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Changes in Ambulatory Blood Pressure during the Transition to Retirement

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Anonymized partial datasets of the Finnish Retirement and Aging study are available by application with bona fide researchers with an established scientific record and bona fide organizations. For more information, please contact prof. Sari Stenholm sari.stenholm[at]utu.fi.

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Abstract

Objectives Retirement is a major life event characterized by removal of work-related stressors and changes in health behaviors. The association between retirement and changes in blood pressure (BP), and particularly in ambulatory BP, has been scarcely studied. We aimed to examine changes in ambulatory BP during retirement transition.

Methods 250 aging workers (mean age 63.2 years, 84% women) from the Finnish Retirement and Aging study participated in annual office BP measurements and 114 (mean age 63.1, 90% women) of them underwent annual ambulatory BP measurements before and after retirement. On average, the participants provided data on ambulatory BP at 2.7 (range 2-4) measurements. We used generalized linear models to examine BP changes at retirement.

Results Most marked changes in BP during the follow-up were observed for asleep systolic BP, which decreased before retirement, increased during retirement transition and plateaued after retirement (before retirement vs. retirement transition p=0.07 and after retirement vs. retirement transition p=0.02). Awake systolic BP and 24-hour systolic BP declined with most apparent decrease before retirement (before retirement vs. retirement transition p=0.07 and p=0.07). Awake diastolic BP and 24-h diastolic BP showed relatively consistent decline throughout the follow-up with no differences between the time periods. Systolic and diastolic BP dipping reduced before and during retirement transition, but not after retirement. Among

shift workers, asleep BP increased and BP dipping decreased more than in regular day workers.

Conclusion Retirement was found to associate with beneficial changes in awake BP but unfavourable changes in asleep BP, especially in shift workers.

Key words: Aging worker, ambulatory blood pressure, blood pressure, blood pressure monitoring, retirement

Introduction

The transition to retirement is a major life event, characterized by removal of work-related stressors and changes in health behaviors, which can affect health. According to a recent systematic review, retirement transition can increase the risk of cardiovascular diseases (1). Retirement may also lead to changes in cardiovascular disease risk factors, such as body weight, sedentary time, physical activity, sleep, smoking and alcohol consumption (2–7).

In addition to these risk factors, previous studies have suggested that retirement has an effect on office blood pressure (BP). In a prospective Chinese study, consisting of participants aged 57.1 years at retirement, retirement was followed by slower systolic BP increase and diastolic BP decrease compared to the time before retirement (8). Another Chinese study which included participants aged 35 to 70 years reported that office BP values and the rate of hypertension decreased with increasing time from retirement (9). In a study from 1980s in the United States that included men aged 55-74 years, BP increased in retirees compared to the working population, but no difference was observed in hypertension incidence (10). Additionally, three previous studies have reported that retirement has either beneficial or neutral effects on hypertension (11–13).

Based on the findings of these prior studies, it remains unclear if retirement has an impartial or favorable effect on BP. Of previous studies, only one study (8) focused on within-individual changes in BP, whereas two studies compared the working and retired populations' BP (9,10). Moreover, the two of three studies focusing on BP

differences where performed on a Chinese population and included relatively young participants (8,9). In addition, previous studies in this domain have used only office BP measurements to assess BP change. However, ambulatory monitoring allows measurement of asleep BP, the strongest predictor of cardiovascular disease in hypertensive patients (14). Furthermore, ambulatory BP has been shown to be superior to office BP in predicting cardiovascular events in general population (15) and cardiovascular mortality in the untreated hypertensive participants (16,17).

The aim of this study was to examine changes in ambulatory BP during retirement transition by following aging workers annually before and after retirement. Since BP levels are known to vary between sex (18), occupational status (19,20), job strain and job demands (21,22), and work-time mode (23), we also examined the moderating role of these factors on BP changes.

Methods

Study population

The study sample included participants from the Finnish Retirement and Aging (FIREA) study, a longitudinal cohort study of older adults established in 2013. The design and implementation of the FIREA study have been reported in detail elsewhere (3). Participants were first approached 18 months prior to their estimated retirement date by sending them a questionnaire. After answering the questionnaire, Finnish speaking participants, with an estimated retirement date between 2017 and 2019, who lived in the Southwest Finland and were still working, were invited to take part in the clinical substudy (n=773). Of them, 290 returned the written informed consent and participated in the study.

At baseline, office BP was successfully measured from 284 participants, ambulatory awake BP from 175 participants and ambulatory asleep BP from 171 participants.

Thereafter the participants have been followed up annually with questionnaires and clinical measurements two to four times in total. Actual retirement day for full-time statutory retirement was inquired during each phase of the data collection and data was then centered around each participant's actual retirement date. There were two possible study waves before and after retirement (-2, -1, +1, +2) depending on the available measurements.

For the current study, we included participants who had at least one valid ambulatory BP measurement before and after retirement (114 for awake BP and 111 for asleep BP). On average, the participants provided data on ambulatory BP at 2.7 (range 2-4) measurements. Office BP was measured repeatedly from 250 participants and they were included in supplementary analysis.

The FIREA study was conducted in accordance with the Helsinki declaration and was approved by the Ethics Committee of Hospital District of Southwest Finland (ETMK: 84/1801/2014). All participants gave written informed consent.

Ambulatory blood pressure

24-hour ambulatory BP measurement was performed with a Microlife WatchBP O3 monitor (24) on a work-day from the non-dominant arm. Approximately one minute before each BP measurement, the device gave an alarm and the participant was then guided to stop walking and to sit down with a relaxed arm, if possible. If the measurement failed, it was repeated immediately until the recording was successful. BP was measured every 30 minutes over the entire 24 hours. Participants reported times of going to bed and waking up, which were used to calculate average awake and asleep BP. Nocturnal BP dipping percentage was calculated as [1 − (asleep BP/awake BP)] × 100. Non-dipping was defined as a nocturnal BP reduction of < 10% (25). We included only those ambulatory measurement occasions that had a sufficient number of valid ambulatory BP readings (≥20 awake measurements or ≥7 asleep measurements) (25).

Office blood pressure

Office BP was measured at each visit with Microlife WatchBP Office Central (26). The participant was asked to sit for five minutes before the measurement. The cuff was installed one minute before the measurement. The brachial BP was measured two times with a one-minute pause between measurements and at the same time from both arms. We used the average of the two measurements taken from the right arm for the analyses.

Covariates

Age and sex were obtained from the register of Finnish Pension Insurance Institute for the Municipal Sector.

