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Social support and ambulatory blood pressure in older people

Brief short title: Social support and blood pressure

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ABSTRACT

Objective. Social support has been associated with greater nocturnal decline (dipping) in blood pressure (BP) in younger and middle-aged individuals. However, it is uncertain if aggregated measures of social support are related to ambulatory systolic BP (SBP) in older adults, where high SBP is frequent and clinically challenging.

Methods. We studied 1047 community-living individuals aged ≥ 60 years in Spain. Twenty-four-hour ambulatory BP was determined under standardized conditions. Social support was assessed with a 7-item questionnaire on marital status, cohabitation, frequency of contact with relatives, or with friends and neighbors, emotional support, instrumental support, and outdoor companionship. A social support score was built by summing the values of the items that were significantly associated with SBP variables, such that the higher the score, the better the support.

Results. Participants' mean age was 71.7 years (50.8% men). Being married, cohabiting, and being accompanied when out of home were the support items significantly associated with SBP variables. After adjustment for sociodemographic (age, sex, education), behavioral (body mass index, alcohol, tobacco, salt consumption, physical activity, mediterranean diet score), and clinical variables (sleep quality, mental stress, comorbidity, BP medication, and ambulatory BP levels and heart rate), 1 additional point in the social support score built with the abovementioned 3 support variables, was associated with a decrease of 0.93 mmHg in nighttime SBP ($p=0.039$), totaling 2.8 mmHg decrease for a score of 3 versus 0. The 3-item social support score was also inversely associated with the night/day SBP ratio ($\text{beta}=-0.006$, $p=0.010$).

Conclusion. In older adults, social support is independently associated with lower nocturnal SBP and greater SBP dipping. Further research is needed in prospective studies to confirm these results.

Keywords: social support; ambulatory blood pressure; blood pressure; elderly

Abbreviations: BP, blood pressure; ABPM, ambulatory blood pressure monitoring;
CVD, cardiovascular disease; BMI, body mass index.

INTRODUCTION

Ambulatory blood pressure monitoring (ABPM) is a useful tool for the diagnosis and management of hypertension because it predicts clinical outcome better than conventional blood pressure (BP) measurements [1-3]. In particular, nighttime BP, especially systolic BP (SBP), is a better predictor of cardiovascular disease (CVD) than daytime BP in both the general and the hypertensive younger and older population [4,5]. BP normally declines during the night (“dipping” phenomenon), and a blunted nocturnal decline is also a risk factor for cardiovascular mortality [6]. The night/day BP ratio expresses the same information as the dipping size [3], and independently predicts total mortality [5].

Social support is usually defined to include both the structure of an individual’s social life (e.g., group memberships, existence of familiar ties) and the more explicit functions it may serve (e.g., emotional support) [7], and it is associated with beneficial health outcomes, including reduction in rates of mortality and morbidity [8-10]. Participation in formal social relationships, such as marriage, is associated with better cardiovascular, immune, psychiatric, and behavioral-related indices [11]. Also in some studies better social support and social network have been associated with lower conventional BP [12-15].

More recent studies have examined the relationship between various social support measures and some ambulatory BP parameters, mainly nocturnal BP dipping [16-22], generally finding protective effects (greater dipping) with better social support. However, important concerns arise when considering the link between social support and ambulatory BP. One is that measures of social support thought to moderate BP may have limited cross-cultural application [23]. Moreover, this relationship can be confounded by sociodemographic, behavioral, and clinical factors, and studies have

generally adjusted for only a few, if any, of these factors [18-20]. Also, most studies were relatively small (generally <300 participants), focused on younger and middle-aged individuals, and yielded heterogeneous results across sex and race/ethnicity subgroups [18].

This study examines the association between single and aggregated indicators of social support and ambulatory SBP-related variables in a relatively large sample of community-living older individuals in Spain, after adjusting for a number of potential confounders. This study is important because high SBP is frequent, clinically challenging, and a stronger predictor of cardiovascular risk than diastolic BP (DBP) in the older population of most countries, including Spain [24-26]. Lastly, this study may shed light on the mechanisms explaining the inverse association between social support and CVD.

