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Self-measured worksite blood pressure and its association with organ damage in working adults: Japan Morning Surge Home Blood Pressure (J-HOP) worksite study

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Abstract

The effects of elevations in blood pressure (BP) on worksite stress as an out-of-office BP setting have been evaluated using ambulatory BP monitoring but not by self-measurement. Herein, we determined the profile of self-measured worksite BP in working adults and its association with organ damage in comparison with office BP and home BP measured by the same home BP monitoring device. A total of 103 prefectural government employees (age 45.3 ± 9.0 years, 77.7% male) self-measured their worksite BP at four timepoints (before starting work, before and after a lunch break, and before leaving the workplace) and home BP in the morning, evening, and nighttime (at 2, 3, and 4 a.m.) each day for 14 consecutive days. In the total group, the average worksite systolic BP (SBP) was significantly higher than the morning home SBP (129.1 ± 14.3 vs. 124.4 ± 16.4 mmHg, $p = .026$). No significant difference was observed among the four worksite SBP values. Although the average worksite BP was higher than the morning home BP in the study participants with office BP < 140/90 mmHg (SBP: 121.4 ± 9.4 vs. 115.1 ± 10.4 mmHg, $p < .001$, DBP: 76.0 ± 7.7 vs. 72.4 ± 8.4 mmHg, $p = .013$), this association was not observed in those with office BP ≥ 140/90 mmHg or those using antihypertensive medication. Worksite SBP was significantly correlated with the left ventricular mass index evaluated by echocardiography ($r = 0.516$, $p < .0001$). The self-measurement of worksite BP would be useful to unveil the risk of hypertension in working adults who show normal office and home BP.

1 | INTRODUCTION

Hypertension, a primary risk factor for cardiovascular disease (CVD), has been typically diagnosed and treated by measuring office blood pressure (BP). Several international guidelines have stressed the importance of an out-of-office BP-guided approach using ambulatory blood pressure monitoring (ABPM) or home BP monitoring (HBPM).[1-3] One of the purposes of measuring BP in an out-of-office setting is to detect masked hypertension, which is defined as having a normal office BP level but out-of-office BP levels in the hypertensive range. Compared to normotension, masked hypertension has been reported to pose an increased risk of target organ damage and CVD events.[4,5] There are several phenotypes of masked hypertension based on elevated BP in different out-of-office settings: morning hypertension, daytime hypertension, and nocturnal hypertension.[6] For example, hypertension in the workplace has been recognized as daytime hypertension.[6]

A majority of the investigations of BP readings in workplaces, which is an out-of-office BP setting, used ABPM.[7,8] Those studies reported that the study participants with high job strain had higher BP levels at workplace than those without it.[7,8] However, this interesting finding has been limited. ABPM provides relatively low reproducibility of BP phenotypes included masked hypertension compared to HBPM.[9] Worksite stress, one of presser effects on worksite BP, can vary every day. However, ABPM has usually been performed over only a single day. In addition, BP measurements assessed by ABPM during the daytime are influenced by physical activity.[10]

The use of HBPM could solve these limitations because self-measured BP monitoring using an HBPM device in the workplace is available to repeatedly measure BP values over a long period, and it would be less affected by physical activity. Reliable worksite BP data reflecting worksite stress could thus be obtained. However, to our knowledge, there is no report about self-measured and repeatedly measured worksite BP on multiple days using an HBPM device.

We conducted the present study to determine the profile of self-measured BP at a worksite over multiple days and its association with target organ damage in employees, compared to the employees' office and home BP assessed by the same device. Recent international guidelines also emphasize the importance of early diagnosis and treatment of hypertension.[1-3] Therefore, we performed the present analysis focusing on participants whose BPs are under the hypertension diagnostic threshold.

2 | STUDY PARTICIPANTS AND METHODS

2.1 | Study participants

This Japan Morning Surge Home Blood Pressure (J-HOP) worksite study is a prospective observational study examining self-measured worksite BP in working adults. Baseline data including BP measurements at the office, home, and worksite were collected between 2006 and 2007 from the employees of the Tochigi prefectural government, and followed up on cardiovascular events for three years by letter. The institutional review board of the Jichi Medical University School of Medicine, Tochigi, Japan, approved the study protocol. Written informed consent was obtained from all participants enrolled in this study. For the present manuscript, we used the baseline data of 103 participants who completed 2-week self-BP measurement at their workplace.

