.21)        | 0.818   |
| Lower                          | 1.01 (0.86–1.18)        | 0.919   | 0.97 (0.83–1.14)        | 0.744   | 0.96 (0.82–1.13)        | 0.626   |
| Never been to school/elementary| 0.96 (0.79–1.17)        | 0.692   | 0.90 (0.74–1.10)        | 0.299   | 0.88 (0.72–1.07)        | 0.197   |

**P value for overall association:** 0.28

#### (c) Hypertension treatment and SES indicators (education, occupational status and occupational level)

|                                | Model 2 OR (95% CI)     | P value | Model 3 OR (95% CI)     | P value | Model 4 OR (95% CI)     | P value |
|--------------------------------|-------------------------|---------|-------------------------|---------|-------------------------|---------|
| **Education (n = 5963)**       |                         |         |                         |         |                         |         |
| Higher                         | ref                     | ref     | ref                     | ref     | ref                     | ref     |
| Intermediate                   | 1.29 (1.09–1.53)        | 0.003   | 1.26 (1.06–1.50)        | 0.009   | 1.23 (1.03–1.47)        | 0.024   |
| Lower                          | 1.38 (1.17–1.63)        | <0.001  | 1.32 (1.12–1.56)        | 0.001   | 1.26 (1.06–1.50)        | 0.008   |
| Never been to school/elementary| 1.24 (1.02–1.51)        | 0.030   | 1.14 (0.93–1.39)        | 0.199   | 1.07 (0.87–1.31)        | 0.528   |

**P value for overall association:** <0.001

#### (d) Hypertension control and SES indicators (education, occupational status and occupational level)

|                                | Model 2 OR (95% CI)     | P value | Model 3 OR (95% CI)     | P value | Model 4 OR (95% CI)     | P value |
|--------------------------------|-------------------------|---------|-------------------------|---------|-------------------------|---------|
| **Education (n = 2997)**       |                         |         |                         |         |                         |         |
| Higher                         | ref                     | ref     | ref                     | ref     | ref                     | ref     |
| Intermediate                   | 0.89 (0.7–1.13)         | 0.341   | 0.89 (0.70–1.14)        | 0.362   | 0.89 (0.70–1.14)        | 0.366   |
| Lower                          | 0.91 (0.73–1.13)        | 0.379   | 0.95 (0.76–1.20)        | 0.682   | 0.92 (0.73–1.16)        | 0.490   |
| Never been to school/elementary| 0.85 (0.65–1.10)        | 0.222   | 0.93 (0.71–1.22)        | 0.613   | 0.91 (0.70–1.20)        | 0.517   |

**P value for overall association:** 0.14

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employed. A similar estimate was found after additionally adjusting for ethnicity [OR 1.30 (1.07–1.53)] but this association disappeared after additional adjustment for BMI, diabetes and history of cardiovascular disease (Table 2a). Compared with those with a higher occupational level, participants working in elementary occupations had an OR of 2.71 (2.44–3.02) for having hypertension (Fig. 2a). This effect remained significant after adjustment for ethnicity, BMI and diabetes [OR 1.29 (1.12–1.48)].

Socioeconomic status and hypertension awareness

We found a significant association between hypertension awareness and occupational status but not for educational or occupation level (Fig. 2b). Participants unfit for work had a significant higher OR [1.24 (1.04–1.48)] for being aware of their hypertension, compared with those in the working population; however, this association was not significant after adjustment for BMI, diabetes and history of cardiovascular disease (Table 2b).

Socioeconomic status and hypertension treatment

In participants with hypertension, both educational level and occupational status were significantly associated with hypertension treatment levels (Fig. 2c). Participants with lower educational level were 1.63 times (1.39–1.90) more likely to receive hypertension treatment, compared with those with a higher educational level in all four models (Table 2c). Participants without any or with elementary schooling only were more likely to be treated compared with those with the highest educational level [OR 1.44 (1.21–1.72), Fig. 2c], also after adjustment for ethnicity but this did not remain significant after additional adjustment for BMI, diabetes and history of cardiovascular disease (Table 2c). Being unemployed was significantly associated with a higher odds of hypertension treatment [OR 1.18 (1.01–1.38)] after adjustment for sex and age (Fig. 2c) but this association disappeared after additional adjustment for ethnicity (Table 2c).

