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Association of depressive symptoms and socioeconomic status in determination of blood pressure levels and hypertension: the CONSTANCES population based study

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ABSTRACT

Background: Inconsistent association between depression and hypertension has been highlighted. The association of depression with blood pressure (BP) might depend upon socioeconomic status (SES), but evidence remains weak.

Objectives: This study aimed to examine how the associations between depressive symptoms and BP levels and hypertension and then, according to SES variables (education, income, occupational status).

Methods: Among 66,478 volunteers of the French CONSTANCES cohort (31,093 men; mean age (standard deviation): 47.8 (12.9) years), depressive symptoms were assessed with the Center of Epidemiologic Studies Depression scale (CES-D). Overall associations between depressive symptoms and BP and hypertension were estimated using regressions and by stratifying on SES.

Results: SES were associated with BP in both genders. CES-D score was negatively associated with systolic BP (SBP) in women ($b=-0.62$ 95%CI [-1.03; -0.21] and in men ($b=-1.03$ 95%CI [-1.45; -0.61]) but not with diastolic BP (DBP) in both genders. In women, the decrease in SBP and DBP was more pronounced as educational level increases (p for interaction: 0.012 and 0.013, respectively). In men, few interactions were observed between CES-D score and SES factors for BP levels. The association between CES-D score and hypertension was significant for men, OR=0.86, 95%CI [0.80; 0.93] but not for women, OR=1.03, 95%CI [0.96; 1.10]. No interactions were observed between CES-D score and SES for hypertension.

Conclusion: Gender differences were observed for considering depressive symptoms according to SES factors for BP variation and hypertension. In women, educational level was the SES factor which has the main modifying effect on this association.

Keywords: depressive symptoms, blood pressure, hypertension, CES-D, socioeconomic status

INTRODUCTION

Hypertension is a major risk factor for cardiovascular diseases (Stokes et al., 1989) and could be more prevalent in persons with psychopathology (Carroll et al., 2001; Matthews et al., 2004). The World Mental Health Survey estimates that depression affects 350 million people worldwide (World Health Organization, 2012). Depression became the second global disease burden after ischemic heart disease since 2020. Recent large population studies have shown that psychiatric disorders were associated with hypertension (Sandström et al., 2016) and some studies have suggested that blood pressure (BP) may explain a part of the well-known association between psychopathology and cardiovascular diseases (CVD) (Scuteri, 2008). Nevertheless, some studies which have investigated the association between depression symptoms and BP have reported positive (Cuffee et al., 2014; Jackson et al., 2016; Maatouk et al., 2016), negative (Hildrum et al., 2011; Park et al., 2018; Wiernik et al., 2018) or nonexistent associations (Grimsrud et al., 2009; Yan et al., 2003). The meta-analysis of Meng et al. has shown that depression is associated with increased risk of hypertension incidence suggesting that it is an independent risk factor of hypertension (Meng et al., 2012). However, studies have observed a significant and negative association between levels of depressive symptoms and BP among large populations (Hildrum et al., 2011; Licht et al., 2009) and among elderly people (Liu et al., 2020). Globally, transversal studies have suggested that depression was negatively associated with blood pressure whereas longitudinal studies have shown a positive association (Nabi et al., 2011).

The literature has accumulated some evaluating effects of psychosocial factors with depression (Michal et al., 2013). Depressive symptoms varied considerably according to the role of contextual factors, including economic, environmental and demographic factors (Kessler et al., 2009). Socioeconomic status (SES) has come into focus as crucial determinant of depressive symptoms (Dinardo et al., 2014), showing that low SES-individuals presented higher odds of being depressed (V et al., 2007).

In parallel, many psychological factors, including depression, have been associated with increased risk of CVD, as has low SES (Havranek et al., 2015). Currently, the notion of social risk factors has been suggested to interact with psychological risk factors as etiology of CVD (Lemogne et al., 2017; Wiernik et al., 2018). Different levels of SES indicators (e.g., education, occupational status, income) could modify the effects of psychological factors in incidence of CVD. Psychosocial changes have brought transformations in social organizations.

The relationship between depressive symptoms and blood pressure has been investigated in many epidemiological studies (Jani et al., 2016; Kim et al., 2010). In parallel, hypertension was mainly associated with SES factors (Cherfan et al., 2019; Leng et al., 2015). Nevertheless, at our knowledge, no study has focused on the interactions between depressive symptoms, hypertension and SES. We hypothesized that depressive symptoms may have different associations with BP and hypertension according to the different levels of SES factors.

Main part of the studies investigating these associations are not representative of general population or country, and standardized measurements or definitions for SES and depression were lacking (Freeman et al., 2016). The CONSTANCES cohort is a large prospective population based cohort designed as a research infrastructure and as a large random sample of the French adult population (Goldberg et al., 2017). The main strengths of the CONSTANCES cohort is that it provides standardized measurements for blood pressure, and standardized definitions of a broad scope of health conditions and determinants, occupational factors and outcomes, including participants living and working in either urban or rural neighborhoods and diversified in terms of jobs of socioeconomic status. In the CONSTANCES cohort, depressive symptoms were evaluated with de CES-D score, which was a self-report scale designed to measure depressive symptomatology in the general population. Validity was established by patterns of correlations with other self-report measures, by correlations with clinical ratings of depression, and by relationships with other variables which support its construct validity (Radloff, 1977; Wiernik et al., 2018). Thus, the purpose of our study was to investigate, stratified by gender, the association between depressive symptoms, estimated by the CES-D score, with blood pressure levels and hypertension. Then, we investigated the extent to which the association between depressive symptoms, estimated by the CES-D score, and BP levels and hypertension might differ according to SES variables based on the CONSTANCES population.