Job strain was measured with Job Content Questionnaire (27). The following job demands items were used: (1) “My job requires working very fast” (2) “My job requires working very hard”, (3) “I am not asked to do an excessive amount of work”, (4) “I have enough time to get my job done” and (5) “My job includes conflicting demands”. Following job control items were used: (1) “My job allows me to make a lot of decisions on my own”, (2) “My job requires me to be creative”, (3) “My job requires that I learn new things”, (4) “My job involves a lot of repetitive work”, (5) “I have a lot of control over what happens at my job”, (6) “My job requires a high level of skill”, (7) I get to do a variety of different things on my job, (8) “I have an opportunity to develop my own special abilities”, (9) “On my job, I am given a lot of freedom to decide how I do my work”. All items had a 5-point response scale, ranging from “I completely agree” to “I completely disagree.” The participants were

categorized into high vs. low demands and high vs. low control based on median scores in the sample (3.40 for demands and 3.76 for control). Participants who had both high demands and low control were included in the high strain group while the other participants were included in the low strain group (28).

Occupational title was obtained from the registry of the Finnish Pension Insurance Institute for the Municipal Sector. Occupational status was categorized as manual (e.g., cleaner or maintenance worker) or non-manual (e.g., office or service occupations). Participants' work-time mode was obtained by asking the participants whether they perform regular day work or shift work (including two- or three-shift work, evening or night work, irregular work).

Study nurse inquired all the current medication used by the participants at each study visit. Antihypertensive medication included ATC-codes C02, C03, C07, C08 and C09. In the analyses, antihypertensive medication at each study wave was considered.

Physical activity was measured with a thigh-worn triaxial Axivity AX3 (Axivity Ltd Newcastle, UK) accelerometer, which a study nurse fastened on participants' right thigh with adhesive tape during the clinical study visit. Participants were advised to wear the device at least four days, of which two were working days and two days off (when still working). Device was worn at all times, including water-based activities. Participants wore the accelerometer on average 5.1/4.5 days (standard

deviation (SD) 1.3/1.2) before retirement (study waves -2 and -1) and 4.6/4.4 days (SD 0.8/1.0) after retirement (study waves +1 and +2).

Triaxial acceleration data were processed with a customized MATLAB program, ACTIPASS, an updated version of Acti4, which determines the type and duration of different activities with a high sensitivity and specificity based on both inclinations and accelerations (29–31). For the current study, daily wake time moderate-to-vigorous physical activity (MVPA) was used in the analysis. MVPA was defined as a sum of daily time spent in fast walking, stair walking, running, cycling and other physical activities more vigorous than slow walking, and averaged across the measurement period.

Sleep duration was assessed in the survey by inquiring the participants, how many hours they usually sleep per 24 hours and recorded to the nearest half number. The response alternatives ranged from “6 hours or less” to “10 hours or more” with 0.5 hour intervals (32).

Body mass index (BMI) was calculated from measured or reported weight and height and calculated as weight divided by height squared (kg/m^2). Smoking status was categorized as non-smokers (never and former) and current smokers. In the analysis information of the covariates was used from the last study wave before retirement (study wave - 1).

In addition, self-reported hypertension (based on a question “Has doctor ever told you have hypertension?”) and information on self-reported leisure-time and

commuting physical activity were used when comparing study population to the FIREA survey participants. Physical activity was measured as the metabolic equivalent task [MET] hours (33,34).

Statistical analyses

Characteristics of the participants are shown as mean values and standard deviation (SD) for continuous variables and frequencies for categorical variables. The mean level of ambulatory BP at each study wave were calculated with the linear regression analysis with generalized estimating equations (GEE). The GEE models take into account the intra-individual correlation between repeated measurements. We used the GEE-models to calculate BP changes in three periods: before retirement (study waves -2 to -1), during retirement transition (study waves -1 to +1) and after retirement (study waves +1 to +2). The study waves occurred at one-year intervals. Differences between periods were compared with contrast statements in the GEE model. At the first phase, we performed the analyses without adjustments. At the second phase, we adjusted analyses for age and sex, and thereafter also with BMI, physical activity and sleep duration as time-varying covariates.

We also examined whether the BP changes during the retirement transition period differed by sex, sociodemographic and work-related characteristics. This was done by adding interaction term sex*time, occupational status*time, job strain*time, job demands*time and shift work*time to the GEE models for ambulatory BP for observations restricted to the transition period. We present the findings for those

with and without shift work, with and without job strain and with and without high job demands.

Finally, we conducted sensitivity analyses by including only participants who were without antihypertensive medication during the study waves. This was performed to illustrate the natural changes in BP around retirement without being confounded by the effect of antihypertensive medication on BP.

The statistical analyses were performed with SAS software, version 9.4 (SAS Institute Inc., Cary, North Carolina, USA).

Results

Characteristics of the study participants before retirement (study wave -1) are presented in **Table 1**. The majority of the participants were women (90%) and the mean age was 63.1±1.1 years. Regarding to occupational characteristics, about one third of the participants worked in manual occupations (28%), a quarter performed shift work (24%), job strain was relatively rare (15%) and one third had high job demands (30%). Approximately half of the participants had systolic hypertension (52%) or diastolic hypertension (45%) based on the office BP measurements and a quarter of the participants (23%) used antihypertensive medication.

Figure 1 depicts the unadjusted mean ambulatory BP values at each study wave and age- and sex –adjusted mean BP values at each study wave are presented in **Supplementary Table 1**. **Table 2** shows age-, sex-, BMI-, physical activity- and sleep duration –adjusted changes in ambulatory BP and BP dipping before, during and after retirement transition. We observed that awake systolic BP decreased significantly before retirement (-5.4 mmHg, 95% CI -8.2 to -2.5) and after retirement (-3.6 mmHg, 95% CI -6.4 to -0.8), but not during retirement transition. When comparing the BP change before retirement transition to change during retirement transition, the change was borderline significant (p=0.077). Awake diastolic BP decreased significantly before retirement (-3.1 mmHg, 95% CI -4.8 to -1.5), during retirement transition (-2.3 mmHg, 95% CI -3.6 to -0.9) and after retirement (-2.4 mmHg, 95% CI -4.0 to -0.7). No statistically significant difference

was observed between before, during and after periods for awake diastolic BP. Asleep systolic BP increased significantly during retirement transition (2.4 mmHg, 95% CI 0.4 to 4.4), but not before or after retirement. The difference between before and during periods was borderline significant (p=0 .074) and between during and after periods statistically significant (p=0.016). We did not observe any changes in asleep diastolic BP.

Changes in 24-hour BP resembled the changes observed for awake BP. 24-hour systolic BP reduced significantly before retirement (-4.5 mmHg, 95% CI -7.3 to -1.8) and after retirement (-3.3 mmHg, 95% CI -5.8 to -0.8) but not during retirement transition. The difference between before and during (p=0.069) as well as during and after periods (p=0.087) were nearly significant. 24-hour diastolic BP reduced significantly before retirement (-2.6 mmHg, 95% CI -4.1 to -1.0), during retirement transition (-1.8 mmHg, 95% CI -3.0 to -0.6) and after retirement (-1.9 mmHg, 95% CI -3.4 to -0.4). No statistically significant difference was observed between before, during and after periods for 24-hour diastolic BP.