METHODS

Study design and participants

Data were taken from the Seniors-ENRICA cohort, whose methods have been previously reported [27,28]. In brief, this cohort was established between 2008 and 2010 with 2614 non-institutionalized individuals selected through stratified random sampling from the population aged 60 years and older in Spain. At baseline, information on sociodemographic variables, lifestyle, health status, and morbidity was collected by telephone interview; also a home visit was conducted to collect blood and urine samples, and another home visit to perform a physical examination and to record habitual diet and prescribed medication. Participants were followed-up until 2012, when a second wave of data collection was performed. Ninety-five participants died during follow-up; from the remaining 2519 subjects, 2037 provided updated information for

the phone interview, the physical examination, diet and medication. Baseline sociodemographic and clinical characteristics of the participants at the inception of the cohort were reasonably similar to those who did not participate [28].

In this second wave, and because of logistic and cost reasons, ABPM was offered to 1698 individuals and performed in 1328 patients (response rate, 78.2%). Compared with participants without ABPM, those who underwent the measurement had similar age (71.8 years vs 71.7 years), proportion of men (47% vs 49%), education level (63% vs 61% with \leq primary studies), mean body mass index (BMI; 27.8 kg/m² vs 27.5 kg/m²), proportion of diabetes (15.1% vs 16.1%), current smoking (11.0% vs 11.7%), and history of cardiovascular disease (5.7% vs 4.5%) [28].

Personnel involved in data collection received specific training in the study procedures. Participants provided written consent and the study was approved by the Clinical Research Ethics Committee of the *La Paz* University Hospital in Madrid.

Blood pressure measurement

BP was measured using standardized procedures [29]. Conventional BP was measured with a validated automatic device (Omron Healthcare, Lake Forest, IL) and appropriately sized cuffs. BP was determined three times at 2-minute intervals after the patients had rested for 5 minutes in a seated position. In the analyses, BP was calculated as the mean of the last two of the three readings.

Thereafter, 24-hour ABPM was performed with a validated automated noninvasive oscillometric device (Microlife WatchBPO3 monitor; Microlife Corp, Widnau, Switzerland) [30] programmed to register BP at 20-minute intervals during the day and at 30-minute intervals during the night. Appropriate cuff sizes were used. Most records were obtained on working days and the subjects were instructed to maintain

their usual activities but keep the arm extended and immobile at the time of cuff inflation. The staff of the study returned to the patients' homes for device removal the following day. Valid ABPM registries had to fulfill a series of preestablished criteria, including 24-hour duration and at least 70% successful SBP and DBP readings during the day and night [2,3]; mean number of nocturnal ambulatory BP readings obtained was 15.8, a number that meets guidelines' requirements [3,31]. Daytime and nighttime periods were defined individually according to the patients' self-reported time of going to bed and getting up. We also collected information from the BP devices on heart rate as it means sympathetic (and vagal) influence, which plays a key role in hypertension and BP levels [32].

Social support assessment

Social support was assessed with a questionnaire including the following 7 items: 1) Marital status (coded as 0=single, separated, or widowed; 1=married); 2) Cohabitation (0=living alone; 1=living with the family, with other flatmate, in an institution, or accompanied in any other situation); 3) Frequency of contact with relatives living apart (0= in-person or phone contact once or twice a week, once or twice a month, every few months, rarely or never; 1=daily or almost daily); 4) Frequency of contact with friends or neighbors (same encoding as the previous item); 5) Emotional support, defined as having someone to share confidences, feelings and problems with, or someone to trust in (0=no; 1=yes); 6) Instrumental support, defined as having someone to help at home (0=no; 1=yes); and 7) Outdoor companionship, defined as usually being accompanied when going out of home (0=no; 1=yes).