2.2 | BP measurements

All BP measurements at the office, home, and worksite were measured by the same validated cuff oscillometric device (HEM-5001; Medinote, Omron Healthcare[11]). This device automatically measures the wearer's BP three times at 15-sec intervals on each occasion for manual measurements, and it can be preset at bedtime to measure the wearer's BP during sleep for nighttime automatic measurements. The nighttime home BP measurements were taken only once at each of three fixed times (2, 3, and 4 a.m.). All BP parameters were stored in the device's memory.

After the participants provided written informed consent, his or her BP was measured three consecutive times at 15-sec intervals (manual measurement of HEM-5001) by research staff at the workplace's clinic. The mean of the three consecutive BP measurements was used as the participant's office BP. The participants were then instructed on how to use the device, and they were asked to measure their BP in the morning (within 1-hr of waking and before taking antihypertensive medication) and in the evening (before going to bed) in a sitting position and their nighttime BPs during sleep at home for 14 consecutive days. For each participant, the means of the morning, evening, and nighttime BP during the 14-day measurement period were used as the participant's morning, evening, and nighttime BP values, respectively.

2.3 | Self-measured worksite BP

The participants were also asked to measure their BP as self-measured worksite BP at four timepoints (before starting work [W1], before the lunch break [W2], after the lunch break [W3], and before leaving the workplace [W4]) in the sitting position at the worksite on each workday during the 14-day measurement period when they measured their home BP. We defined the worksite BP average per day as the mean of the worksite BP values for all four timepoints (W1-W4) for each workday during the 14-day measurement period.

Every BP reading taken at home and at the worksite for each participant was measured by an identical home BP device throughout the 14-day period. An example of self-measured worksite and home BP readings is given as Figure S1.

2.4 | Office BP-based hypertension categories

We divided the 103 participants into four groups as follows. Those who are using antihypertensive treatment were categorized as "Treated," and the others were categorized based on their office BP levels. "Untreated" was defined as office systolic BP (SBP) ≥140 mmHg or diastolic BP (DBP) ≥90 mmHg. In the untreated individuals, "Elevated" was defined as SBP 120-139 mmHg or DBP 80-90 mmHg. "Normal" was defined as SBP < 120 mmHg and DBP < 80 mmHg according to current guidelines.

2.5 | Echocardiography

Of the 103 participants, 77 participants underwent echocardiography (ACUSON Cypress). The echo-study was performed by two echographers. Standard images were obtained, and primary measures of left ventricular (LV) dimensions, volumes, and wall thickness were obtained according to the guidelines of the American Society of Echocardiography and the European Association of Echocardiography[12]: LV mass = 0.8 (1.04([LVIDD + PWTD + IVSTD]^3 − [LVIDD]^3)) + 0.6 g. The LV mass index (LVMI) was calculated as the LV mass divided by the body surface area.

2.6 | Statistical analysis

Results are expressed as means (± standard deviation) or percentages. Welch's t-test was used for the comparisons of continuous variables between different BP measurements or groups, and a one-way analysis of variance (ANOVA) was used to assess differences among three or more groups. The chi-square test was used to evaluate differences between categorical variables. Pearson's correlation coefficient was used to examine the association of LVMI and BP indices. To assess the independent predictive utility of the different BP measurements, we used a multiple liner regression model to estimate the relationship with LVMI including age and sex as covariates and each BP measurement as primary predictors. A stepwise forward selection was used to assess the association between LVMI and BP indexes. All data analyses were conducted using SAS ver. 9.4 software (SAS Institute, Cary, NC, USA). Two-sided *p*-values < .05 were considered significant.

3 | RESULTS

3.1 | Characteristics of study participants

Table 1 shows the characteristics of the 103 participants in this study. The mean age was 45.3 ± 9.0 (range 22-60) years, with 80 (77.7%) males and 23 (22.3%) females; the average BMI was 23.7 ± 3.7 kg/m^2. The following prevalences were observed: regular alcohol use, 35.3%; smoking, 19.4%; hypertension, 20.4%; diabetes mellitus, 3.9%; and hyperlipidemia, 15.5%.

