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PERCEIVED STRESS, GENDER AND OCCUPATIONAL STATUS INTERACT TO INCREASE THE RISK OF FUTURE HIGH BLOOD PRESSURE: THE IPC COHORT STUDY

Short title: Current stress and future blood pressure

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Abstract

Contrary to lay beliefs, current perceived stress is not consistently associated with the incidence of high blood pressure (BP) in prospective studies, possibly because of moderating factors. The present prospective study examined this association and explored potential moderating effects of gender or occupational status. The 4-item Perceived Stress Scale was filled at baseline by 19,766 normotensive adults (13,652 men, mean age±standard deviation: 46.8±9.3 years), without history of cardiovascular and renal disease and not on either psychotropic or antihypertensive drugs. After a mean follow-up of 5.8±2.1 years, 3,774 participants (19.1%) had high BP, defined as having a systolic BP ≥140 mmHg or a diastolic BP ≥90 mmHg or using antihypertensive drugs. There was a significant interaction between baseline perceived stress and gender (p=0.02) in relation to high BP at follow-up. After adjustment for potential confounders, baseline perceived stress was associated with high BP at follow-up in women (OR [CI]: 1.20 [1.03-1.38]; p=0.016). In addition, the interaction between perceived stress and occupational status was significant among women (p=0.02). Baseline perceived stress was positively associated with high BP at follow-up among women of medium or low occupational status, with OR suggesting a linear increase of the risk (p=0.005). Perceived stress may be considered as a risk factor for hypertension in women of lower occupational status. Research addressing the relationships between stress and high BP should systematically look for possible interactions with gender and occupational status.

Key Words

Epidemiology, gender, hypertension, interaction, occupational status, prospective study, socioeconomic position, stress

Introduction

Although hypertension has several known risk factors such as obesity, smoking, excessive alcohol or salt intake, most patients with hypertension lend great importance to psychological stress in the regulation of blood pressure (BP) and in the need for taking antihypertensive drugs [1]. The association between acute psychological stress and a transient BP elevation is well established [2]. However, epidemiological studies do not consistently show psychological stress to be associated with BP in the long-term [3]. One possible reason for these conflicting results is that the moderating role of some factors has been overlooked. Here we aimed to test the hypothesis that the association between perceived stress and high BP might depend on gender or occupational status.

As regards gender, differences exist in levels of perceived stress [4], type of stressors [5], the way to report and to cope with stress [6], but also in the prevalence [7], pathophysiology [8] (e.g. the contribution of the renin–angiotensin system [9]) and risk factors of hypertension (e.g. menopause [10] or the use of contraceptives [11]). In addition, there is some evidence suggesting that psychological variables might be related to several cardiovascular outcomes to a different extent among men and women [12-20]. Likewise, perceived stress might be associated with BP differently in men and women.

With regard to occupational status, a recent study conducted by our group showed that there was a significant interaction between perceived stress and occupational status in relation to BP. Precisely, we found that perceived stress was negatively associated with high BP among individuals of high occupational status but positively associated among those of low status or unemployed [21]. This finding is in line with previous evidence showing that job strain may relate to BP at work site [22] or to the risk of stroke [23] differently across occupational categories. However, this

previous study, as several others, was cross-sectional. Hence, it remains unknown whether this association could be replicated in studies with a prospective design.

The main aim of this study was to examine the longitudinal association between perceived stress and the subsequent occurrence of high BP, and to explore the potential moderating role of gender or occupational status on this association.

Methods

Participants

According to the longitudinal design of the study, our target population was composed of all subjects who had at least two health checkups at the "Investigations Préventives et Cliniques" (IPC) Center (Paris, France) from January 1996 to December 2011. This medical Center, which is subsidized by the French national health care system, offers all working and retired individuals and their families a free medical examination with a minimum interval ranging from one to five years. It carries out approximately 25,000 examinations per year for people living in the Paris area. Our target population was composed of all subjects who had at least two health checkups at the IPC Center in the period from January 1996 to December 2011, with a time interval between visits of 1 year or more. All clinical and biological parameters were evaluated on the same day at the examination. In the case of participants who benefited from more than two examinations, only data from the first and second examinations were considered. Eligibility criteria were: 30 years of age or more at the first visit (owing to the low prevalence of hypertension in younger individuals), able to fill out the study questionnaires, no missing data for selected variables (see below) and a normal BP at the first visit: a systolic BP <140 mmHg, a diastolic BP <90 mmHg [24] and not using

antihypertensive drugs. To minimize potential biases, individuals with a history of cardiovascular or renal disease, which may confound the association between perceived stress and BP, and those who reported using psychotropic drugs, which may blur this association [25], were not included. The IPC Center received authorization from a local ethics committee and from the "Comité National d'Informatique et des Libertés" to conduct these analyses. All subjects gave their informed consent at the time of each examination. The data were rendered anonymous before analysis.