METHODS

The CONSTANCES cohort

This ancillary study is a cross-sectional analysis using data from the CONSTANCES study. The general aim of CONSTANCES is to establish a large population-based cohort to contribute to the development of epidemiologic research (www.constances.fr). Details about the study design and methods have been extensively discussed (Zins et al., 2015).

CONSTANCES is an ongoing prospective cohort that started in 2012. Adults aged 18–69 at inception were randomly selected from the National Health Insurance Fund (CNAMTS: *Caisse Nationale d'Assurance Maladie des Travailleurs Salariés*) that covers salaried workers, professionally active or retired and their dependents (more than 85% of the French population) following a sampling scheme stratified on age, sex, socioeconomic status and region of France to ensure a representative sample of the CNAMTS.

Data collection

At enrollment, volunteer participants completed self-administered questionnaires where social, demographic, health information including personal and family history of diseases and events, and lifestyle behavior characteristics were gathered. In addition, they presented to the nearest of the 22-selected health-screening centers (HSCs) located throughout France, to benefit from a comprehensive health examination whereby medical, clinic exams, anthropometric measurements and biologic tests were performed. Furthermore, participants were linked through national social and health administrative databases, through which detailed information concerning health events and medical acts (medication, hospitalization) were noted.

Ethical considerations

All the participants included in the CONSTANCES cohort have signed an informed consent form. This research follows the tenets of the Declaration of Helsinki and was approved by the National Data Protection Authority (No. 910486) and the Institutional Review Board of the National Institute for Medical Research and the local Committee for Persons Protection.

Study population

Between February 2012 and January 2018, a total of 87,808 volunteers were recruited and linked to the French health insurance administrative database. Of them, we excluded 21,330 for missing data and not categorized variables and excluding participants with previous CV events. CV events were commonly recognize as cause of depression (Hare et al., 2014). We therefore analyzed data from 66,478 volunteers (**Figure 1**).

Hypertension and blood pressure

BP measurements were taken during the clinical examination at the HSC based on standardized operational procedures (Ruiz et al., 2016). SBP and DBP were measured in each

arm at 2 min interval after 5 min of rest and using an automated oscillometric sphygmomanometer. The arm giving the highest SBP was considered the reference arm and a third BP measure was taken after 1 min of rest, the average of these two measurements was considered. Prevalent HTN was defined by a SBP at least 140 mmHg and/or a DBP at least 90mmHg or by individuals taking antihypertensive medications (Williams et al., 2018).

Depressive symptoms

Depressive symptoms were assessed using the validated self-administered Center of Epidemiologic Studies Depression scale (CES-D) (Fuhrer and Rouillon, 1989; Radloff, 1977). This 20-item questionnaire has been designed for use in community studies. The CES-D score evaluates the frequency of depressive symptoms during the previous week (e.g., I felt depressed, I felt everything I did was an effort, my sleep was restless). Responses range from 0 (hardly ever) to 3 (most of the time). The CES-D score was used as a continuous variable with taking the interval between the 25th and the 75th percentile as unit, the meaning of one-point increase in CES-D could be hard to figure out while one could more intuitively compare an individual in the middle of the upper half of the CES-D score distribution with an individual in the middle of the lower half.

Socioeconomic factors

Educational level was collected according to the International Standard Classification of Education (Schneider, 2013) and was then classified into three levels: Low (High school diploma or less for 13 years of education), moderate (undergraduate degree for 14–16 years of education) and high (postgraduate degree for >17 years of education). Household monthly income was categorized into: low (less than 2100 Euros per month); moderate (2100–4199); and high (at least 4200).

Occupational status was collected according to the French “Occupations and Socio-occupational Categories” [Professions et Catégories Socioprofessionnelles (PCS)] classification system (INSEE, 2003) then categorized in three broad classes: high (e.g., managers), moderate (e.g., clerks or first-line supervisors) and low (e.g., plant and machine operators, cleaners).

Drugs treatments

Reimbursement of anti-hypertensive and antidepressant treatments were obtained by matching the individual data of the subjects included in the study with the data from the

SNDS (*Système national des données de santé*). The names of the treatments and the reimbursement date in the year preceding the health examination were collected. Anti-hypertensive and antidepressant medications were determined based on the Anatomical Therapeutic Chemical (ATC) code assigned to respondents' medications. Codes indicative of anti-hypertensive medications were: beta blockers (ATC codes C07, excluding C07AA07, C07AA12 and C07AG02); agents acting on the renin- angiotensin system (ATC codes C09); thiazide diuretics (ATC codes C03, excluding C03BA08 and C03CA01); calcium channel antagonists (ATC codes C08); and miscellaneous anti-hypertensive medication (ATC codes C02, excluding C02KX01). Codes indicative of antidepressant medications were ATC codes N06A.

Covariates

Age, gender, couple status (couple life or single which included widowed or separated/divorced), alcohol consumption, dietary intake, physical activity, and smoking status (never, former, current smokers) were collected with a self-reported questionnaire. Body mass index (BMI, kg/m²) was measured at the examination. Alcohol consumption was defined in g/day of alcohol consumption. Dietary assessment was done through a validated 52- items food frequency questionnaire from which a DASH score was constructed based on food groups described by Fung et al (Cherfan et al., 2019; Fung et al., 2008). Physical activity (PA) was assessed through three questions that considered the frequency of transferring, leisure time activity and sports. A score of 0-6 was calculated and physical activity level was classified as low (0-2), moderate(3-4) and high (5-6) (Merle et al., 2018). Diabetes mellitus status was based on either self-reported type II diabetes, receiving anti-diabetic medication or a fasting blood glucose concentration greater than or equal to 7mmol/l. Dyslipidemia was defined as having hypercholesterolemia and/or hypertriglyceridemia; either recorded by the health care practitioner at the HSC or by a fasting plasma total-cholesterol or triglycerides level of at least 6.61mmol/l or more than 1.7mmol/l, respectively.