Systolic BP dipping decreased significantly before retirement (-2.1 %, 95% CI -3.9 to -0.3) and during retirement transition (-3.0 %, 95% CI -4.7 to -1.3) but not after retirement. Diastolic BP dipping decreased significantly during retirement transition (-2.4 %, 95% CI -4.2 to -0.6) but not before or after retirement. No statistically significant difference was observed between before, during and after periods for systolic or diastolic BP dipping.

The unadjusted values for changes in ambulatory BP and BP dipping before, during and after retirement are presented in **Supplementary Table 2**.

Table 3 presents the results of the sensitivity analyses, with only participants without antihypertensive medication included (n=82). The results were largely similar with the main analyses. The main exception was that, awake diastolic BP no longer decreased significantly after retirement (-2.6 mmHg, 95% CI -5.3 to 0.2). Moreover, the 24-hour diastolic BP no longer decreased during retirement transition (-1.3 mmHg, 95% CI-2.9 to 0.4) or after retirement (-2.0 mmHg, 95% CI -4.3 to 0.4).

We also tested whether sex, occupational status, job strain, job demands or work-time mode modifies the changes in ambulatory BP and BP dipping during retirement transition. We observed differences in terms of work-time mode (**Supplementary Table 3**). While the awake BP values did not change during transition to retirement, asleep BP increased in shift workers more than in regular day workers (asleep systolic BP p for interaction 0.023; asleep diastolic BP p for interaction 0.024). In addition, the 24-hour diastolic BP reduced more in shift workers than in regular day workers (p for interaction 0.047). Similarly, BP dipping decline was greater in shift workers than in regular day workers during the retirement transition (systolic BP dipping p for interaction 0.082; asleep diastolic BP p for interaction 0.014). We did not find differences in ambulatory BP and BP dipping between groups by sex, occupational status, job strain and job demands

(analysis for job strain in Supplementary Table 4 and analysis for job demands in Supplementary Table 5, otherwise data not shown).

To enable comparison to previous studies, we also conducted the analysis using office BP measurements (n=250). The age- and sex –adjusted mean office BP values at each study wave are presented in **Supplementary Table 2**. We did not observe any changes in office systolic or diastolic BP in any of the periods; before retirement: systolic BP 0.9 (95 % CI -1.4 to 3.2), diastolic BP -1.1 (95% CI -2.3 to 0.04), during retirement transition: systolic BP -0.9 (95% CI -2.9 to 1.1), diastolic BP -0.9 (95% CI -2.0 to 0.2), or after retirement transition: systolic BP 0.5 (95% CI -2.2 to 3.3), diastolic BP -0.6 (95% CI -2.3 to 1.1).

When comparing the participants who underwent ambulatory BP measurements to those who participated only in the office BP measurements, the groups were very similar suggesting no health-related selection into the ambulatory measurements. In comparison to the overall FIREA survey population, participants in the ambulatory and office BP measurements reported less hypertension (25% vs. 35%), and were physically more active (27.3 and 26.6 vs. 23.6 MET-hours), but no marked differences were found in terms of sociodemographic and work characteristics (**Supplementary Table 6**).

Discussion

In this follow-up study, we examined the changes in ambulatory BP values around retirement transition. The most marked changes were observed for asleep systolic BP, which decreased before retirement, increased during retirement transition and became steady after retirement. Awake systolic and diastolic BP declined quite consistently throughout the follow-up with no differences between before, during or after retirement periods. Systolic and diastolic BP dipping decreased before and during retirement transition, but not after retirement. Changes in 24-hour BP resembled the changes observed for awake BP. The 24-hour systolic BP decreased before and after retirement and plateaued during retirement transition while the 24-hour diastolic BP decreased before, after and during retirement transition.

To our knowledge, studies reporting ambulatory BP profile changes around retirement have not been previously published. Earlier studies based on office BP measurements have reported that systolic BP increases and diastolic BP decreases after age of 60 years (35,36), which is consistent to our finding of declining awake diastolic BP before, during and after retirement. Thus, we can assume that this finding is not caused mainly by retirement. However, we also discovered that awake systolic BP decreased after and before retirement, whereas this decrease regressed during the retirement transition. As these changes are to the opposite direction than expected considering the ageing of the participants, retirement may be a key factor underlying these findings.

Interestingly, asleep systolic BP increased during retirement transition with a clear deviation from the declining values before and after retirement. This suggests that exiting from working life to full-time retirement may influence night-time BP. This finding is plausible as there is evidence that stress may increase susceptibility to cardiovascular diseases via activation of sympathetic nervous system and hypothalamic-pituitary-axis (37), and the autonomic regulation of BP is very complicated during night-time (38). However, main results may be driven by the shift workers as a clear association between work-time mode and nighttime BP was observed despite relatively small number of participants. The asleep BP increased more during retirement transition in shift workers than in regular day workers and the BP dipping values reduced more in shift workers than in regular day workers. As we have previously reported, that shift workers have higher awake systolic BP and higher diastolic BP dipping (39) than the regular day workers, the results of the current study also highlight the effects of work-time mode on variability of BP values.

We did not find any changes in office BP values before, during or after retirement transition. This was in contrast to earlier studies from China, which have reported beneficial changes in office BP (8,9). Direct comparison of results from our study and the Chinese studies is difficult due to differences in working cultures and conditions, BP levels (40), as well as younger retirement age in China compared to Finland.

We also examined the role of sociodemographic and other work-related factors on the BP changes around retirement, but no differences were observed for sociodemographic factors, job strain or job demands. This is in contrast to results from a prior study from China reporting that the association with retirement and office BP is stronger with men and urban dwellers (8). As in earlier studies the deleterious association between job strain and elevated BP has been shown especially in men (21), our results do not confirm that the BP levels normalize after removal of job strain. Instead, as the removal of job strain after retirement was not associated with decreased BP, there may be other post-retirement stressors, which may influence BP.

The strengths of our study are annually repeated ambulatory BP measurements which provide more detailed information about the BP compared to office measurements and are considered superior to office BP in predicting cardiovascular events (17). Moreover, as our sub-study sample was very similar with the overall survey sample including a wide range of municipal occupations, the results of this study are generalizable to the western public sector employees, who are at the point of statutory retirement. We also conducted sensitivity analysis by excluding participants with antihypertensive medication, which did not alter our findings. The limitation of this study is that the study population of the current study expresses a selected group of mainly female workers, who have continued working close or beyond their statutory retirement age (in Finland around 63 years). Moreover, the data was small which resulted in relatively wide confidence intervals.

In addition, we were unable to determine, whether participants of the current study changed diet during retirement, this being a potential mediator between retirement and BP change since salt has been found to have effect on BP levels (41), for example.

Conclusions

We observed beneficial changes in awake BP values among people in their 60's before, during and after retirement. On the other hand, especially the transition-period from work to retirement may increase asleep BP values. Focus should be put on shift workers which showed unfavorable BP changes during the retirement transition. Further studies are needed to replicate these results. As the results confirm the association between retirement and ambulatory BP, it is important to pay attention to cardiovascular health promotion during the retirement transition.