Blood pressure and outcome

After a 10-minute rest period, supine brachial systolic and diastolic BP were measured 3 times by trained nurses in the right arm using an automated sphygmomanometer. A standard cuff size was used, but a large cuff was utilized if necessary. The mean of the last 2 measurements was considered as the BP value. The primary outcome of the present study was a high BP at the second visit, defined as having a systolic BP ≥140 mmHg or a diastolic BP ≥90 mmHg or using antihypertensive drugs (see below).

Psychological variables

Perceived stress was measured with the French version of the 4-item Perceived Stress Scale (PSS-4) [26,27]. Each item is rated on a 0 to 4 scale (see Text S1, Supplemental Digital Content 1). The PSS-4 total score ranges from 0 to 16 and has a one-factor structure and a satisfactory internal consistency (α=0.73). It measures the degree to which situations in one's life over the past month were appraised as stressful (e.g. "In the past month, how often have you felt it was difficult to control the important

things in your life?"). In order to obtain meaningful odds ratios, the variable was rescaled using the difference between the 25th and the 75th percentile as the unit.

Since stress is linked to depressive mood that may in turn be associated with a lower BP [28], depressive mood was included as a covariate. It was measured with a French 13-item questionnaire (QD2A, Questionnaire of Depression 2nd version, Abridged) [29,30]. Building on previous questionnaires, this 13-item questionnaire was specifically designed for depression screening in community studies and has a high internal consistency (α=0.91). Participants had to give a yes/no answer to each item as regards their current emotional state (e.g. "I am disappointed and disgusted with myself," "I'm sad these days," "I feel hopeless about the future"). The number of "yes" answers is summed, a total score $\geq$7 indicating a high probability of major depression. The QD2A has been found to predict suicide in the IPC Cohort Study [31].

Occupational status

Occupational status was categorized in 5 classes: (1) high (e.g. managers); (2) medium (e.g. clerks or first line supervisors); (3) low (e.g. blue collar workers); (4) unemployed participants (i.e. seeking employment); (5) participants without a paid occupation (e.g. housewives). Retired participants were assigned to their last occupational category. The distinction of three categories among working participants is standard among occupational cohorts examining the relationships between psychosocial variables and physical health outcomes [32].

Other variables

Other variables included time interval between visits, age, gender, living status (living alone or not), smoking status (non-smoker, ex-smoker, current smoker of 1-10

cigarettes/day, 11-20 cigarettes/day, >20 cigarettes/day), alcohol intake (0 glasses/week, 1-6 glasses/week for women or 1-13 glasses/week for men, 7-20 glasses/week for women or 14-27 glasses/week for men, >21 glasses/week for women or >28 glasses/week for men), and regular physical activity (i.e. estimated equivalent to at least one hour/day of walking). Personal history of cardiovascular or renal disease, and family history of hypertension were self-reported (yes, no), as well as current medications including diuretics, antihypertensive drugs (other than diuretics), medications "to sleep" or "for anxiety or depression." Among participants reporting taking diuretics, only those that reported doing this "to lower BP" were considered as taking an antihypertensive drug. Perceived health status was collected with a 10-point scale (with 10 considered to be "excellent health"). Body mass index (BMI) was calculated and categorized in 4 classes (<18.5; 18.5-24.9; 25-29.9; ≥30 kg/m^2). Resting heart rate (HR) was measured in beats per minute with a 10-cycle electrocardiogram (HR = 60 / RR interval in seconds) and fasting glycemia in mmol/L. Menopausal status was self-reported for women and categorized in 3 classes (not menopausal at second visit, menopausal at second visit only, already menopausal at first visit).

Statistical analysis

The dependent variable was high BP at follow-up (i.e. the second visit) and, according to the main aim of this study, our independent variables were those measured at baseline (i.e. the first visit). The relationship between perceived stress at baseline and the likelihood of having high BP at follow-up was examined using univariate and multivariate binary logistic regression models with odds ratio (OR) and 95% confidence interval (CI). Except for BP and BMI, all variables were analyzed as continuous when available as such. First, we tested the main effect of stress, as well as interactions

between stress and gender and between stress and occupational status in relation to the risk of high BP at follow-up. The interactions were tested by including in the same model the two variables of interest (e.g. gender and perceived stress, separately) as well as their interaction term (i.e. gender by perceived stress). In the case of statistically significant interactions, analyses were stratified by gender or occupational status, including all other covariates. Statistical analysis was carried out with the PASW Statistics software (version 18.0, SPSS Inc., Chicago).