Statistical analysis

Characteristics of the study population were described as the means with standard deviation (SD) for continuous variables. Categorical variables were described as numbers and proportions. Comparisons between groups were performed using Student's test for continuous variables. Pearson's χ^2 test was performed for categorical variables. SES factors were

considered as ordinal variables. Statistical analyses were stratified on gender since hypertension differs between men and women (Vallée et al., 2020), as well as depression (Van de Velde et al., 2010).

Associations between depressive symptoms and blood pressure levels were examined with gender linear regression models computing coefficients (b) and their 95% confidence intervals. Association between depressive symptoms and hypertension were examined with gender logistic regression models computing odds ratio (OR) and their 95% confidence intervals. Gender models were adjusted for age, antihypertensive and antidepressant medications, BMI, DASH score, alcohol consumption, diabetes, dyslipidemia, physical activity, tobacco habits and couple status.

First, we performed regression models including CES-D score with all covariates in same models to determine their significant impact on blood pressure and hypertension. Second, to assess possible effect modification, we stratified the CES-D score and blood pressure levels and hypertension analyses by each of the three SES variables, separately, and tested the statistical significance of these associations. Interactions were examined by including simultaneously CES-D score and one of the three SES factors and their interaction term. Statistics were performed using SAS software (version 9.4; SAS Institute, Carry, NC). A p value <0.05 was considered statistically significant.

RESULTS

A total of 66,478 volunteers without missing or not categorized data were included in the study, their characteristics are described in **Table 1**. The mean average CES-D score was 10.6 (8.7) for overall population, with a difference of 9 points between the 25th and 75th percentiles, mean CES-D score was 11.8 (9.3) for women and 9.2 (7.8) for men. 6.7% of the overall population had an antidepressant medication (8.7% for women, 4.4% for men). 28.6% of the overall population was hypertensive (20.9% for women, 37.4% for men).

The linear regression coefficient for the association between CES-D score and SBP was negative and significant in both women $b=-0.64$ 95%CI [-1.08; -0.21] and men $b=-1.12$ 95%CI [-1.55; -0.70]. SBP was decreased of 0.64 mmHg in women and of 1.12 mmHg in men between the 25th and the 75th percentiles of CES-D score (**Table 2**).

The linear regression coefficient for the association between CES-D score and DBP was significant neither in women $b=-0.21$ 95%CI [-0.49; 0.07] nor in men $b=-0.29$ 95%CI [-0.61; 0.03] (**Table 2**).

The association between CES-D score and hypertension was significant for men, OR=0.86 [0.80; 0.93], $p<0.001$ but not for women, OR=1.03 [0.96; 1.10], $p=0.219$ (**Table 2**).

Supplementary file presented the regression coefficient and OR for all covariates of adjustment (**Supplementary file 1**).

When considering CES-D score as continuous variable, after adjustment on covariates, the linear regression coefficient for the association between CES-D score and SBP was negative and significant in both women $b=-0.04$ 95%CI [-0.06; -0.02], $p<0.001$ and men, $b=-0.07$ 95%CI [-0.09; -0.05], $p<0.001$, but not for DBP (in women, $b=-0.01$ [-0.03; 0.01], $p=0.401$ and in men, $b=-0.001$ [-0.01; 0.01], $p=0.937$). In multivariate logistic regression, a significant association was observed between CES-D score, as continuous variable, and hypertension prevalence among men (OR=0.98 [0.97; 0.99], $p<0.001$), but not among women (OR=1.01 [0.99; 1.02], $p=0.569$).

Figure 2 and **Figure 3** present the regression coefficients and OR and their 95%CI for the different interactions between CES-D score and SES factors for BP and hypertension according to gender. The regression coefficients correspond to the mean difference in mmHg between participants in the middle of the upper half and thus in the middle of the lower half of the CES-D score distribution.

Among women, the interactions between CES-D score and educational levels were significant for both SBP ($p=0.028$) and DBP ($p=0.036$) (**Figure 2**). When women were categorized by income level or occupational status, the interactions were not significant for both SBP and DBP.

The association between CES-D score and SBP, which was not significant among participants with low educational level, became progressively more negative with increase educational level, being significant for high educational level. The mean SBP difference between the 25th and the 75th percentiles of CES-D score was -1.09 mmHg 95%CI [-1.76; -0.42] for high educational level (**Figure 2**). Likewise, the associations between CES-D score and DBP were not significant among women participants with low and moderate educational level but became significant for high educational level. The mean DBP difference was -0.46 mmHg 95%CI [-0.90; -0.02] for high educational level. Moreover, when the three factors of SES and their interactions with CES-D score were simultaneously included in the women model, only the interaction between CES-D score and educational level remained significant ($p=0.045$ for SBP and $p=0.022$ for DBP). No significant associations and interactions were observed

between CES-D score and hypertension when women were categorized by SES factors (Figure 2).