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Author contributions

S.K., S.S. and T.J.N. conceived and designed the work. J.V., K.S., O.J.H., S.S. and T.J.N contributed to data acquisition. S.K., J.P., S.S. and T.J.N. analyzed and interpreted the data. S.K., S.S. and T.J.N. drafted the manuscript. J.V., K.S., J.P. and O.J.H. revised the manuscript critically for important intellectual content. Authors declare no conflicts of interest.

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FIGURE LEGENDS

Figure 1. Mean level of

ambulatory systolic blood pressure (Panel A);

ambulatory diastolic blood pressure (Panel B) and

blood pressure dipping (Panel C) at each study wave before and after retirement.

Values are from unadjusted model.

SBP systolic blood pressure *DBP* diastolic blood pressure

Table 1. Characteristics of the study participants before retirement (at study wave -1).

Characteristic	Participants with ambulatory BP (n=114)
Women (n, %)	103 (90)
Age (mean, SD)	63.1 (1.1)
Married or cohabitating (n, %)	72 (67)
High demands (n, %)	33 (30)
Job strain (n, %)	15 (15)
Manual occupation (n, %)	32 (28)
Shift work (n, %)	25 (24)
MVPA (hours) (mean, SD)	1.3 (0.4)
Sleep duration (hours) (mean, SD)	7.0 (0.9)
BMI (kg/m^2) (mean, SD)	26.3 (4.2)
Current smoker (n, %)	5 (5)
Systolic hypertension[a] (n, %)	57 (52)
Diastolic hypertension[a] (n, %)	49 (45)
Antihypertensive medication (n, %)	26 (23)

Data is presented as number of participants (percentage) for class variables or as mean (SD) for continuous variables.
BP blood pressure *SD* standard deviation *MVPA* Moderate-to-vigorous physical activity *BMI* body mass index
[a]Office systolic BP ≥ 140 mmHg or office diastolic BP ≥ 90 mmHg or antihypertensive medication

Table 2. Changes in office and ambulatory blood pressure and blood pressure dipping before, during and after retirement (n=114).

	Pre-retirement level (wave -1) Mean (95% CI)	Change before retirement (wave -1 vs -2) Mean (95% CI)	Change during retirement transition (wave +1 vs -1) Mean (95% CI)	Change after retirement (wave +2 vs +1) Mean (95% CI)	P for before vs. during retirement	P for after vs. during retirement
Awake systolic BP	128.5 (125.2 to 131.9)	-5.4 (-8.2 to -2.5)	-1.6 (-3.8 to 0.6)	-3.6 (-6.4 to -0.8)	0.077	0.23
Awake diastolic BP	78.3 (76.0 to 80.5)	-3.1 (-4.8 to -1.5)	-2.3 (-3.6 to -0.9)	-2.4 (-4.0 to -0.7)	0.51	0.95
Asleep systolic BP	110.0 (106.7 to 113.2)	-1.8 (-4.8 to 1.2)	2.4 (0.4 to 4.4)	-2.4 (-5.7 to 0.9)	0.074	0.016
Asleep diastolic BP	64.3 (62.5 to 66.1)	-1.0 (-2.8 to 0.9)	0.1 (-1.2 to 1.4)	-1.0 (-3.3 to 1.3)	0.44	0.42
24-h systolic BP	122.6 (119.4 to 125.9)	-4.5 (-7.3 to -1.8)	-0.7 (-2.7 to 1.3)	-3.3 (-5.8 to -0.8)	0.069	0.087
24-h diastolic BP	73.9 (71.8 to 75.9)	-2.6 (-4.1 to -1.0)	-1.8 (-3.0 to -0.6)	-1.9 (-3.4 to -0.4)	0.55	0.97
Systolic BP dipping (%)	14.3 (12.9 to 15.7)	-2.1 (-3.9 to -0.3)	-3.0 (-4.7 to -1.3)	-0.4 (-3.3 to 2.5)	0.53	0.14
Diastolic BP dipping (%)	17.5 (15.9 to 19.2)	-2.1 (-4.2 to 0.06)	-2.4 (-4.2 to -0.6)	-1.3 (-4.4 to 1.9)	0.84	0.58

BP blood pressure *CI* confidence interval

The means (95% CI) are adjusted for sex and age before retirement and BMI, physical activity and sleep duration as time-varying covariates.

Nocturnal dipping status was calculated as [1 − (asleep BP/awake BP)] × 100.

Table 3. Changes in ambulatory blood pressure and blood pressure dipping before, during and after retirement among participants without antihypertensive medication (n=82).

	Pre-retirement level (wave -1) Mean (95% CI)	Change before retirement (wave -1 vs -2) Mean (95% CI)	Change during retirement transition (wave +1 vs -1) Mean (95% CI)	Change after retirement (wave +2 vs +1) Mean (95% CI)	P for before vs. during retirement	P for after vs. during retirement
Awake systolic BP	130.3 (127.4 to 133.2)	-5.2 (-8.4 to -2.0)	-1.8 (-4.5 to 0.9)	-4.7 (-8.8 to -0.5)	0.14	0.20
Awake diastolic BP	79.3 (77.3 to 81.4)	-3.6 (-5.7 to -1.5)	-2.0 (-3.9 to -0.0)	-2.6 (-5.3 to 0.2)	0.31	0.70
Asleep systolic BP	111.5 (109.0 to 114.1)	-2.3 (-6.2 to 1.7)	2.9 (0.9 to 5.0)	-1.4 (-5.4 to 2.5)	0.037	0.023
Asleep diastolic BP	65.1 (63.6 to 66.6)	-1.5 (-3.9 to 0.9)	0.9 (-0.5 to 2.2)	-1.1 (-4.6 to 2.3)	0.13	0.27
24-h systolic BP	124.4 (121.7 to 127.1)	-4.3 (-7.6 to -0.9)	-0.5 (-2.8 to 1.9)	-3.9 (-7.6 to -0.3)	0.094	0.070
24-h diastolic BP	74.9 (73.1 to 76.7)	-3.0 (-5.1 to -0.9)	-1.3 (-2.9 to 0.4)	-2.0 (-4.3 to 0.4)	0.24	0.55
Systolic BP dipping (%)	14.2 (13.0 to 15.5)	-2.5 (-4.7 to -0.3)	-3.9 (-5.9 to -1.8)	-1.8 (-5.7 to 2.1)	0.44	0.35
Diastolic BP dipping (%)	17.7 (16.3 to 19.2)	-1.9 (-4.4 to 0.5)	-3.2 (-5.4 to -1.1)	-1.5 (-6.7 to 3.7)	0.49	0.55

BP Blood pressure *CI* Confidence interval

The means are adjusted for sex and age before retirement and BMI, physical activity and sleep duration as time-varying covariates.