Other study variables

Study participants reported their sociodemographic characteristics -sex, age, educational level (\leq primary, secondary, and university education), smoking status, and alcohol consumption (never-, ex-drinker, moderate- and excessive-drinking, with the threshold between the latter two categories being 50 g/day in men and 25 g/day in women). Salt intake (g/day) was assessed with a validated computerized diet history developed from that used in the EPIC cohort study in Spain [33,34]. Adherence to the Mediterranean diet was summarized with the Mediterranean diet adherence screener (MEDAS) [35]. MEDAS consists of 12 items with targets on food consumption and another 2 items with targets for food intake habits characteristic of the Mediterranean diet in Spain. One point is given for each target achieved. The total MEDAS score ranged from 0 to 14, with a higher score indicating better Mediterranean adherence. For the purpose of analysis we excluded alcohol consumption from the MEDAS as this variable is considered as a specific variable in this study. Information on physical activity was also obtained with the EPIC instrument, and individuals were classified as inactive, moderately active, or intensively active. Participants reported their usual sleep quality during the night ("very good", "good", "fair", "bad" and "very bad"). We approached psychological distress through a single-item question on the General Health Questionnaire [36], on how frequently the individual felt recently constantly under strain? (not at all, no more than usual, rather more than usual, much more than usual). Medication use was collected by a face-to-face interview and verified against drug packaging during the home visit. Antihypertensive medications were classified according to international guidelines [2,37].

Participants also reported if they suffered from any of the following physician-diagnosed diseases: cardiovascular disease (myocardial infarction, stroke, heart failure), diabetes mellitus, cancer at any site, asthma or chronic bronchitis, osteomuscular

disease (osteo-arthritis, arthritis, hip fracture), or depression requiring drug treatment. Lastly, the BMI was calculated as measured weight in kg divided by square height in m.

Statistical analysis

The analyses were conducted among 1047 individuals with $\geq 70\%$ valid ABPM readings and complete information on study variables (78.8% of all with available ABPM).

Conventional and ambulatory hypertension were defined using consensus criteria (BP $\geq 140/90$ or on treatment and $\geq 130/80$ mmHg or on treatment, respectively) [2,3]. We used the night/day ratio as an estimate of nocturnal BP dipping, such that the lower the ratio, the greater the dipping [3]. To compare means across groups we used the Student t-test or analysis of variance, while for proportions we used the Pearson χ^2 test.

We then examined the multivariable relationship of social support items with SBP-related variables. Associations adjusted for demographic variables and BMI pointed to three single social support items. We then built a social support score calculated by summing the responses to these 3 social support items (possible range 0 to 3), and categorized as: 0, 1, 2, and 3, such that the higher the score, the better the social support. We ran two multiple linear regressions with nighttime SBP and night-to-day SBP ratio as continuous outcomes (the two SBP variables associated with the social support score). Social support score was the main independent variable, modeled as continuous. Models were adjusted for important clinical variables associated with social support and known effects on BP dipping [16,18,22]. A basic model was adjusted for sociodemographic variables (age, sex, and educational level), and then it was added to this basic model other important covariates: lifestyle variables (BMI, alcohol consumption, smoking, salt intake, and physical activity), MEDAS score, sleep quality,

mental stress, number of comorbidities, number of BP medications, daytime SBP (for the nighttime SBP-based model) or 24-h SBP (for the night/day SBP ratio-based model), and 24h heart rate. A final model included full adjustment for all the above variables. All these covariates were modeled as defined above (also see table 1). Lastly, to test whether the association between social support and BP varied with sex, we used an interaction term formed by multiplying the social support score (continuous) and sex. Statistical significance was set at $p < 0.05$. The analyses were performed with SPSS v. 21 (IBM; Armonk, NY).