Among men, none of the three analyses yielded significant interactions between SES factors and SBP. Only the interaction between income level and CES-D score was significant for DBP in men ($p=0.010$) (Figure 3). When introducing the three SES factors and their interactions with CES-D score simultaneously in the SBP model in men, none of the three were significant. When the three SES factors and their interactions were including simultaneously in DBP men model with CES-D score, only income level interaction was significant ($p=0.010$). No significant difference was observed among low and moderate income for DBP whereas high income level showed a significant difference $b=-0.67$ mmHg 95%CI [-1.11; -0.23]. No interactions were significantly observed among men between SES factors and hypertension although high income level presented the highest significant association, with OR=0.79, 95%CI [0.70; 0.88] (Figure 3).

Sensitivity analyses

When excluding from the analyses participants who received antihypertensive drugs ($N=7,298$), CES-D score remained significantly associated with SBP among women ($b=-0.62$ 95%CI [-1.07; -0.18] and among men ($b=-1.23$ 95%CI [-1.67; -0.80] but not for DBP analyses among women ($b=-0.18$ 95%CI [-0.47; 0.10]) and among men ($b=-0.53$ 95%CI [-0.70; 0.07]).

When excluding antidepressant medications ($N=4,460$) from the analyses, CES-D score remained significantly associated with SBP among women ($b=-0.62$ 95%CI [-1.05; -0.19]) and among men ($b=-1.20$ 95%CI [-1.63; -0.77]) but not for DBP analyses among women ($b=-0.63$ 95%CI [-1.27; 0.01]) and among men ($b=-0.41$ 95%CI [-0.85; 0.03]).

When excluding participants who received antihypertensive and/or antidepressant drugs ($N=10,891$) from the models, CES-D score remained significantly associated with SBP among women ($b=-0.63$ 95%CI [-1.07; -0.17] and among men ($b=-1.31$ 95%CI [-1.76; -0.87] but not for DBP among women ($b=-0.20$ 95%CI [-0.49; 0.10]) and among men ($b=-0.45$ 95%CI [-0.97; 0.07]).

When excluding participants who received antidepressant drugs ($N=4,460$) from hypertension prevalence models, CES-D remained significantly associated with hypertension among men (OR=0.85 [0.79; 0.91], but not for women (OR=1.06 [0.97; 1.15]).

DISCUSSION

Our study investigated the association between CES-D score and BP levels and hypertension and then, how these associations could differ between participants according to their SES levels. Our main finding is that SBP was inversely associated with CES-D score in both genders. But, only men presented a negative association between CES-D score and hypertension prevalence, whereas women presented no significant association. For SBP, women, a significant interaction was observed between CES-D score and educational level whereas in men there was no significant interaction between SES factors and CES-D score. For DBP, women presented a significant interaction between CES-D score and educational level whereas men presented a significant interaction between CES-D score and income level. The association between CES-D score and SES factors was stronger in women with high educational level for SBP and DBP and for DBP of men with high income level. No interactions between CES-D score and SES factors for hypertension prevalence were observed in both men and women.

Studies examining the association between depression and blood pressure and hypertension yielded inconsistent results (Trudel-Fitzgerald et al., 2015) although many found a negative association (Hildrum et al., 2011; Lenoir et al., 2008; Licht et al., 2009; Park et al., 2018; Shah et al., 2013; Wiernik et al., 2018), so that depression was associated with lower BP in cross-sectional studies. Longitudinal studies have suggested that depression may be a risk factor of incident hypertension (Meng et al., 2012). Nevertheless, a follow-up conducted on over 20 years in the Nord-Trondelag Health Study (HUNT) showed that low BP was associated with increased prevalence of depression (Hildrum et al., 2011).

Several possible mechanisms for low BP in depressive symptoms have been hypothesized. First, chronic low BP itself could be a cause of depressive symptoms, as fatigue and cognitive impairment (Licht et al., 2009). This possibility has been shown in recent longitudinal studies, although with inconsistent results, that low BP at baseline could be considered as a predictive factor for depressive symptoms at follow-up but not the other way around (Paterniti et al., 2000), whereas other studies have found the opposite association (Hildrum et al., 2008). Another explanation for the observed association does not assume causality but instead assumes a common underlying factor that independently enhances the risk for depression, as well as the factor to conserve a low BP level. The central monoamine system could be a possible cause of this factor (Head, 1992; Stahl, 2000). For instance, depression is

characterized by the alteration of neuropeptide Y levels, a major modulator of the norepinephrine signaling. Dysregulation in neuropeptide Y could decrease the sympathetic activity and BP (Karl and Herzog, 2007; Michalkiewicz et al., 2003). More studies are required to unravel these underlying mechanisms implicated in the low BP of subjects with depression.

In our study, we have included participants with antihypertensive and antidepressant drugs. Previous studies suggested that depression could be a side effect of some antihypertensive agents (Prisant et al., 1991). Hypertension awareness may also induce depressive symptoms. Moreover, antidepressant drugs may increase BP (Razavi Ratki et al., 2016). Regulation of the circulatory system and the autonomic vascular tone by serotonin and nitric-oxide may explain this mechanism. Nevertheless, sensitive analyses were performed in our study by excluding antihypertensive and antidepressant drugs and showed similar associations in our overall population and groups excluding these drugs.