Results

Figure S1 (see Supplemental Digital Content 2) presents the flow chart of the study population selection and Table S1 (see Supplemental Digital Content 3) compared the baseline characteristics of individuals who had only one health check-up at the IPC center to the characteristics of those who came twice. The final study population consisted of 19,766 participants (13,652 men and 6,114 women) with a mean age of 46.8±9.3 years. The mean perceived stress score was 3.6±2.9 with a 5-point difference between the 25^{th} and the 75^{th} percentile.

After a mean follow-up of 5.8±2.1 years, 3,774 participants (19.1%) had high BP, including 417 with an antihypertensive drug (mean systolic / diastolic BP: 136±17 / 81±10 mmHg) and 3,357 without drug (mean systolic / diastolic BP: 149±11 / 88±9 mmHg). When men and women were included together, baseline perceived stress was not associated with greater risk of high BP at follow-up (OR [CI]: 1.00 [0.93-1.06]; p=0.86). However, there was a significant interaction between baseline perceived stress and gender (p=0.02) in relation to high BP at follow-up, but not between baseline perceived stress and occupational status (p=0.60). Thus, the association between baseline perceived stress and high BP at follow-up has been examined separately in men

and women. Table 1 shows the characteristics of study participants.

Univariate analyses in men and women separately are displayed in Table S2 (see Supplemental Digital Content 4). Fully adjusted models in men and women are displayed in Table 2. Adjusting for all variables, the association between baseline perceived stress and high BP at follow-up was significant in women (OR [CI]: 1.20 [1.03-1.38]; p=0.016). In sensitivity analyses, this association remained significant after further adjustment for menopausal status (OR [CI]: 1.20 [1.04-1.39]; p=0.01) or after adjustment for covariates measured at the follow-up visit instead of covariates measured at baseline (OR [CI]: 1.15 [1.01-1.32]; p=0.04). Similar results were also obtained if retired participants were not included (OR [CI]: 1.19 [1.02-1.40]; p=0.03).

In addition, we found a significant interaction between perceived stress and occupational status among women (p=0.02), suggesting that the association between baseline perceived stress and future high BP might be different across occupational categories in women. Adjusting for all other variables, baseline perceived stress was positively associated with future high BP among women of low or medium occupational status, but not among other occupational categories (Table 3 and Figure 1). The OR values among women of high, medium and low status suggested a possible linear increase of the association across occupational status. To examine whether this linear trend was significant, we restricted our analyses to women of high, medium or low occupational status and found a significant interaction between perceived stress and occupational status taken as a linear variable (p=0.005). Taking the use of antihypertensive drugs as an alternative endpoint, baseline perceived stress remained positively associated with future high BP among women of medium occupational status (OR [CI]: 1.74 [1.06-2.88]; p=0.03). For women of low occupational status, only 5 women were taking antihypertensive drugs at follow-up, thus preventing further statistical analyses.

Discussion

Summary of results

This prospective study aimed to examine the association between baseline perceived stress and the incidence of high BP, and to explore a potential moderating effect of gender or occupational status. After adjustment for all variables, current perceived stress was associated with future high BP in women only. In addition, the interaction between occupational status and perceived stress was significant in women. In analyses stratified by occupational categories, perceived stress was positively associated with high BP among women of medium or low occupational status, with OR suggesting a linear increase of the risk.

Explanatory hypotheses

Many hypotheses could explain gender differences in the association of baseline perceived stress with the occurrence of high BP. First, men and women are not exposed to the same stressors [5]. Therefore, perceived stress in women may relate to stressors associated with high BP to a greater extent than in men. Second, women might have reported their emotional state, and thus perceived stress, more accurately than men for at least two reasons: a better ability to recognize this emotional state [33] and a higher tendency to disclose emotional state once recognized [34]. A better accuracy in the estimation of stress might thus have led to a better accuracy when looking for an association with high BP. Third, there is strong evidence for gender differences in emotion regulation strategies: in particular, women exhibit higher levels of rumination,

defined as a perseverative focus on one's negative emotions and the causes and consequences of them, leading to mentally reliving stressful events [6]. Rumination is associated with poor BP recovery after acute stress [35] and people who tend toward greater rumination exhibit more BP reactivity to repeated mental stress tasks [36]. Therefore, a greater proneness to ruminate among women might explain why perceived stress may lead to higher levels of BP in the long run. In addition, women might also cope with stress with behaviors that were not adjusted for in the current analysis. For example, perceived stress is associated with more frequent consumption of sweets/fast foods in women especially [37] and might be a barrier to engage in health-promoting behaviors like physical exercise or refraining from snacking [38].

Finally, at a neural level, the impact of acute stress on blood pressure depends on the interplay of inhibitory control from prefrontal regions with excitatory input from limbic regions [39]. During acute stress, men might respond with a more favorable cortical-limbic balance than women that may result in lower effects of stress on BP levels [40,41].