Nocturnal dipping status was calculated as [1 − (asleep BP/awake BP)] × 100.

SUPPLEMENTARY TABLES

Supplementary Table 1. Mean level of office and ambulatory blood pressure at different study waves before and after retirement, adjusted for age before retirement and sex.

	Wave -2 (Mean, 95% CI)	Wave -1 (Mean, 95% CI)	Wave +1 (Mean, 95% CI)	Wave +2 (Mean, 95% CI)
Office systolic BP	139.1 (136.0 to 142.2)	140.0 (137.1 to 143.0)	139.4 (136.4 to 142.4)	140.0 (136.8 to 143.2)
Office diastolic BP	85.6 (84.0 to 87.2)	85.0 (83.4 to 86.5)	84.5 (83.0 to 85.9)	84.2 (82.3 to 86.2)
Awake systolic BP	130.8 (126.8 to 134.8)	128.1 (124.4 to 131.7)	127.2 (123.7 to 130.8)	124.5 (120.2 to 128.8)
Awake diastolic BP	80.0 (77.5 to 82.5)	78.1 (75.8 to 80.3)	76.3 (74.0 to 78.6)	74.9 (72.1 to 77.7)
Asleep systolic BP	110.9 (106.8 to 115.0)	109.5 (106.0 to 113.1)	111.8 (108.2 to 115.4)	110.3 (105.2 to 115.3)
Asleep diastolic BP	64.9 (62.7 to 67.0)	64.1 (62.3 to 66.0)	64.4 (62.5 to 66.3)	64.3 (61.6 to 67.1)
24-h systolic BP	124.8 (120.8 to 128.7)	122.2 (118.7 to 125.8)	122.0 (118.5 to 125.6)	119.8 (115.4 to 124.2)
24-h diastolic BP	75.3 (73.0 to 77.6)	73.7 (71.6 to 75.8)	72.3 (70.2 to 74.4)	71.4 (68.7 to 74.0)
Systolic BP dipping (%)	15.0 (13.5 to 16.4)	14.3 (12.9 to 15.7)	11.9 (10.3 to 13.5)	11.8 (9.8 to 13.7)
Diastolic BP dipping (%)	18.6 (17.0 to 20.2)	17.5 (15.9 to 19.2)	15.3 (13.7 to 16.9)	14.5 (12.2 to 16.8)

BP blood pressure *CI* confidence interval

Nocturnal dipping status was calculated as [1 − (asleep BP/awake BP)] × 100

Supplementary Table 2. Changes in office and ambulatory blood pressure and blood pressure dipping before, during and after retirement. Values are from unadjusted model.

	Pre-retirement level (wave -1) Mean (95% CI)	Change before retirement (wave -1 vs -2) Mean (95% CI)	Change during retirement transition (wave +1 vs -1) Mean (95% CI)	Change after retirement (wave +2 vs +1) Mean (95% CI)	P for before vs. during retirement	P for after vs. during retirement
Office Systolic BP	140.0 (137.1 to 143.0)	1.4 (-0.9 to 3.6)	-0.5 (-2.4 to 1.4)	0.6 (-1.9 to 3.1)	0.30	0.57
Office Diastolic BP	85.0 (83.4 to 86.5)	-0.6 (-1.7 to 0.5)	-0.4 (-1.5 to 0.6)	-0.5 (-2.2 to 1.2)	0.84	0.96
Awake systolic BP	127.5 (125.5 to 129.5)	-3.3 (-6.3 to -0.2)	-0.8 (-2.7 to 1.1)	-3.9 (-6.8 to -1.1)	0.25	0.084
Awake diastolic BP	77.0 (75.7 to 78.3)	-2.2 (-3.9 to -0.5)	-1.7 (-3.0 to -0.4)	-2.6 (-4.2 to -0.9)	0.72	0.45
Asleep systolic BP	109.9 (107.9 to 111.9)	-1.6 (-4.7 to 1.5)	2.0 (0.1 to 3.9)	-2.8 (-6.2 to 0.5)	0.10	0.020
Asleep diastolic BP	63.4 (62.2 to 64.6)	-0.8 (-2.8 to 1.1)	0.3 (-0.9 to 1.5)	-1.1 (-3.3 to 1.2)	0.40	0.33
24-h systolic BP	138.2 (136.1 to 140.4)	-2.9 (-5.8 to 0.1)	-0.2 (-1.9 to 1.5)	-3.4 (-6.1 to -0.6)	0.19	0.057
24-h diastolic BP	83.0 (81.8 to 84.2)	-1.7 (-3.4 to 0.0)	-1.3 (-2.4 to -0.2)	-1.8 (-3.4 to -0.3)	0.75	0.57
Systolic BP dipping (%)	13.7 (12.4 to 15.0)	-0.9 (-2.5 to 0.7)	-2.3 (-3.8 to -0.8)	-0.2 (-2.5 to 2.1)	0.33	0.20
Diastolic BP dipping (%)	17.5 (16.1 to 18.9)	-1.3 (-3.4 to 0.7)	-2.2 (-3.8 to -0.5)	-1.3 (-3.9 to 1.2)	0.60	0.62

BP blood pressure *CI* confidence interval

Nocturnal dipping status was calculated as [1 − (asleep BP/awake BP)] × 100.

Supplementary Table 3. Ambulatory blood pressure before and after retirement among those with and without shift work.

	Wave -1 (Mean, 95% CI)	Wave +1 (Mean, 95% CI)	Mean difference (95% CI)	Interaction, p-value
Awake systolic BP				
Regular day work	127.3 (123.5 to 131.1)	126.7 (122.7 to 130.7)	-0.6 (-2.6 to 1.3)	0.12
Shift work	130.1 (124.5 to 135.8)	128.9 (123.7 to 134.2)	-1.2 (-6.1 to 3.7)	
Awake diastolic BP				
Regular day work	77.4 (75.0 to 79.9)	76.0 (73.5 to 78.6)	-1.4 (-2.9 to 0.0)	0.13
Shift work	79.6 (76.4 to 82.8)	76.9 (73.7 to 80.2)	-2.7 (-5.5 to 0.1)	
Asleep systolic BP				
Regular day work	109.6 (105.9 to 113.2)	111.1 (107.4 to 114.9)	1.6 (-0.2 to 3.3)	0.023
Shift work	109.0 (103.1 to 114.9)	114.2 (108.7 to 119.7)	5.2 (-0.4 to 10.8)	
Asleep diastolic BP				
Regular day work	64.3 (62.3 to 66.3)	64.0 (62.0 to 66.0)	-0.2 (-1.6 to 1.2)	0.024
Shift work	63.4 (60.4 to 66.4)	65.7 (62.5 to 68.9)	2.3 (-0.6 to 5.1)	
24-h systolic BP				
Regular day work	121.7 (118.0 to 125.4)	121.5 (117.6 to 125.3)	-0.3 (-1.9 to 1.4)	0.055
Shift work	123.4 (118.0 to 128.9)	124.1 (119.0 to 129.1)	0.6 (-4.0 to 5.2)	
24-h diastolic BP				
Regular day work	73.2 (70.9 to 75.5)	72.0 (69.6 to 74.3)	-1.2 (-2.5 to 0.0)	0.047
Shift work	74.8 (71.9 to 77.8)	73.2 (70.2 to 76.3)	-1.6 (-4.2 to 1.0)	
Systolic BP dipping (%)				
Regular day work	13.8 (12.2 to 15.4)	12.1 (10.4 to 13.8)	-1.7 (-3.2 to -0.08)	0.082
Shift work	15.9 (12.7 to 19.2)	11.2 (7.8 to 14.6)	-4.8 (-8.5 to -1.1)	
Diastolic BP dipping (%)				
Regular day work	16.5 (14.6 to 18.4)	15.5 (13.8 to 17.3)	-1.0 (-2.9 to 0.9)	0.014
Shift work	20.3 (17.3 to 23.3)	14.4 (11.4 to 17.4)	-5.9 (-9.2 to -2.7)	