RESULTS

Mean age of study participants was 71.7 (± 6.3) years, 50.8% were men, and 59% did at least moderate physical activity. Median salt intake was 2.6 g/day and mean BMI was 28.1 kg/m² (**Table 1**). Mean number of comorbidities was 1.4, mean number of BP medications among treated hypertensive patients was 1.7, and mean social support score was 4.8. Some 67% of individuals had conventional hypertension, and 52% had elevated BP based on 24-h values. Mean clinic BP was 137.8/74 mmHg, mean daytime BP was 127.0/72.4 mmHg, mean nighttime BP was 117.8/64.8 mmHg, mean 24h BP was 123.6/69.8 mmHg, and the mean night/day ratio was 0.93. Mean clinic heart rate was 71.0 \pm 13.2 bpm, and mean 24h heart rate was 67.1 \pm 8.9 bpm (70.0 bpm during daytime and 62.2 bpm during nighttime).

Associations with social support items

Only three single items of social support were significantly associated with ambulatory SBP variables (**Table 2**). Being married was significantly associated with lower daytime and nighttime SBP and lower night/day ratio. Not living alone was significantly

associated with lower daytime and nighttime SBP, and being accompanied when going out of home was significantly associated with lower nighttime SBP and night/day ratio.

Associations with social support score

There was a trend towards lower SBP values across the increasing social support score built with these 3 significant social support items, though these trends only reached statistical significance for nighttime SBP and night-to-day SBP ratio (**Table 3**). Also, in comparison with individuals with a score 0, those with a score ≥ 1 had lower nighttime SBP (mean difference, 3.1 mmHg, $p=0.016$) and lower night-to-day SBP ratio (difference, 0.017, $p=0.006$).

When adjusting for sociodemographic variables, the beta coefficient was -1.063 ($p=0.012$), which means a 15% smaller decrease in nocturnal SBP when compared with the unadjusted estimate (-1.253, **Table 4**). When additionally adjusted for lifestyles or clinical variables, beta values remained significant, with small changes in magnitude, with slightly greater decreases in nocturnal SBP after adjustment for mediterranean diet score, stress, or heart rate (-1.102, -1.075, and -1.069, respectively vs -1.063), except for adjustment for daytime SBP, which was associated with a 16% smaller decrease in nighttime SBP (beta -0.886 vs -1.063). Overall, after full adjustment 1 additional point in the social support score built with the 3 significant support variables, was associated with a decrease of 0.928 mmHg in nighttime SBP ($p=0.039$), totaling 2.8 mmHg decrease for a score of 3 versus 0.

Despite absence of statistical interaction between social support score and sex ($p=0.579$), an inverse association between social support score and nighttime SBP was observed among men (fully-adjusted beta=-1.568, $p=0.027$), but non-significant among women (beta=-0.518, $p=0.3$).

The social support score was also inversely associated with the night/day SBP ratio (fully adjusted $\beta=-0.006$, $p=0.010$) (**Table 5**), translating into greater dipping, meaning that the higher the social support score, the lower the ratio and thus the greater the SBP dipping.

DISCUSSION

In this study, we found that nocturnal systolic BP and night/day ratio were lower in older individuals with higher social support score regardless of other relevant sociodemographic, behavioral, and clinical covariates. This is important since both high nocturnal BP and BP nondipping pattern have been associated with a worse cardiovascular risk profile and an increased risk of all-cause and cardiovascular mortality, and coexistence of both BP-related variables is associated with the worst cardiovascular risk profile [38-40].

In particular, fully adjusted regression models indicated that the aggregation of being married, cohabiting, and being accompanied when out of home in community-living older adults was independently associated with a decrease of almost 3 mmHg in nocturnal BP. Given that the association between nighttime BP (and nocturnal BP decline) and cardiovascular risk is linear and potent [5,6,41], even moderate decreases in nocturnal BP could be potentially associated with meaningful population benefits in terms of cardiovascular outcomes. Interestingly, the magnitude of this association is comparable to that of some single lifestyle interventions on nocturnal fall in mean BP [42].