Differences in the association of baseline perceived stress with the occurrence of high BP according to occupational status among women mirror the results of our previous cross-sectional study among men and women [21] as well as those from stress at work studies [22]. Occupational categories may differ in terms of exposure to work-related stress and particularly to job strain, which combines high job demands with low control at work [32] and tends to be associated with both high BP and lower occupational category [22,42]. Beyond job strain, perceived stress may also relate to exposure to occupational stressors that are specific to certain occupational categories (e.g., noise, cardiotoxic chemicals) and differently associated with the risk of hypertension [43,44]. Participants with lower occupational status might also have been less likely to deal with stress with adaptive health behaviors (e.g., physical activity) and

more with detrimental ones (e.g., alcohol consumption) [45]. Finally, lower socioeconomic status may be associated with lower probability to be diagnosed with hypertension or to take an antihypertensive drug once diagnosed [46], even in countries with an equal access to care [47,48]. This is consistent with the small number of women of low occupational status taking antihypertensive drugs at follow-up.

However, it is not clear why the above-mentioned mechanisms should apply for women only. This is unlikely to be explained in terms of statistical power due to the greater number of men among each occupational categories in which the association was significant. First, according to the Karasek model, differences in the ratio between job demands and latitude decision across occupational categories might be greater in women than men [49]. Second, according to the Siegrist model, differences in the ratio between reward and efforts at work might also be greater in women [50]. Interestingly, effort–reward imbalance has recently been found to predict future high BP in women only [20]. According to these two well-defined, internationally recognized models, such discrepancies may explain why perceived stress might have a particular impact among women of lower status. Third, in addition to occupational stressors, women are more likely than men to be exposed to non-occupational stressors such as household tasks, child care, care of sick or elderly relatives [51]. Perceived stress in women of low occupational status might thus be more likely to overwhelm their coping resources owing to the cumulative effects of these two sources of stress. In addition, gender differences in coping strategies, including the above-mentioned proneness to rumination, might depend upon occupational status, so that these differences might be less marked in individuals of high status [52,53]. In accordance with this hypothesis, a large cohort study recently found neuroticism (i.e. a personality trait associated with poor emotion regulation) to predict cardiovascular mortality in women of low socioeconomic status, but not in men regardless of their socioeconomic status [54].

Strengths and limitations

To our knowledge, this is the largest study to address this question and the first one to show that gender moderates the association between perceived stress and high BP. Strengths of the study are its prospective design, a large sample size allowing subsample analyses and the wide set of covariates considered, including a measure of depressive mood. For women, the potential role of menopause was taken into account. Some limitations should also be acknowledged. First, BP was not measured at several successive consultations. However, high BP has been associated with cardiovascular mortality in the IPC cohort study [55], as well as in other cohorts [56-58]. Furthermore, taking the use of antihypertensive drugs as an alternative endpoint, baseline perceived stress remained positively associated with future high BP among women of medium occupational status. Second, some potential confounders were not measured, such as diet, salt consumption, ethnicity, social support, and personality variables. Likewise, mental health was not fully explored and the QD2A does not allow making the diagnosis of clinical depression. As regards considered confounders, their measures might have been too crude or changes might have occurred during the follow-up in relation to perceived stress. However, these changes are unlikely to account for the prospective association of baseline perceived stress with high BP at follow-up, as this association remained significant even when adjusting for confounders measured at follow-up. Third, a large sample size ensures statistical power but not clinical significance because even small differences may reach statistical significance. Finally, the IPC cohort is not be representative of the general French population. Study recruitment was limited to the Paris area and two thirds of the participants were men, which potentially limits the generalizability of our results. Compared with Paris area

inhabitants, individuals in the IPC cohort were less likely to live alone, and more likely to have a professional activity and a higher occupational status (http://www.recensement.insee.fr/home.action). In addition, the present participants had asked for two preventive medical examinations, and thus may presumably display increased interest in their own health. For instance, they were more likely to have a normal BMI and to be non-smokers than the individuals who had only one health check-up at the IPC center. However, the incidence of high BP in the present sample was consistent with the incidence of hypertension in France [59]. Furthermore, these potential selection biases are unlikely to account for the relationships we found within the present sample, especially those characterized by the interactions of stress with gender and occupational status.

Perspectives

Although previous studies failed to establish stress as a risk factor for hypertension, the present results suggest that overlooking the moderating role of gender and occupational status might have blurred the relationship between stress and hypertension. From a clinical perspective, they suggest that perceived stress could be considered as a risk factor for hypertension in women of lower occupational status. Further studies are warranted to elucidate the mechanisms of this association, as such knowledge may eventually inform prevention strategies.

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Table 1. Characteristics of study participants.