BP blood pressure *CI* confidence interval
The means are adjusted for age before retirement and sex
Nocturnal dipping status was calculated as [1 − (asleep BP/awake BP)] × 100

Supplementary Table 4. Ambulatory blood pressure before and after retirement among those with and without job strain.

	Wave -1 (Mean, 95% CI)	Wave +1 (Mean, 95% CI)	Mean difference (95% CI)	Interaction, p-value
Awake systolic BP				
No job strain	127.7 (123.5 to 131.8)	127.3 (123.2 to 131.4)	-0.4 (-2.6 to 1.8)	0.25
Job strain	128.7 (123.7 to 133.7)	126.6 (121.6 to 131.6)	-2.1 (-5.0 to 0.8)	
Awake diastolic BP				
No job strain	77.5 (74.9 to 80.1)	76.2 (73.6 to 78.8)	-1.3 (-2.8 to 0.1)	0.26
Job strain	79.9 (76.4 to 83.4)	76.5 (73.1 to 80.0)	-3.4 (-5.9 to -0.9)	
Asleep systolic BP				
No job strain	109.4 (105.4 to 113.4)	112.4 (108.2 to 116.5)	3.0 (0.8 to 5.2)	0.25
Job strain	109.5 (104.5 to 114.4)	109.50 (105.1 to 113.9)	0.01 (-3.7 to 3.8)	
Asleep diastolic BP				
No job strain	64.1 (62.0 to 66.2)	64.7 (62.5 to 66.9)	0.5 (-0.9 to 2.0)	0.41
Job strain	63.9 (61.0 to 66.8)	63.4 (61.0 to 65.7)	-0.5 (-3.4 to 2.4)	
24-h systolic BP				
No job strain	121.9 (117.9 to 126.0)	122.3 (118.2 to 126.3)	0.3 (-1.6 to 2.3)	0.20
Job strain	122.7 (118.1 to 127.4)	121.0 (116.6 to 125.3)	-1.8 (-4.7 to 1.2)	
24-h diastolic BP				
No job strain	73.3 (70.9 to 75.6)	72.2 (69.8 to 74.7)	-1.0 (-2.3 to 0.3)	0.18
Job strain	75.2 (72.1 to 78.3)	72.3 (69.5 to 75.1)	-2.9 (-5.1 to -0.8)	
Systolic BP dipping (%)				
No job strain	14.2 (12.6 to 15.8)	11.5 (9.7 to 13.3)	-2.7 (-4.4 to -0.9)	0.75
Job strain	14.6 (11.0 to 18.3)	13.3 (10.6 to 16.1)	-1.3 (-4.4 to 1.8)	
Diastolic BP dipping (%)				
No job strain	17.0 (15.1 to 18.8)	14.9 (13.1 to 16.6)	-2.1 (-3.9 to -0.3)	0.84
Job strain	19.7 (15.7 to 23.6)	16.8 (13.5 to 20.0)	-2.9 (-7.7 to 2.0)	

BP blood pressure *CI* confidence interval

The means are adjusted for age before retirement and sex

Nocturnal dipping status was calculated as [1 − (asleep BP/awake BP)] × 100

Supplementary Table 5. Ambulatory blood pressure before and after retirement among those with low and high job demands.

	Wave -1 (Mean, 95% CI)	Wave +1 (Mean, 95% CI)	Mean difference (95% CI)	Interaction, p-value
Awake systolic BP				
Low demand	128.0 (123.7 to 132.2)	127.7 (123.5 to 131.8)	-0.3 (-2.8 to 2.1)	0.88
High demand	127.2 (122.7 to 131.7)	125.7 (120.8 to 130.6)	-1.5 (-4.3 to 1.4)	
Awake diastolic BP				
Low demand	77.5 (74.8 to 80.1)	76.5 (73.8 to 79.2)	-1.0 (-2.6 to 0.7)	0.29
High demand	78.9 (75.8 to 81.9)	75.6 (72.6 to 78.6)	-3.2 (-5.2 to -1.3)	
Asleep systolic BP				
Low demand	109.9 (105.8 to 114.0)	112.6 (108.4 to 116.8)	2.7 (0.5 to 4.9)	0.91
High demand	108.0 (103.2 to 112.7)	110.1 (105.3 to 114.9)	2.1 (-1.9 to 6.1)	
Asleep diastolic BP				
Low demand	64.1 (61.9 to 66.3)	64.8 (62.6 to 67.1)	0.7 (-0.8 to 2.3)	0.61
High demand	63.9 (61.3 to 66.4)	63.4 (61.0 to 65.8)	-0.4 (-2.8 to 2.0)	
24-h systolic BP				
Low demand	122.2 (118.1 to 126.4)	122.5 (118.4 to 126.6)	0.2 (-1.9 to 2.3)	0.97
High demand	121.3 (116.9 to 125.8)	120.8 (116.1 to 125.5)	-0.6 (-3.6 to 2.5)	
24-h diastolic BP				
Low demand	73.2 (70.8 to 75.7)	72.5 (70.0 to 75.0)	-0.7 (-2.2 to 0.7)	0.35
High demand	74.4 (71.6 to 77.1)	71.8 (69.1 to 74.4)	-2.6 (-4.4 to -0.8)	
Systolic BP dipping (%)				
Low demand	14.0 (12.3 to 15.6)	11.6 (9.7 to 13.5)	-2.4 (-4.3 to -0.5)	0.65
High demand	14.9 (12.1 to 17.6)	12.2 (9.9 to 14.6)	-2.6 (-5.2 to -0.1)	
Diastolic BP dipping (%)				
Low demand	16.9 (15.0 to 18.9)	15.0 (13.1 to 16.8)	-2.0 (-3.9 to -0.0)	0.58
High demand	18.6 (15.6 to 21.6)	15.7 (13.3 to 18.1)	-2.8 (-6.2 to 0.5)	