Comparisons with other studies

Due to methodological differences among studies, to variations in the definition of social support and the outcome variables, and to differences on subgroups analyzed [18,20,21,23], results across studies are heterogeneous making comparisons difficult to make. Nevertheless, our specific result on marital status and nocturnal BP is comparable to that found in a small clinical-trial study, which reported an adjusted 2.4 mmHg lower nighttime SBP in married adults vs. unmarried adults [16]. We obtained a similar nocturnal SBP difference of 2.8 mmHg lower in married vs unmarried older individuals. As some other studies [16,18], but not all [21], we also found stronger associations in men than in women, probably because women are more likely than men to attempt to control others' health; thus, when marriage promotes better health habits, these effects are relatively larger for men than women. In any case, our findings extend previous observations on the protective effect of social support measures on BP dipping and nocturnal BP [16,18-20,22], to a much larger population of community-living hypertensive and normotensive older adults in a Mediterranean country, where this relationship has hardly been tested. By doing this, they provide evidence on a mechanism by which explain the known relationship between social relationships and cardiovascular health [43].

Mechanisms explaining the association

The mechanisms whereby social support affects health aspects in general, and nocturnal BP and dipping BP pattern in particular, are not well known, and behavioral, psychological, and biological processes have been proposed [9,44]. In this sense, constant exposure to mental and physical stress and elevated neurohumoral activation could significantly impact BP level, as well as the dipping BP pattern [41]. Moreover, less social support could also lead to lower adoption of healthy behaviors relevant for

BP (e.g., healthy diet and exercise) and to worse medication adherence [9,44].

Nevertheless, the fact that in our study the effect of social support on these nighttime BP variables was weakened but did not substantially change after adjustment for a number of variables, including comorbidities, medication, and heart rate, and also including some mediators of the association, such as behavior factors, dietary variables, or mental stress points to the role of other mediators not included in the analyses.

Nocturnal SBP and night/day SBP ratio were lower for all the seven social interactions, but failed to reach statistical significance for frequency of contact with family or friends/neighbors, emotional support, and instrumental support. Among possible explanations, we suggest that marital status and cohabitation involve a longer time of exposure to social support, greater commitment or intimacy than other variables such as frequency of contacts with family/friends/neighbors. Outdoor companionship is a common characteristic in Spain, coexist frequently with talking, and it may be associated with reinforcement of healthy habits or reminder of buying healthy foods or prescribed medications, and thus higher adherence to healthy diet or drug treatment is plausible to occur. Also, the frequency of contacts and emotional support are very common in Spain, thus these variables could discriminate worse than other measures of social support. Overall, further research is needed to examine systematically potential biological and psychosocial mechanisms.

Methodological aspects

The strengths of this study include its large sample size when compared to other studies on this issue, the fact that we adjusted for a number of important covariates, and its focus on a community-living older population.

Study's limitations include its cross-sectional design, which does not allow for causal interpretation. Generalizability of our findings is limited because poor social network is a reason for institutionalization, so that exclusion of institutionalized individuals may have underestimated the relationship between social support and BP. Also, comparisons with our findings are limited by differences on social support assessment. Nevertheless, although we have not formally assessed the reliability of our social support questionnaire, the questions used are simple and easy to recall reliably. Also, the score instrument has an acceptable internal consistency (Cronbach's alpha, 0.79). The questions that we used have certain content validity because they covered several aspects of the contact with the network of people surrounding an individual, such as the structure (marital status and whether individuals live alone), and other types of social interactions (e.g., outdoor companionship). Other researchers in this field have also used similar questions [18]. A final issue affecting content validity is the weight given to each question in the instrument. Our model of social support did not specify the relative importance of each social measure but a simple summing of items, as we did, is usually the most sensible approach [45]. An additional limitation is that we have mainly assessed structural social support measures, except for instrumental support. Also, we have not collected information on participation in social activities or volunteer groups. Nevertheless, we believe that these activities are not culturally appropriate for Spanish elderly. Volunteer groups with participation of elderly people do not have a strong tradition in Spain; these groups have been developed quite recently, and participation of elderly people is still very infrequent. Our measure of social support has some criterion validity, because most of the questions used have been shown to be associated with both the physical and social dimensions of health-related quality of life, as measured by the SF-36 questionnaire, on a sample of persons representative of the Spanish population

aged >60 years [46]. Lastly, we cannot rule out certain residual confounding due to unmeasured variables, such as marriage quality [11,19], income, or more refined methods to measure stressful experiences.