	Men (n=13,652)	**Women (n=6,114)**	**p**
CONTINUOUS VARIABLES *	**Mean (SD)**	**Mean (SD)**	
Age (years)	46.09 (8.87)	48.35 (10.01)	<0.001
Perceived Stress (PSS-4)	3.38 (2.77)	4.18 (2.94)	<0.001
Depressive mood (QD2A)	1.13 (2.07)	1.94 (2.64)	<0.001
Perceived health status (10-point scale)	7.82 (1.54)	7.49 (1.69)	<0.001
Systolic BP (mmHg)	122.82 (9.18)	119.00 (10.61)	<0.001
Diastolic BP (mmHg)	74.71 (7.13)	72.03 (7.67)	<0.001
Heart rate (beats per minute)	60.70 (9.14)	64.31 (9.31)	<0.001
Fasting glycemia (mmol/L)	5.42 (0.68)	5.15 (0.64)	<0.001
Interval between visits (years)	5.89 (2.12)	5.66 (2.21)	<0.001
DISCRETE VARIABLES *	**N (%)**	**N (%)**	
High BP at follow-up (see text)			<0.001
No	10,937 (80.1)	5,055 (82.7)	
Yes	2,715 (19.9)	1,059 (17.3)	
Occupational status			
High	6,837 (50.1)	1,473 (24.1)	<0.001
Medium	3,317 (24.3)	2,707 (44.3)	
Low	1,616 (11.8)	294 (4.8)	
Unemployed	1,803 (13.2)	923 (15.1)	
Unpaid occupation	79 (0.6)	717 (11.7)	
Living status			<0.001
Living alone	2,762 (20.2)	1,810 (29.6)	

Not living alone	10,890 (79.8)	4,304 (70.4)	
BMI (kg/m^2)			<0.001
<18.5	129 (0.9)	256 (4.2)	
18.5-24.9	7,445 (54.5)	4,287 (70.1)	
25-29.9	5,379 (39.4)	1,217 (19.9)	
≥30	699 (5.1)	354 (5.8)	
Smoking status			
No-smokers	6,674 (48.9)	4,084 (66.8)	<0.001
Ex-smokers	3,423 (25.1)	889 (14.5)	
1-10 cigarettes/day	1,827 (13.4)	639 (10.5)	
11-20 cigarettes/day	1,329 (9.7)	401 (6.6)	
>20 cigarettes/day	399 (2.9)	101 (1.7)	
Alcohol intake			<0.001
0 glasses/week	6,873 (50.3)	4,390 (71.8)	
1-6 gl./w. for women or 1-13 gl./w. for men	5,119 (37.5)	1,118 (18.3)	
7-20 gl./w. for women or 14-27 gl./w. for men	1,132 (8.3)	498 (8.1)	
>21 gl./w. for women or >28 gl./w. for men	528 (3.9)	108 (1.8)	
Regular physical activity			0.247
<1 hour of walking/day	7,312 (53.6)	3,329 (54.4)	
≥1 hour of walking/day	6,340 (46.4)	2,785 (45.6)	
Familial history of hypertension			<0.001
Yes	3,068 (22.5)	2,003 (32.8)	

No	10,584 (77.5)	4,111 (67.2)
Menopausal status		
Not menopausal at second visit		2,585 (42.3)
Already menopausal at first visit		1,883 (30.8)
Menopausal at second visit only		1,628 (26.6)
Missing data		18 (0.3)

BMI indicates body mass index; BP, blood pressure; PSS-4, 4-item Perceived Stress Scale; QD2A, questionnaire of depression 2nd version abridged; and SD, Standard Deviation.

* Unless otherwise specified, figures indicate baseline values

Table 2. Associations between each variable at baseline and high BP (see text) at follow-up in fully adjusted models.

INDEPENDENT VARIABLES	Men	Women
CONTINUOUS VARIABLES *	**OR [95%CI]**	**OR [95%CI]**
Age (years)	1.05† [1.04-1.05]	1.06† [1.05-1.07]
Perceived Stress (PSS-4)	0.97 [0.88-1.07]	1.20§ [1.03-1.38]
Depressive mood (QD2A)	1.02 [0.99-1.04]	0.97 [0.94-1.01]
Perceived health status (10-point scale)	1.02 [0.99-1.05]	0.97 [0.92-1.01]
Heart rate (beats per minute)	1.03† [1.03-1.04]	1.03† [1.02-1.04]
Fasting glycemia (mmol/L)	1.01† [1.00-1.01]	1.00 [1.00-1.01]
Interval between visits (years)	1.09† [1.06-1.12]	1.09† [1.05-1.13]
DISCRETE VARIABLES	**OR [95%CI]**	**OR [95%CI]**
Occupational status		
High	Reference	Reference
Medium	1.06 [0.95-1.18]	1.14 [0.95-1.37]
Low	1.32† [1.15-1.53]	1.41§ [1.00-1.99]
Unemployed	1.01 [0.85-1.19]	0.91 [0.69-1.20]
Unpaid occupation	1.51 [0.87-2.63]	1.19 [0.93-1.53]
Living alone (vs. not living alone)	1.10 [0.98-1.24]	0.96 [0.81-1.13]
BMI		
<18.5	0.65 [0.36-1.17]	0.75 [0.48-1.18]
18.5-24.9	Reference	Reference
25-29.9	1.57† [1.44-1.73]	1.92† [1.62-2.26]
≥30	2.59† [2.17-3.09]	2.59† [1.98-3.37]
Smoking status		