Our results suggest that men had a somewhat stronger association between CES-D score and SBP than women. This result could be explained by many mechanisms. The prevalence of depression and hypertension differ between genders. Women had higher prevalence of depression and lower prevalence of hypertension than men. In the present study, SES interactions were observed in women but not in men. The association between depression and SES may result from several pathways that may differ to some extent between women and men. For instance, alcohol use, which is a risk factor of elevated BP, may mediate this association to a greater extent in men than women (Chazelle et al., 2011). Regarding, the association between hypertension and SES seems to be based mainly on dietary habits and especially salt intake. Individuals risk factors of hypertension could be influenced by individual behaviors depending on SES status (Psaltopoulou et al., 2017). Salt consumption has been considered as one of the main cause of hypertension (Gibbs et al., 2000), and its use differed between gender (Vallée et al., 2019). The importance of salt consumption was mainly observed among SES underprivileged groups who usually consume snacks of fast type of food full of salt (Psaltopoulou et al., 2017). Moreover, psychosocial processes could be additional pathways by which SES affects blood pressure.(Pickering, 1999) However, these links remained unclear in literacy (Grotto et al., 2008). Epidemiologic studies have shown that poor SES groups had more health problem than others (Davari et al., 2019). Another study has shown that lowest education category was associated with a greater risk of

hypertension (Hoang et al., 2007). Moreover, the lack of knowledge of hypertension as well as its predictive factors among less educated layers could result to an unawareness of hypertension prevention and a misunderstanding in detrimental health dietary lifestyle (Fenech et al., 2020; Grotto et al., 2008). Difference in health behaviors between men and women can also affect SES status (Ryu et al., 2020). Health status varies by gender and the different aspects of SES have varying degrees of impact on health status between gender. Education and income levels are mainly associated with obesity, diabetes and hypertension and could explain the gender differences (Zhang et al., 2017).

Strengths and Limitations

The main strength of our study is the design of CONSTANCES, which ensure sufficient power; we adopted a population-based approach using a large nationwide randomly selected sample of participants. In addition, we used standardized protocols to collect anthropometric data including BP measurements; this ensures replication of data collection for all volunteers regardless of when, where and by whom they are performed and adds validity to our results (Ruiz et al., 2016). Furthermore, data were collected through different reliable methods, using national databases and validated questionnaires. Moreover, the CONSTANCES cohort randomly recruited its participants, this population may be representative of the general population (Rothman et al., 2013).

However, some our study presents some limitations. socio-economic data were collected by self-reporting. Medical history and comorbidities have been collected by self-reporting and physician assertion during medical examination in health centers. The cross-sectional design of the study may represent a limitation since reverse causation cannot be excluded.

CONCLUSION

Our study highlighted that increased CES-D score was associated with lower SBP in both genders **but only with low rate of hypertension in men**. Moreover, our current results show that in women, CES-D score was associated with lowered BP among high educational level. Men present few interaction between CES-D score and SES factors. Thus, our results support an importance of considering depressive symptoms according to SES factors for blood pressure variation among women. Nevertheless, gender differences should be mainly explored in longitudinal cohorts to warrant the association between SES factors and depressive symptoms with hypertension.

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Figure 1: Flow chart

Not categorized data refer to participants whose responses were not missing but could not be included in the ordered classification of each SES variable (e.g. “other diploma”, “craftsman” or “farmer” and “don’t know the answer”, for educational level, occupation status and income level).

Table 1: Characteristics of the study population

Table 2: Regression models for SBP, DBP and hypertension according to genders

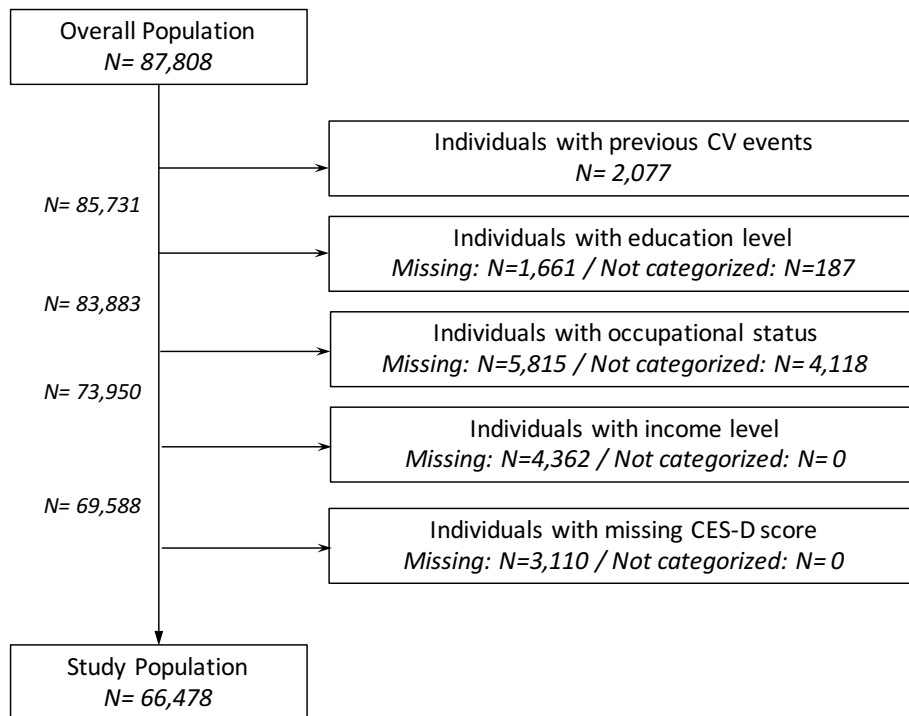
Regression coefficients present the decrease or increase in BP (systolic and diastolic blood pressure) in participants between the 25th and the 75th percentile of CES-D.

Odds ratio (OR) present the association between hypertension and the different covariates, and in participants between the 25th and the 75th percentile of CES-D.