In an age —sex-adjusted model, the elementary occupational level was associated with 1.46 times (1.23–1.72) higher odds of receiving treatment, compared with the highest occupational level (Fig. 2c). When additionally adjusting for ethnicity, BMI and diabetes with or without additional adjustment for cardiovascular disease, this association did not remain significant (Table 2c).

Socioeconomic status and hypertension control

Hypertension was less controlled among participants with elementary school or lower education [OR 0.78 (0.63–0.97)] compared with those with higher level of education (Fig. 2d). Participants with an elementary occupational level had lower rates of hypertension control [OR 0.76 (0.60–0.95)], compared with those with higher occupation level. These two associations did not remain significant after adjustment for ethnicity, BMI and diabetes (Table 2d). There was no association for hypertension control with other levels of education or occupational status (Fig. 2d).

Impact of ethnicity on the associations between socioeconomic status and hypertension

No significant interaction was found between sex and the SES indicators for all hypertension indicators. Therefore, we did not stratify by sex. Regarding hypertension prevalence, significant interaction was observed between ethnicity and the SES indicator education and occupational level (P < 0.001, see Supplemental Files 3, http://links.lww.com/HJH/B858 and 4, http://links.lww.com/HJH/B858). In Dutch educated people, from the lowest OR3.16 (2.12–4.73) to the intermediate level [OR1.91 (1.59–2.06)], it was more likely that hypertension was present compared with those with a higher level of education from the same ethnic origin (Fig. 3). This trend was also found in South-Asian Suriname and Turkish participants. In other ethnic minority groups, this tendency was also apparent but was not significant (P > 0.05). Regarding occupational level, Turkish participants with elementary [OR 2.87 (1.97–4.24)] and lower [OR 2.09 (1.46–3.04)] levels of occupation had higher odds of hypertension compared with those with a higher occupational level from this ethnic origin. An equivalent tendency was seen for participants of Moroccan descent. In contrast, for Ghanaians and South-Asian Surinamese, there was no significant difference between the participants working on lower occupational level compared with those working on a higher level.

Impact of ethnicity on the relation between socioeconomic status and hypertension awareness, treatment and control

No significant interactions were found between ethnicity and the SES indicators education, occupational status and occupational level (P > 0.05) and ethnicity did not significantly impact the association between hypertension control and SES indicators (education, occupational status and occupational level).
awareness and SES. However, significant interaction between ethnicity and the SES indicator education was observed for hypertension treatment ($P < 0.05$, Fig. 3). Dutch participants with lower [OR 1.98 (1.43–2.76)] and intermediate [OR 1.47 (1.05–2.06)] levels of education had higher odds of receiving treatment compared with Dutch with a higher level of education. In African Surinamese, those who never went to school or had elementary schooling were more likely (OR 2.02 [1.27–3.27]) to receive antihypertensive treatment compared with higher educated participants in this ethnic group, as were those with lower levels of education [OR 1.44 (1.10–1.89)]. In contrast, Moroccans with lower level of education were less likely to receive antihypertensive therapy [OR 0.40 (0.17–0.94)], compared with those with a higher level of education in this group. There were no other differences between the ethnic groups in the associations between educational level, occupational status and occupational level and hypertension treatment ($P > 0.05$). Regarding hypertension control, no significant interaction between ethnicity and the SES indicators’ education, occupational status and occupational level were found ($P > 0.05$).

### DISCUSSION

#### Key findings

In this large multiethnic population, lower SES was associated with higher hypertension prevalence, higher treatment levels and lower control rates.