Non-smokers	Reference	Reference
Ex-smokers	1.13§ [1.02-1.26]	0.80§ [0.64-0.99]
1-10 cigarettes/day	0.97 [0.84-1.12]	0.81 [0.62-1.06]
11-20 cigarettes/day	1.17§ [1.00-1.37]	1.22 [0.91-1.64]
>20 cigarettes/day	1.49‡ [1.17-1.90]	1.33 [0.75-2.36]
Alcohol intake		
0 gl./w.	Reference	Reference
1-6 gl./w. for women or 1-13 gl./w. for men	1.34† [1.21-1.47]	1.35‡ [1.13-1.61]
7-20 gl./w. for women or 14-27 gl./w. for men	0.74‡ [0.61-0.89]	0.96 [0.73-1.26]
>21 gl./w. for women or >28 gl./w. for men	1.14 [0.91-1.44]	0.66 [0.35-1.24]
≥1 hour of walking/day (vs. <1 hour)	1.10§ [1.01-1.21]	0.98 [0.84-1.13]
Familial history of hypertension	1.29† [1.16-1.43]	1.30† [1.12-1.51]

BMI indicates body mass index; BP, blood pressure; CI, confidence interval; OR, odds ratio; PSS-4, 4-item Perceived Stress Scale; and QD2A, questionnaire of depression 2nd version abridged.

*OR is given per 5-point increment for the PSS-4 and per unit for the other continuous variables.

† P<0.001; ‡ P<0.01; § P<0.05.

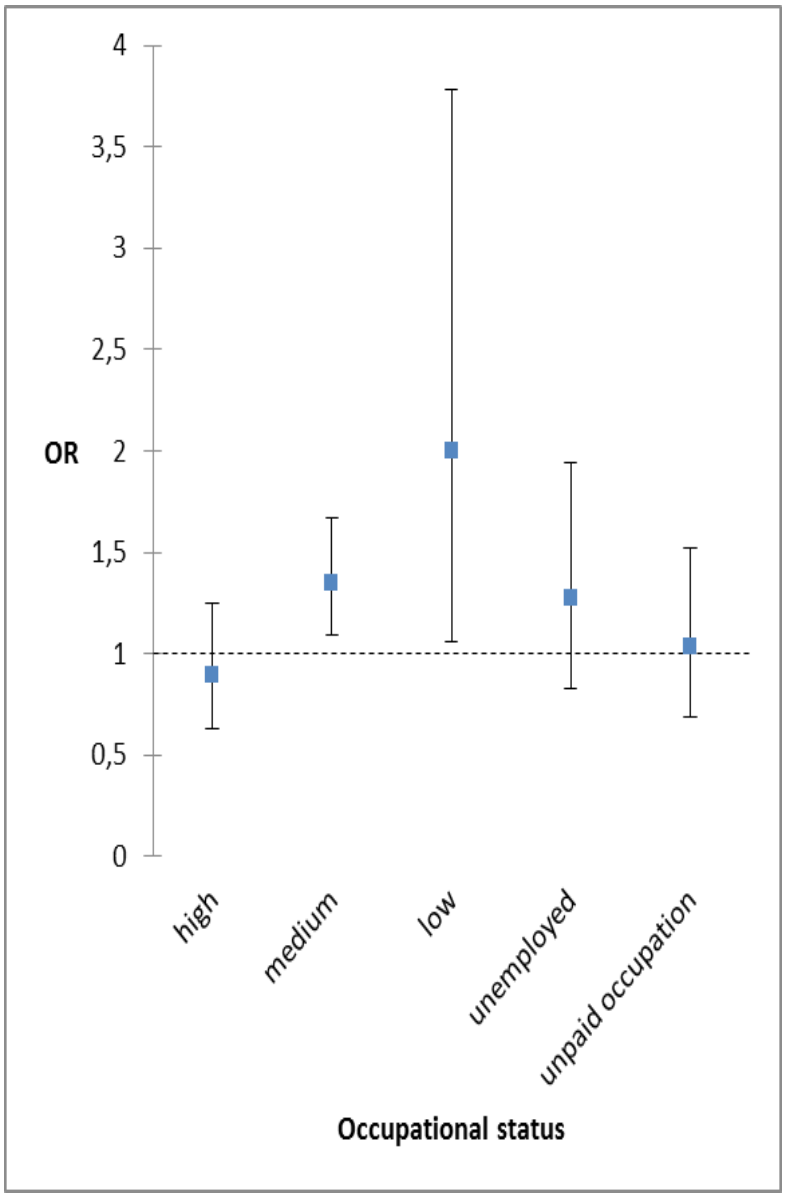
Table 3. Association between baseline perceived stress and high BP (see text) at follow-up across occupational categories in women. Odds ratios (OR) are given per 5-point increment of the 4-item Perceived Stress Scale score (ie, the difference between the 25th and the 75th percentile).