BP blood pressure *CI* confidence interval

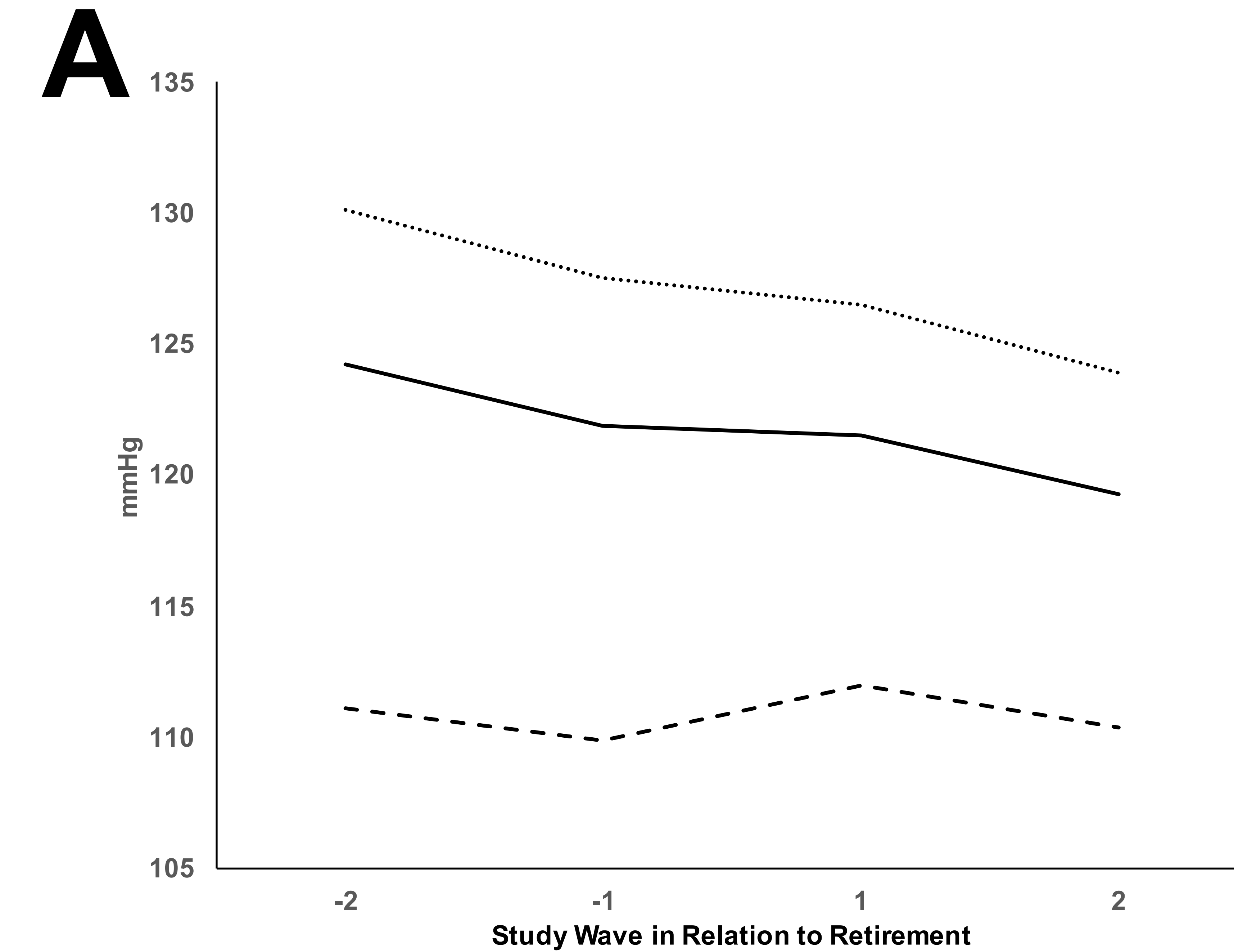
The means are adjusted for age before retirement and sex

Nocturnal dipping status was calculated as [1 − (asleep BP/awake BP)] × 100

Supplementary Table 6. Comparison between the study population and the FIREA survey participants.

	Ambulatory BP measurements (n=114)	Office BP measurements (n=250)	Survey population (n=3426)
Women (n, %)	103 (90)	210 (84)	2848 (83)
Age (Mean, SD)	63.1 (1.1)	63.2 (1.1)	63.3 (1.4)
Married or cohabitating (n, %)	72 (67)	166 (69)	2388 (72)
Job strain (n, %)	15 (15)	33 (14)	641 (20)
Manual occupation (n, %)	32 (28)	82 (33)	1217 (36)
Shift work (n, %)	25 (24)	58 (26)	763 (24)
Self-reported physical activity (MET hours) (mean, SD)	27.3 (19.5)	26.6 (18.7)	23.6 (19.7)
Sleep duration (Hours)	7.0 (0.9)	7.2 (0.9)	
BMI (kg/m^2) (Mean, SD)	26.3 (4.2)	26.3 (4.8)	26.8 (4.5)
Current smoker (n, %)	5 (5)	12 (5)	294 (9)
Self-reported hypertension	25 (25)	58 (25)	1104 (35)
Systolic hypertension[a] (n, %)	57 (52)	135 (56)	N/A
Diastolic hypertension[a] (n, %)	49 (45)	103 (43)	N/A
Antihypertensive medication (n, %)	26 (23)	59 (24)	N/A