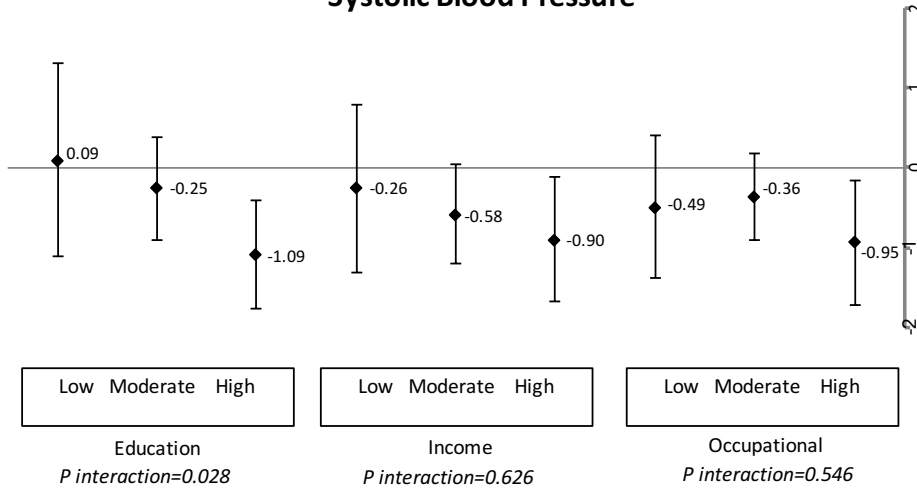
Models were adjusted for antihypertensive, antidepressant drugs, BMI, DASH score, Alcohol consumption, Diabetes, Dyslipidemia, Physical activity, Tobacco habits and couple status.

Figure 2: Regression coefficients and 95% confidence interval for the association between CES-D score interquartile and Blood Pressure and Odds ratio (OR) with 5% CI for the association between CES-D score interquartile and hypertension prevalence according to SES factors among women.

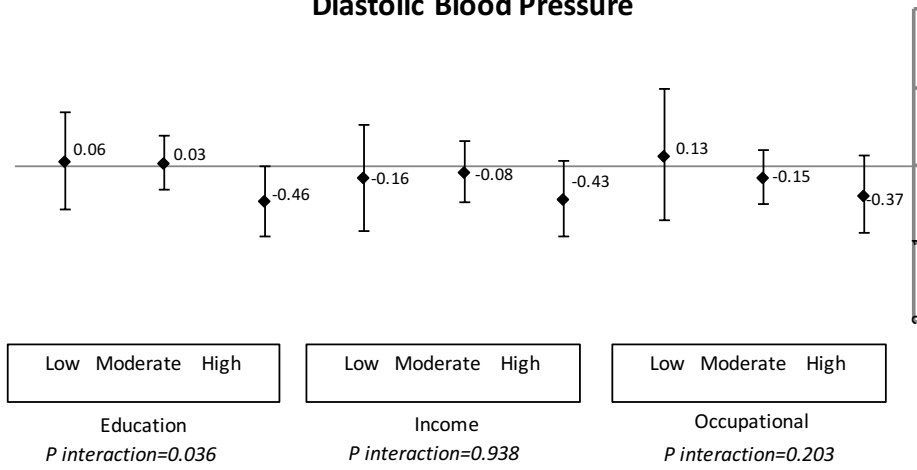
Figure 3: Regression coefficients and 95% confidence interval for the association between CES-D score interquartile and Blood Pressure and Odds ratio (OR) with 5% CI for the association between CES-D score interquartile and hypertension prevalence according to SES factors among men.