Moreover, the association between hypertension prevalence and the SES indicators educational and occupational level differed between ethnic groups. Lower educated Dutch, South-Asian Surinamese and Turkish participants had higher odds for hypertension prevalence compared with higher educated individuals with the same ethnic background, whereas this was not observed for Ghanaians, African-Surinamese and Moroccans. Turkish and Moroccan participants had higher odds for hypertension prevalence when they were working on a lower occupational level compared with those working on a higher occupational level from the same ethnic origin. In contrast, this tendency was not found for Dutch, African-Surinamese, South-Asian Surinamese and Ghanaians. Additionally, we found that participants unfit for work were more likely to be...
aware of hypertension than those in the working population.

Ethnic disparities were also observed in the association between hypertension treatment and the SES indicator education, with lower educated Dutch and African Surinamese participants having a higher odd of receiving antihypertensive treatment compared with those with a higher level of education, whereas the opposite was observed in Moroccan participants.

Discussion of key findings

The association of SES with hypertension prevalence found in this study in part confirms previous observations from both high-income and middle-income countries and has been extensively documented in earlier research [6,11,17,18]. In all ethnic groups, lower SES was associated with higher hypertension prevalence rates, but there were no differences in hypertension awareness between individuals with lower and higher SES. This may point towards a relatively high accessibility of the Dutch healthcare system, which has a relatively low threshold resulting from universal health insurance coverage. This nationally mandatory health insurance is provided by private nonprofit insurers and covers all health expenditures with free access to general practitioners’ care and antihypertensive medication. Additionally, the Dutch healthcare system provides reimbursement of healthcare expenditure for people with lower income, so that accessibility across all SES groups is maximally enhanced [19,20]. The effectiveness of these measures can be observed in previous research, which has demonstrated that in ethnic minority groups in the Netherlands, despite a lower SES as defined, among others, by income, healthcare utilization is not lower than in the Dutch origin population [21]. In fact, utilization of general practitioner services, primary responsible for hypertension treatment, was found to be higher across all migrant groups, possibly caused by more comorbidity.

However, these associations may also result from a higher prevalence of comorbidities in individuals with lower SES, which may also explain why people who were unfit to work had a slightly higher chance of being aware, compared with employed individuals. This is consistent with previous findings from Howard et al. [22], indicating that awareness is greater among individuals with a more adverse risk factor profile, and specifically among individuals with diabetes and a history of CVD.

In contrast to previous reports, in which lower education and occupational level were related to a lower probability of receiving antihypertensive treatment, we found an inverse association between SES and hypertension treatment, where lower SES was associated with higher rates of hypertension treatment. Again, higher rates of adverse risk profiles in individuals with lower SES might lead to higher treatment rates, as we showed that ORs for hypertension treatment in different SES groups were substantially attenuated when adjusting for BMI and diabetes. In the Netherlands, the Dutch cardiovascular risk management guideline is used for decisions on drug treatment in hypertensive individuals. Deciding to start BP-lowering medication not only depends on the level of SBP, DBP or the presence of diabetes but also on the presence of other cardiovascular risk factors, such as smoking, family history of heart disease and high levels of cholesterol [23]. People from lower SES groups generally suffer from more cardiovascular risk factors, and are therefore, more likely to receive BP-lowering medication [24,25]. In addition, although evidence on this topic is scarce, it has been suggested that individuals with higher SES are more articulate in expressing preferences towards their physicians and might urge to postpone start of medication and await the effect of lifestyle changes [26]. Results from the SUNSET trial, however, contradict this as no association was observed between education and hypertension treatment in Dutch, African-Surinamese and South-Asian Surinamese [27]. We hypothesize that poor health outcomes among individuals with low SES has intensified the focus on low SES population by healthcare professionals, for example, general practitioners, as reflected by the high treatment rate observed in our study.

Ethnicity played a significant role in the association between educational level and hypertension treatment. Dutch and Surinamese of both African and South-Asian descent with lower educational level were more likely to receive treatment compared with those with higher educational level, albeit not significant in South-Asians. The opposite was found for Moroccan individuals, who had lower hypertension treatment levels with lower educational, whereas the opposite was observed in Ghanaian and Turkish descent participants. As also African and South-Asian Surinamese speak Dutch as their native language, we estimate that these disparities may relate to the ability to speak Dutch, which reduces possible barriers in healthcare communication and access.