3.2 | BP measurements

The BP values of the 103 participants measured at the physician's office, home, and worksite are presented in Table 1. The mean office BP was 125.1 ± 16.6 mmHg for SBP and 81.0 ± 12.3 mmHg for DBP. During the BP measurement period at home (13.8 ± 0.9 days), the average of the morning and evening (ME) home BP values was 122.5 ± 14.6/76.3 ± 10.8 mmHg, and the average of the nighttime home BP values was 111.5 ± 14.2/68.3 ± 10.7 mmHg. The number of working days was 9.2 ± 1.6 days, and the worksite BP average was 129.1 ± 14.3/81.6 ± 10.5 mmHg.

TABLE 1 Characteristics of the J-HOP worksite study participants (*n* = 103)

Age, yrs	45.3 ± 9.0
BMI, kg/m^2	23.7 ± 3.7
Male, %	77.7
Drinking, %	35.3
Current smoking, %	19.4
Hypertension, %	20.4
Diabetes mellitus, %	3.9
Hyperlipidemia, %	15.5
SBP, mmHg	
Office	125.1 ± 16.6
Morning–evening average home	122.5 ± 14.6
Morning home	124.4 ± 16.4
Evening home	120.3 ± 13.8
Nighttime home	111.5 ± 14.2
Worksite average	129.1 ± 14.3
DBP, mmHg	
Office	81.0 ± 12.3
Morning–evening average home	76.3 ± 10.8
Morning home	79.2 ± 12.1
Evening home	72.8 ± 10.1
Nighttime home	68.3 ± 10.7
Worksite average	81.6 ± 10.5

Abbreviations: BMI, body mass index; DBP. diastolic blood pressure; SBP. systolic blood pressure.
Data are mean ± SD and percentage.

Table 2 shows the differences between worksite and office or home BP. The worksite BP average tended to be higher than the office BP (*p* = .060) and was significantly higher than the morning SBP (*p* = .026) and ME average (*p* = .001) SBP. The worksite DBP average was not significantly higher than the office and morning home DBP, and it was significantly higher than the ME average (*p* = .001). The same analysis for the 77 participants who underwent echocardiography was performed. The results of statistical significance and BP levels were essentially same as those in total population. The prevalence of masked hypertension (office BP < 140/90 mmHg and out-of-office BP over the hypertension threshold) was highest when out-of-office BP is defined by the worksite SBP values (Table S1).

No significant difference was observed among the SBP values measured at the four timepoints at the worksite (mean ± SD; W1:128.1 ± 14.6 mmHg, W2: 129.1 ± 14.5 mmHg, W3: 128.2 ± 13.6 mmHg, W4: 130.2 ± 15.2 mmHg, one-way ANOVA; *p* = .724). However, there was a significant difference among the DBP values (mean ± SD; W1: 80.7 ± 11.0 mmHg, W2: 82.9 ± 11.1 mmHg, W3: 79.3 ± 10.3 mmHg, W4: 83.1 ± 10.9 mmHg, one-way ANOVA; *p* = .035). There was a significant decrease in DBP measured after the lunch break [W3] (vs. before lunch break [W2], *p* = .020) and a significant increase in DBP measured before

TABLE 2 Differences between worksite blood pressure and office and home blood pressures

Office and home BP	Worksite BP minus office or home BP	*p*-value
SBP, mmHg		
Office	4.1 ± 15.5	.060
Morning home	4.8 ± 15.4	.026
ME average home	6.6 ± 14.5	.001
Nighttime home	17.7 ± 14.3	<.001
DBP, mmHg		
Office	0.5 ± 11.5	.734
Morning home	2.3 ± 11.4	.157
ME average home	5.3 ± 10.6	.001
Nighttime home	13.3 ± 10.6	<.001

Abbreviations: BP, blood pressure; DBPl, diastolic blood pressure; ME, morning and evening; SBP, systolic blood pressure.

leaving the workplace [W4] (vs. [W3], p = .012) as illustrated in Figure 1. The morning SBP measurement at worksite [W1] tended to be higher than the morning home SBP (128.1 ± 14.6 mmHg vs. 124.4 ± 16.4 mmHg, p = .082).