OCCUPATIONAL STATUS	OR [95%CI]
High	0.89 (0.63-1.25)
Medium	1.35‡ (1.09-1.67)
Low	2.00§ (1.06-3.78)
Unemployed	1.27 (0.83-1.94)
Unpaid occupation	1.03 (0.69-1.52)

CI, confidence interval.

‡ P<0.01; § P<0.05.

Figure 1. Association between baseline perceived stress and high BP (see text) at follow-up across occupational categories in women. Odds ratios (OR) are given per 5-point increment of the 4-item Perceived Stress Scale score (ie, the difference between the 25th and the 75th percentile).



Text S1. English version of the 4-item Perceived Stress Scale (PSS-4)

Instructions

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, please indicate with a check how often you felt or thought a certain way.

1. In the last month, how often have you felt that you were unable to control the important things in your life?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

2. In the last month, how often have you felt confident about your ability to handle your personal problems?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

3. In the last month, how often have you felt that things were going your way?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

4. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

Scoring

PSS-4 scores are obtained by reverse coding the positive items, e.g., 0=4, 1=3, 2=2, etc. and then summing across all 4 items. Items 2 and 3 are the positively stated items.

Figure S1. Flow chart of the study population selection

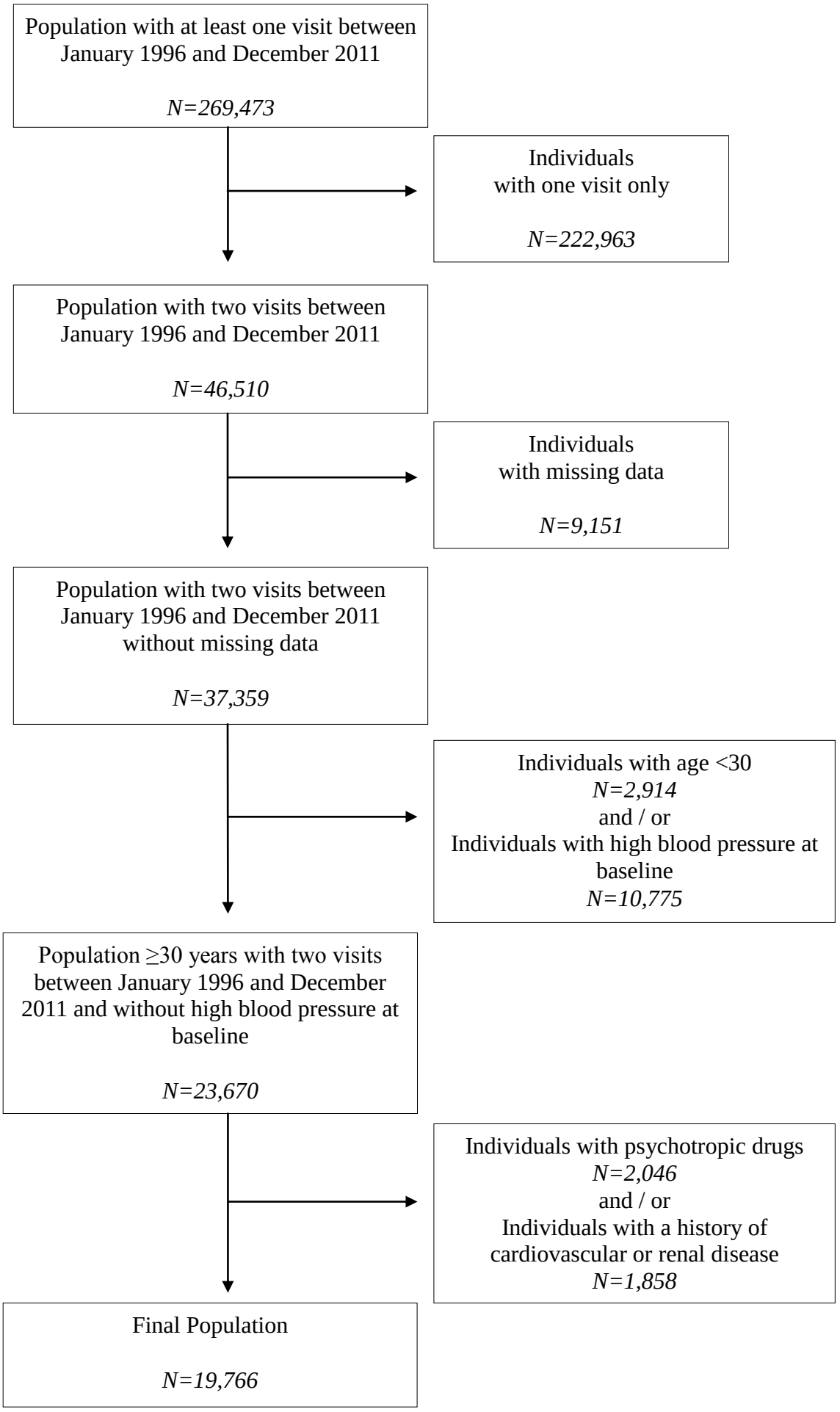


Table S1. Baseline characteristics of included and excluded participants.

	Participants with 1 visit		Participants with 2 visits		p
CONTINUOUS VARIABLES	**N**	**Mean SD**	**N**	**Mean SD**	
Age (years)	222,963	43.93 (13.22)	46,510	47.06 (12.30)	<0.001
Perceived Stress (PSS-4)	219,391	4.26 (3.08)	45,363	4.14 (3.07)	<0.001
Depressive mood (QD2A)	216,948	1.68 (2.7)	44,744	1.76 (2.71)	<0.001
Perceived health status (10-point scale)	222,619	7.25 (1.79)	46,418	7.39 (1.77)	<0.001