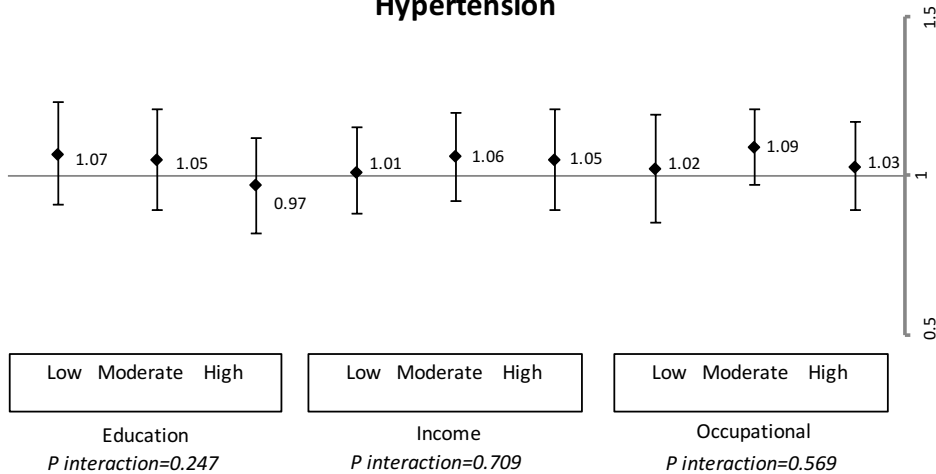
Systolic Blood Pressure



Diastolic Blood Pressure



Hypertension



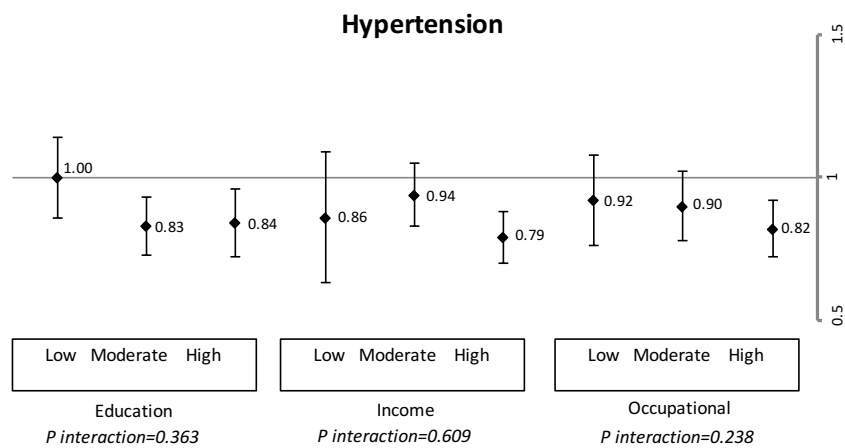
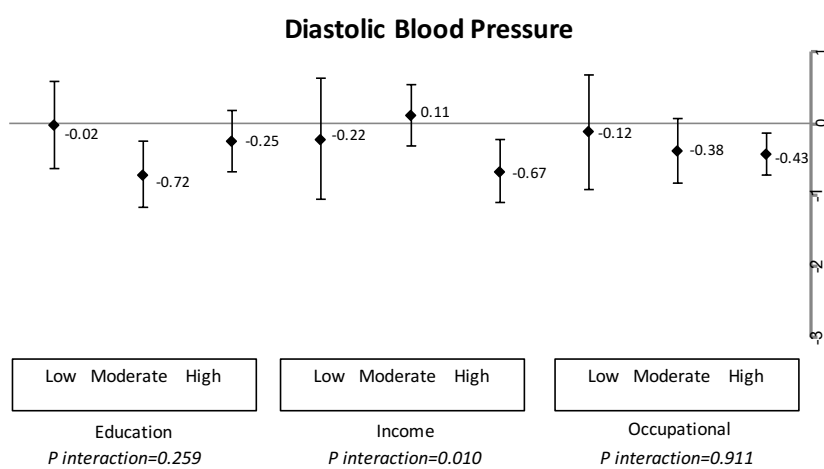
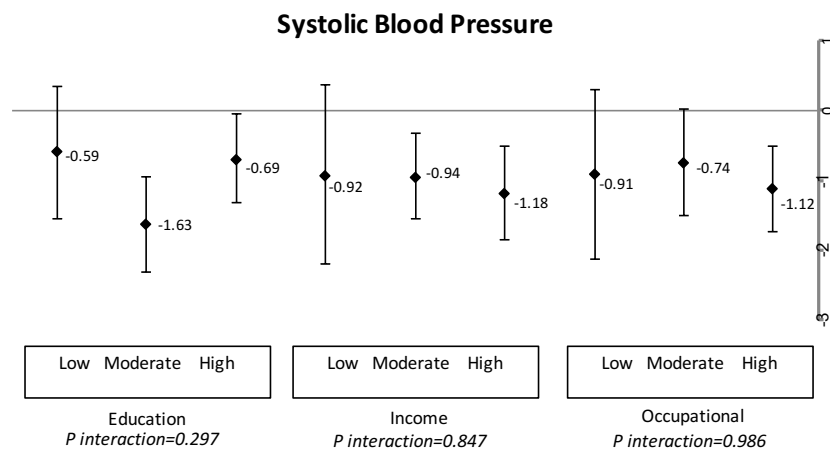


Table 1: Characteristics of the study population

	Overall population	Women	Men	P value
	N=66,478	N=35,385	N=31,093	
Age	47.2 (12.8)	46.7 (12.8)	47.8 (12.8)	<0.001
SBP	129 (16)	124 (16)	135 (15)	<0.001
DBP	77 (10)	75 (9)	79 (10)	<0.001
Hypertension	19,013 (28.6)	7,386 (20.9)	11,627 (37.4)	<0.001
CES-D score	10.6 (8.7)	11.8 (9.3)	9.2 (7.8)	<0.001
Depressive symptoms*	12,492 (18.8)	8,331 (23.5)	4,161 (13.4)	<0.001
Education level				<0.001
<i>Low</i>	14,548 (21.9)	6,674 (18.9)	7,874 (25.3)	
<i>Moderate</i>	28,058 (42.2)	16,506 (46.7)	11,552 (37.2)	
<i>High</i>	23,872 (35.9)	12,205 (34.5)	11,667 (37.5)	
Income level				<0.001
<i>Low</i>	13,680 (20.6)	8,128 (23.0)	5,552 (17.9)	
<i>Moderate</i>	32,328 (48.6)	17,341 (49.0)	14,987 (48.2)	
<i>High</i>	20,470 (30.8)	9,916 (28.0)	10,554 (33.9)	
Occupational status				<0.001
<i>Low</i>	6,144 (9.2)	1,235 (3.5)	4,909 (15.8)	
<i>Moderate</i>	37,599 (56.6)	24,767 (70.0)	12,832 (41.3)	
<i>High</i>	22,735 (34.2)	9,383 (26.5)	13,352 (42.9)	
Antihypertensive drugs	7,298 (11.0)	3,537 (10.0)	3,761 (12.1)	<0.001
Antidepressant drugs	4,460 (6.7)	3,083 (8.7)	1,377 (4.4)	<0.001
Couple	49,731 (74.8)	25,346 (71.3)	24,385 (78.4)	<0.001
Diabetes	2211 (3.3)	800 (2.3)	1,411 (4.5)	<0.001
Dyslipidemia	19,318 (29.1)	8,447 (23.9)	10,871 (35.0)	<0.001
Physical activity				<0.001
<i>High</i>	33,690 (50.7)	18,123 (51.2)	15,567 (50.1)	
<i>Moderate</i>	26,444 (39.8)	14,106 (39.9)	12,338 (39.7)	
<i>Low</i>	6344 (9.5)	3,156 (8.9)	3,188 (10.2)	
Tobacco				<0.001
<i>Current</i>	12,102 (18.2)	6,206 (17.5)	5,896 (19.0)	
<i>Past</i>	22,022 (33.1)	10,640 (30.1)	11,382 (36.6)	
<i>Never</i>	32,354 (48.7)	19,539 (52.4)	13,815 (44.4)	
BMI (kg/m2)	24.8 (4.3)	24.3 (4.6)	25.5 (3.8)	<0.001
Alcohol (g/day)	1.2 (1.5)	0.8 (1.0)	1.6 (1.8)	<0.001
DASH score	26 (4)	27 (4)	25 (4)	<0.001