Conclusions and perspectives

In summary, in a large sample of community-living individuals aged 60 and over in Spain, social support score is associated with lower nocturnal systolic BP and higher BP dipping beyond the effect of known covariates. This study adds to the still scarce literature on the BP benefits of social support in older community dwellers. This association also suggests a pathway through which social support affect cardiovascular health. However, this relationship needs to be confirmed in longitudinal studies. Future studies should also explore more in depth the potential difference in the association by gender, people institutionalized, and other specific subgroups, and refining the way to obtain information on complex social support and social network variables.

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Table 1. Characteristics of the study participants (n=1047)

Age (years)	71.7±6.3
Men, %	50.8
Educational level, %	
≤Primary studies	61.4
Secondary or university	38.6
Current smokers, %	6.7
Alcohol consumption, %	
Never drinker	36.2
Ex-drinker	9.2
Moderate drinker	45.8
Excessive drinker	8.8
Salt intake, g/day	2.6 (2.0-3.4)
Body mass index, kg/m²	28.1±4.6
Physical activity, %	
Low	41
Moderate or intense	59
Mediterranean diet score, points	6.9±1.7
Sleep quality, %	
Very good	9.5
Good	61.2
Regular	24.9
Bad	4.1
Very bad	0.3
Constantly under strain, %	
Not at all	40.5
No more than usual	38.6
Rather more than usual	17.7
Much more than usual	3.2
Blood pressure, mmHg	
24h systolic/diastolic blood pressure	123.6±11.4 /69.8±7.0
Daytime systolic/diastolic blood pressure	127.0±11.6 /72.4±7.5
Nighttime systolic/diastolic blood pressure	117.8±13.0 /64.8±7.7
Night/day systolic blood pressure ratio	0.93±0.06
Heart rate, bpm	
24h heart rate	67.1±8.9
Number of antihypertensive drugs, %	
0	57.1
1	21.9
2	15.2
3	2.6
≥4	3.2
Number of comorbidities, %	
0	30.1
1	29.6
2	22.3
3	9.7
≥4	8.2

Values are mean±SD for continuous variables or % for categorical variables, except for salt intake (median (interquartile range)).

Table 2. Blood pressure variables according to social support items.

	N (%)	Daytime SBP, mmHg		Nighttime SBP, mmHg		Night/day SBP ratio	
		Mean±SD	Beta (SE)‡	Mean±SD	Beta (SE)‡	Mean±SD	Beta (SE)‡
Marital status							
Married	748 (71.4)	126.7±11.6	-1.7 (0.8)*	117.2±13.0*	-2.8 (0.9)**	0.925±0.065*	-0.010 (0.005)*
Not married	299 (28.6)	127.5±11.4	Ref.	119.2±12.8	Ref.	0.935±0.059	Ref.
Living alone							
No	845 (80.7)	126.7±11.7	-2.0 (0.9)*	117.4±13.2*	-2.5 (1.0)*	0.927±0.065	-0.005 (0.005)
Yes	202 (19.3)	128.0±10.9	Ref.	119.4±11.9	Ref.	0.933±0.057	Ref.
Frequency of contact with family							
Daily/almost daily	724 (69.1)	126.9±11.5	0.1 (0.8)	117.6±13.0	-0.6 (0.8)	0.927±0.065	-0.006 (0.004)
Less frequently	323 (30.9)	127.1±11.5	Ref.	118.1±12.7	Ref.	0.930±0.061	Ref.
Frequency of contact with friends or neighbors							
Daily/almost daily	635 (60.6)	126.7±11.7	-0.6 (0.7)	117.4±12.9	-0.8 (0.8)	0.928±0.063	-0.002 (0.004)
Less frequently	412 (39.4)	127.3±11.2	Ref.	118.2±13.0	Ref.	0.928±0.064	Ref.
Emotional support							
Yes	974 (93.0)	127.0±11.6	0.8 (1.4)	117.7±13.0	-0.2 (1.5)	0.927±0.064	-0.007 (0.008)
No	73 (7.0)	126.4±10.9	Ref.	118.4±12.3	Ref.	0.937±0.053	Ref.
Instrumental support							
Yes	556 (53.1)	127.0±11.8	0.1 (0.7)	117.5±13.2	-0.5 (0.8)	0.926±0.061	-0.005 (0.004)
No	491 (46.9)	127.0±11.2	Ref.	118.0±12.7	Ref.	0.930±0.066	Ref.
Accompanied when out of home							
Yes	599 (57.2)	126.6±10.9	-0.8 (0.7)	116.9±12.7*	-2.0 (0.8)*	0.923±0.064*	-0.011 (0.004)**
No	448 (42.8)	127.4±12.3	Ref.	119.0±13.2	Ref.	0.934±0.063	Ref.