Systolic BP (mmHg)	214,031	128.61 (18.02)	45,791	129.24 (17.38)	<0.001
Diastolic BP (mmHg)	213,630	77.03 (11.21)	45,722	77.64 (10.91)	<0.001
Heart rate (beats per minute)	203,714	64.04 (10.66)	42,957	63.18 (10.11)	<0.001
Fasting glycemia (mmol/L)	221,358	5.39 (1.02)	46,339	5.38 (0.87)	0.017
DISCRETE VARIABLES		**N (%)**		**N (%)**	
High BP (see text)					<0.001
No		154,647 (72.1)		32,538 (71.0)	
Yes		59,929 (27.9)		13,290 (29.0)	
Gender					<0.001
Men		136,569 (61.3)		30,096 (64.7)	
Women		86,394 (38.7)		16,414 (35.3)	
Occupational status					<0.001
High		68,624 (30.8)		16,142 (34.8)	
Medium		72,443 (32.6)		13,550 (29.1)	
Low		27,689 (12.4)		4,638 (10.0)	
Unemployed		28,544 (12.8)		8,071 (17.4)	
Unpaid occupation		25,258 (11.3)		4,021 (8.6)	
Living status					<0.001
Living alone		63,288 (28.5)		12,239 (26.4)	
Not living alone		159,038 (71.5)		34,156 (73.6)	
BMI (kg/m^2)					<0.001
<18.5		6,429 (2.9)		1,039 (2.2)	
18.5-24.9		115,677 (52.3)		24,866 (53.7)	
25-29.9		72,981 (33.0)		16,214 (35.0)	
≥30		25,966 (11.7)		4,181 (9.0)	
Smoking status					<0.001
No-smokers		114,504 (52.6)		25,482 (55.6)	
Ex-smokers		40,875 (18.8)		9,703 (21.2)	
1-10 cigarettes/day		29,577 (13.6)		5,505 (12.0)	
11-20 cigarettes/day		24,949 (11.5)		3,855 (8.4)	
>20 cigarettes/day		7,831 (3.6)		1,246 (2.7)	
Alcohol intake					<0.001
0 glasses/week		154,317 (69.2)		27,774 (59.7)	
1-6 gl./w. for women or 1-13 gl./w. for men		39,568 (17.8)		12,894 (27.7)	

7-20 gl./w. for women or 14-27 gl./w. for men	18,869 (8.5)	3,904 (8.4)	
>21 gl./w. for women or >28 gl./w. for men	10,138 (4.5)	1,928 (4.1)	
Regular physical activity			<0.001
<1 hour of walking/day	123,250 (55.3)	24,793 (53.5)	
≥1 hour of walking/day	99,640 (44.7)	21,715 (46.7)	
Familial history of hypertension			
Yes	66,247 (29.8)	13,740 (29.5)	
No	156,180 (70.2)	32,769 (70.5)	0,301

BMI indicates body mass index; BP, blood pressure; PSS-4, 4-item Perceived Stress Scale; QD2A, questionnaire of depression 2nd version abridged; and SD, Standard Deviation.