*Depressive symptoms were defined as CES-D \geq 19 and/or antidepressant drugs use

SBP: systolic blood pressure

DBP: diastolic blood pressure

CES-D score: Center of Epidemiologic Studies Depression score

Table 2: Regression models for SBP, DBP and hypertension according to genders

Regression coefficients present the decrease or increase in BP (systolic and diastolic blood pressure) in participants between the 25th and the 75th percentile of CES-D.

Odds ratio (OR) present the association between hypertension and the different covariates, and in participants between the 25th and the 75th percentile of CES-D.

Models were adjusted for antihypertensive, antidepressant drugs, BMI, DASH score, Alcohol consumption, Diabetes, Dyslipidemia, Physical activity, Tobacco habits and couple status.

WOMEN			MEN		
Systolic Blood Pressure					
Parameters	B 95% CI	P value	Parameters	B 95% CI	P value
Age	0.42 (0.40; 0.44)	<0.001	Age	0.47 (0.45; 0.49)	<0.001
CES-D score	-0.64 (-1.08; -0.21)	0.004	CES-D score	-1.12 (-1.55; -0.70)	<0.001
Income		<0.001	Income		<0.001
Low	Ref.		Low	Ref.	
Moderate	-1.30 (-1.76; -0.84)	<0.001	Moderate	-0.90 (-1.40; -0.40)	0.004
High	-2.18 (-2.76; -1.59)	<0.001	High	-2.04 (-2.65; -1.43)	<0.001
Occupational status		0.006	Occupational status		0.002
Low	Ref.		Low	Ref.	
Moderate	-0.62 (-1.51; 0.27)	0.175	Moderate	-0.04 (-0.53; 0.46)	0.878
High	-1.24 (-2.22; -0.26)	0.013	High	-0.79 (-1.41; -0.18)	0.011
Education		<0.001	Education		<0.001
Low	Ref.		Low	Ref.	
Moderate	-0.54 (-0.99; -0.08)	0.020	Moderate	-0.45 (-0.89; -0.01)	0.050
High	-1.31 (-1.86; -0.38)	<0.001	High	-1.19 (-1.75; -0.63)	<0.0001
Diastolic Blood Pressure					
Parameters	B 95% CI	P value	Parameters	B 95% CI	P value
Age	0.13 (0.12; 0.15)	<0.001	Age	0.19 (0.18; 0.20)	<0.001
CES-D score	-0.21 (-0.49; 0.07)	0.135	CES-D score	-0.29 (-0.61; 0.03)	0.082
Income		0.229	Income		0.705
Low	Ref.		Low	Ref.	
Moderate	-0.26 (-0.55; 0.04)	0.089	Moderate	0.09 (-0.42; 0.23)	0.584
High	-0.21 (-0.58; -0.16)	0.265	High	0.01 (-0.39, 0.40)	0.982
Occupational status		0.166	Occupational status		0.137
Low	Ref.		Low	Ref.	
Moderate	-0.32 (-0.84; 0.20)	0.235	Moderate	-0.29 (-0.63; 0.03)	0.079
High	-0.59 (-1.17; -0.01)	0.049	High	-0.13 (-0.54; -0.27)	0.528
Education		<0.001	Education		<0.001
Low	Ref.		Low	Ref.	
Moderate	0.06 (-0.23; 0.35)	0.689	Moderate	-0.56 (-0.86; -0.26)	0.002
High	-0.19 (-0.54; 0.16)	0.301	High	-1.06 (-1.43; -0.69)	<0.001
Hypertension					
Parameters	OR 95% CI	P value	Parameters	OR 95% CI	P value
Age	1.08 [1.07 – 1.09]	<0.001	Age	1.06 [1.05 - 1.07]	<0.001
CES-D score	1.03 [0.96 – 1.10]	0.219	CES-D score	0.86 [0.80 – 0.93]	<0.001
Income			Income		
Low	Ref.		Low	Ref.	
Moderate	0.90 [0.81 – 0.99]	0.037	Moderate	0.89 [0.81 – 0.97]	0.011
High	0.84 [0.75 – 0.96]	0.008	High	0.77 [0.69 – 0.87]	<0.001
Occupational status			Occupational status		
Low	Ref.		Low	Ref.	
Moderate	0.91 [0.77 – 1.08]	0.285	Moderate	0.99 [0.91 – 1.08]	0.889

<i>High</i>	0.80 [0.66 – 0.96]	0.019	High	0.91 [0.82 – 1.01]	0.089
Education			Education		
<i>Low</i>	Ref.		Low	Ref.	
<i>Moderate</i>	0.89 [0.82 – 0.97]	0.006	Moderate	0.97 [0.90 – 1.05]	0.474
<i>High</i>	0.86 [0.77 - 0.96]	0.005	High	0.87 [0.79 – 0.96]	0.005