Finally, cultural and ethnic factors may play a role in the treatment and control rates of certain groups. We found that both people with lower education and the lowest occupational level were less likely to achieve blood pressure control compared with those with higher levels of education and occupational level. This is consistent with above-mentioned research by Howard et al., showing that lower SES, defined by lower education and lower income, was related to less hypertension control in the USA. In this study, they observed significant ethnic differences in hypertension control that were only slightly reduced after adjustment for SES levels [22]. Findings from the multinational EIGHT Study also show an increase of uncontrolled hypertension with a decreasing level of individual wealth, however, this was only observed in low-income and not middle-income countries. Additionally, Beune et al. have suggested that social, cultural or migration-related issues play a role in the association between lower SES and hypertension control [28]. Self-alteration of prescribed medication and cultural beliefs, including reliance on natural additives and perceived side-effects have been described as probable causes of low BP control in migrants [29]. Additionally, medication self-efficacy and social support have been identified as main determinants of adherence to medication recommendations among patients from African descents in the Netherlands [30]. Therefore, despite high healthcare consumption and treatment rate, limited medication adherence might lead to lower control in these groups. We hypothesize that comorbidity and health literacy and the
penetration of prevention measures especially in migrants’ communities are most relevant in the association between SES and hypertension awareness and treatment but differences in ethnicity could be more valuable to focus on in hypertension control.

Although it is known that variables, such as BMI and diabetes mellitus, explain part of the differences in hypertension prevalence between ethnic groups, our aim was to include them in order to investigate their impact on the association between SES and hypertension across different ethnic groups. On the basis of these findings, we observed an important role for SES and ethnicity in hypertension management. We advocate for clinicians to consider the socioeconomic background of patients, of which most are generally well aware, in the management of hypertension by explaining therapy and giving lifestyle advice, especially in ethnic minority groups.

**Strengths and limitations**

The strengths of the HELIUS cohort are the inclusion of a large number of participants from several ethnic groups living in the same city and the collection of data from an extensive set of questionnaires and physical measurements. Outcomes and risk factors are measured based on the same methodology across all ethnic groups, including the majority population. The differences in baseline characteristics between ethnic groups are representative of the population living in the Netherlands.

Study limitations include first the lack of data on household income. It is possible that income may have differential effects on hypertension prevalence, awareness, treatment and control. Notwithstanding cultural differences and reservations on the communication of household income, the Dutch healthcare system provides free healthcare to all with health insurance, and essentially all inhabitants, including migrants, are insured. Therefore, we estimate that the role of financial status on hypertension awareness, treatment and control is limited [31]. Additionally, the indicators that we were able to include, such as education, have shown to be a powerful predictor for SES [32]. Second, although smoking causes an acute rise in blood pressure, the relation between chronic smoking and hypertension is less clear [33,34].

For the current analyses, we excluded participants lacking one or more SES indicators. Compared with those with complete cases, excluded participants had a lower level of education and were more likely to be unemployed. We think, however, that by excluding people with lower SES, some associations might have been attenuated rather than overestimated.

For the analysis on occupational status, we excluded participants outside the working population, which may have caused overrepresentation of older participants in the excluded group. However, the dispersion of age in this group represented a considerable number of both younger students and older retirees that would otherwise interfere with our analysis on occupational status (see Supplemental File 2, http://links.lww.com/HJH/B858).

Finally, blood pressure measurements were based on an average of two measurements on a single visit, which might have overestimated the blood pressure levels because of the ‘white-coat effect’. In a systematic review of previous studies, our group found no differences in white-coat effect between ethnic groups, therefore, this is unlikely to have had substantial impact on the analyses [35]. It is known that lower SES contributes to low health literacy, and therefore, could cause bias in reporting rates of self-reported use of BP-lowering medication among individuals with lower SES.

In conclusion, our study highlights that SES is associated with hypertension prevalence, treatment and control — but not awareness — in the Netherlands, and that the association between SES indicators and hypertension treatment differs between ethnic groups. We encourage clinicians to consider the socioeconomic background of patients, also in ethnic minority groups.

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**Conflicts of interest**

There are no conflicts of interest.

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