Data is presented as number of participants (percentage) for class variables or as mean (SD) for continuous variables.
SD Standard deviation *BP* Blood pressure *BMI* Body mass index
[a]Office systolic BP ≥ 140 mmHg or office diastolic BP ≥ 90 mmHg or antihypertensive medication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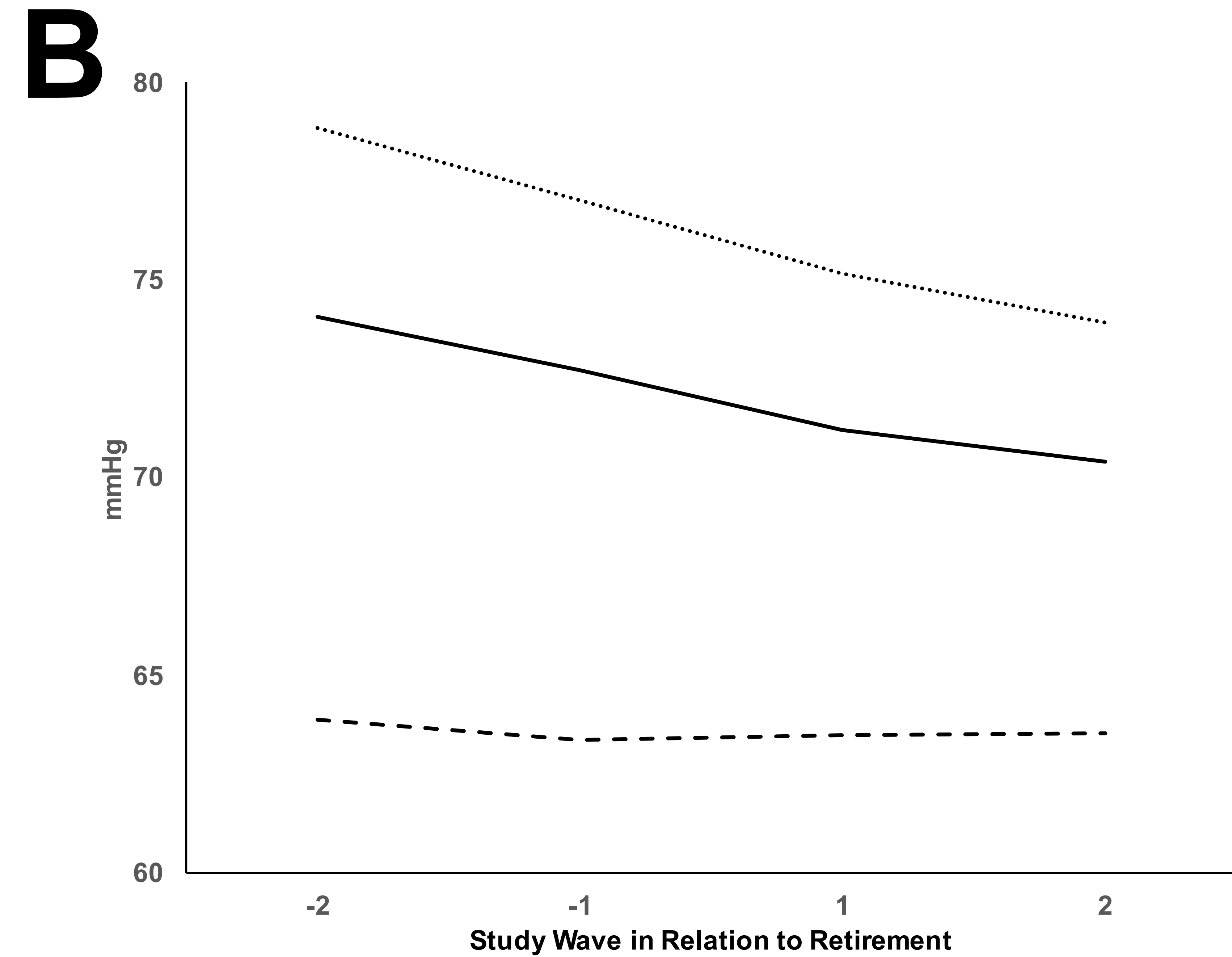
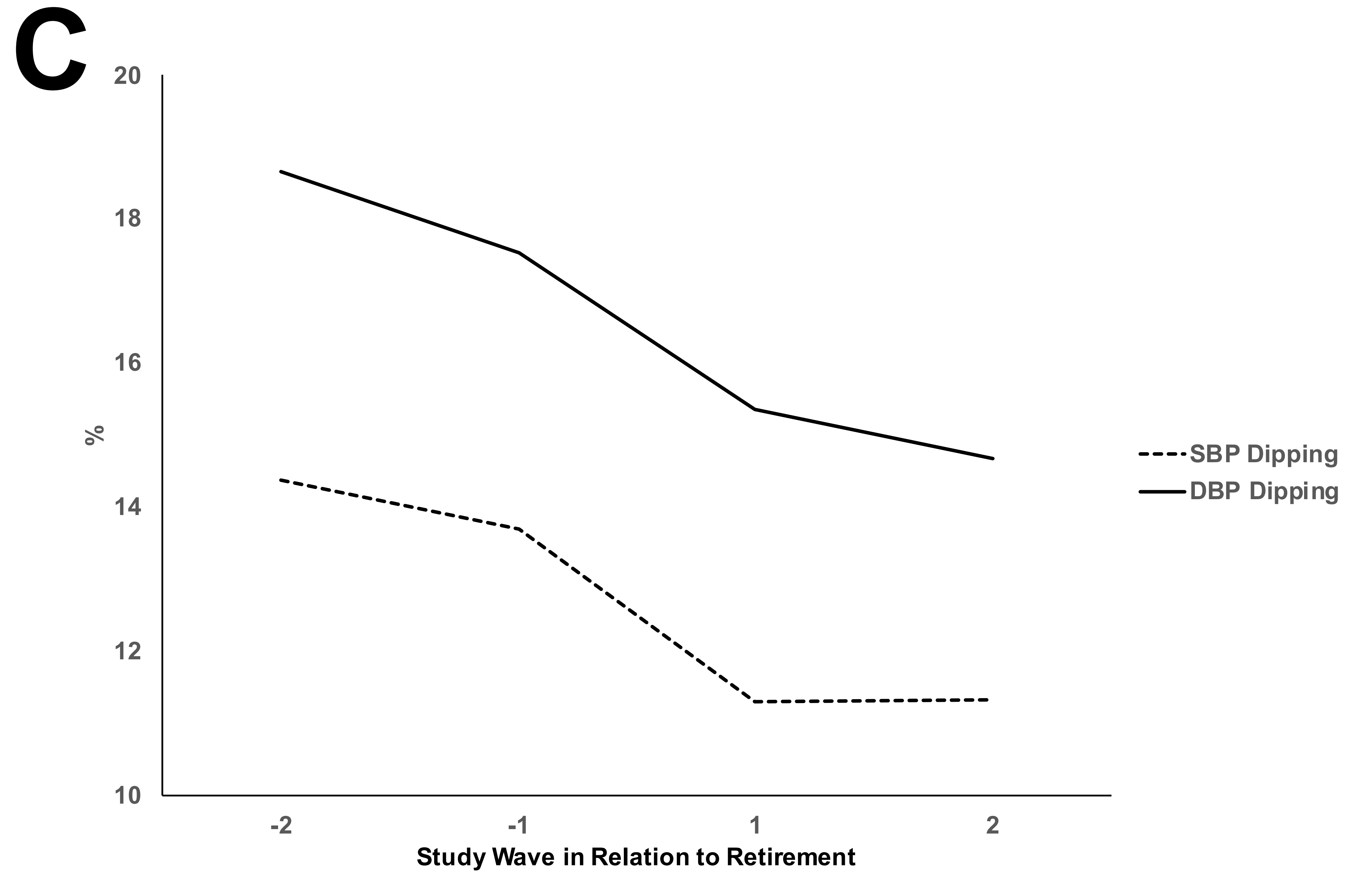
105
-2
-1
1
2
Study Wave in Relation to Retirement
Awake SBP
Asleep SBP
24-h SBP


B
mmHg
80
75
70
65
60
-2
-1
1
2
Study Wave in Relation to Retirement
Awake DBP
Asleep DBP
24-h DBP


C
%
20
18
16
14
12
10
-2
-1
1
2
Study Wave in Relation to Retirement
SBP Dipping
DBP Dipping