Systolic blood pressure (SBP) values are unadjusted mean±standard deviation. *p<0.05, **p<0.01.

‡Beta coefficients (standard error) are adjusted for demographic variables and body mass index through multiple linear regression.

Table 3. Association between social support score and blood-pressure variables.

Score	N (%)	Daytime SBP, mmHg	Nighttime SBP, mmHg	Night/day SBP ratio
0	116 (11.1)	127.8±10.9	120.5±12.1	0.943±0.057
1	129 (12.3)	128.1±11.7	118.4±12.7	0.925±0.012
2	343 (32.8)	127.0±12.5	118.3±13.6	0.932±0.062
3	459 (43.8)	126.4±10.8	116.5±12.7	0.922±0.066
P trend		0.39	0.014	0.005
0	116 (11.1)	127.8±10.9	120.5±12.1	0.943±0.057
≥1	931 (88.9)	126.7±11.6	117.4±13.1	0.926±0.064
P		0.39	0.016	0.006

Systolic blood pressure (SBP) values are unadjusted mean±SD.

Table 4. Multivariate association between social support score with nighttime systolic blood pressure

	Beta	Standard error	P value
Unadjusted	-1.253	0.401	0.002
Adjustment for sociodemographic variables (age, sex, educational level)	-1.063	0.421	0.012
SD+Body mass index, alcohol, smoking, salt intake, physical activity	-1.056	0.418	0.012
SD+Mediterranean diet score	1.102	0.421	0.009
SD+Sleep quality	-1.057	0.423	0.013
SD+Mental stress	-1.075	0.421	0.011
SD+Number of comorbidities	-1.060	0.422	0.012
SD+Number of antihypertensive drugs	-0.957	0.447	0.033
SD+Daytime systolic blood pressure	-0.886	0.427	0.038
SD+24h heart rate	-1.069	0.422	0.012
Full adjustment for all the above covariates	-0.928	0.499	0.039

The relationships were modeled through multiple linear regression. SD: sociodemographic. For variables coding see Methods.

Table 5. Multivariate association between social support score with night/day systolic blood pressure ratio

	Beta	Standard error	P value
Unadjusted	-0.006	0.002	0.004
Adjustment for sociodemographic variables (age, sex, educational level)	-0.005	0.002	0.017
SD+Body mass index, alcohol, smoking, salt intake, physical activity	-0.005	0.002	0.016
SD+Mediterranean diet score	-0.006	0.002	0.009
SD+Sleep quality	-0.005	0.002	0.012
SD+Mental stress	-0.005	0.002	0.010
SD+Number of comorbidities	-0.006	0.002	0.013
SD+Number of antihypertensive drugs	-0.006	0.002	0.009
SD+24-h systolic blood pressure	-0.005	0.002	0.004
SD+24h heart rate	-0.005	0.002	0.006
Full adjustment for all the above covariates	-0.006	0.002	0.010

The relationships were modeled through multiple linear regression. SD: sociodemographic. For variables coding see Methods.