3.3 | BP in the hypertension categories

Figure 2 shows the home and worksite BP average values by the four office BP-based hypertension categories, ie, the Treated (n = 15), Untreated (n = 23), Elevated (n = 26), and Normal (n = 39) subgroups. The worksite SBP average (average of four worksite measurements) was significantly higher than the morning SBP in the Normal and Elevated groups (both $p < .05$), whereas there were no significant differences in the Treated and Untreated groups. A similar tendency was observed in DBP. When comparing morning worksite SBP [W1] with morning home SBP, W1 was also significantly higher than the morning SBP only in the Normal and Elevated groups (both $p < .05$). In addition, a sensitivity analysis was performed on 77 participants with LVMI data. The differences in the four hypertension categories showed similar results to those shown in total population.

In the participants with office BP < 140/90 mmHg (the non-hypertension group [Normal and Elevated subgroups], n = 65), the worksite BP average was significantly higher than the morning BP (SBP: 121.4 ± 9.4 vs. 115.1 ± 10.4 mmHg, $p < .001$; DBP: 76.0 ± 7.7 vs. 72.4 ± 8.4 mmHg, p = .013), while this association was not observed (SBP: 142.5 ± 11.2 vs. 140.3 ± 11.8 mmHg, p = .410; DBP: 91.1 ± 7.4 vs. 90.8 ± 7.9 mmHg, p = .879) in the participants with office BP ≥ 140/90 mmHg or those being treated for hypertension (the hypertension group [Treated and Untreated subgroups], n = 38). Similar results were found in the analysis of 77 participants categorized into the hypertension and non-hypertension groups.

3.4 | Association between BP measurements and LVMI

Figure 3 shows the relationships between the LVMI and office, morning, worksite, and nighttime SBPs among the 77 participants who underwent echocardiography. The average LVMI was 78.6 ± 19.1 g/m^2. Significant correlations were observed in worksite SBP, office SBP, and morning SBP (r = 0.516, 0.427, and 0.484, respectively; all $p < .0001$), and a weaker correlation was observed in nighttime SBP (r = 0.302, p = .010). However, no statistically significant difference was found between each correlation coefficient.

In the separate multiple linear regression analysis, each of the worksite SBP average and morning SBP was significantly associated with LVMI, independent of age and sex (worksite SBP average:

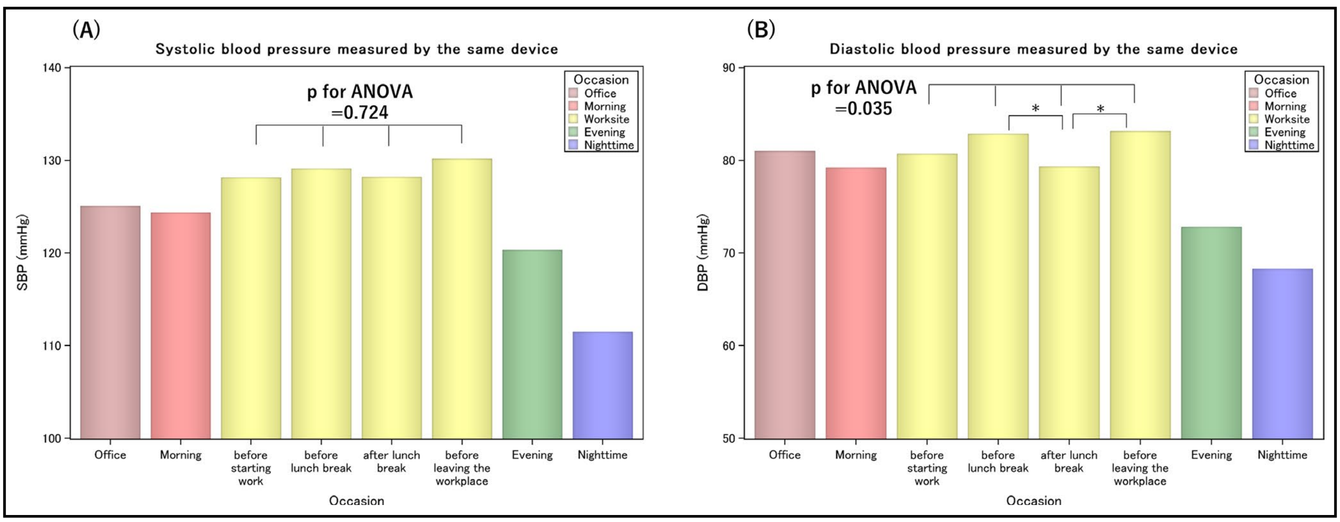
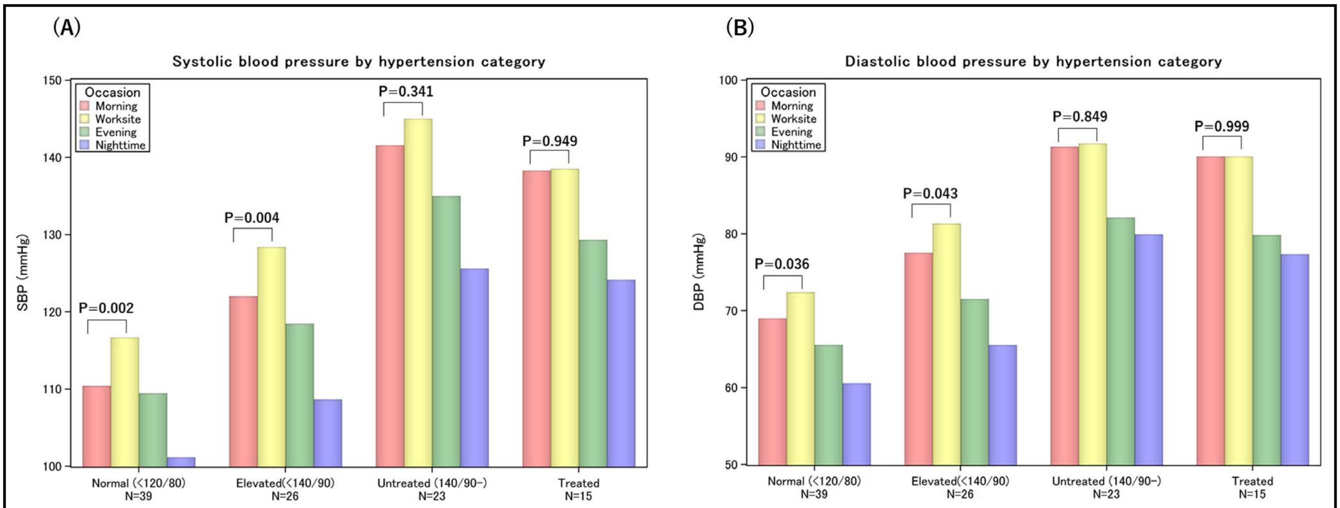


FIGURE 1 Blood pressure readings measured by the same HBPM device. All BPs were measured by the same device. A, Systolic blood pressure. B. Diastolic blood pressure



	Normal	Elevated	Untreated	Treated
Morning, mmHg	110.4 ± 9.1	122.0 ± 8.2	141.6 ± 12.8	138.3 ± 10.1
Worksite, mmHg	116.7 ± 7.6	128.4 ± 7.2	145.0 ± 11.5	138.5 ± 9.8
Evening, mmHg	109.5 ± 8.0	118.5 ± 6.0	135.0 ± 13.8	129.3 ± 8.3
Nighttime, mmHg	101.1 ± 6.9	108.6 ± 10.4	125.6 ± 11.5	124.1 ± 12.7

	Normal	Elevated	Untreated	Treated
Morning, mmHg	69.0 ± 7.6	77.5 ± 6.9	91.3 ± 8.3	90.1 ± 7.6
Worksite, mmHg	72.4 ± 6.5	81.3 ± 6.3	91.8 ± 7.5	90.1 ± 7.3
Evening, mmHg	65.6 ± 7.2	71.5 ± 6.3	82.1 ± 9.9	79.8 ± 6.5
Nighttime, mmHg	60.6 ± 5.8	65.5 ± 7.1	79.9 ± 8.2	77.3 ± 8.3

FIGURE 2 Blood pressure across hypertension categories based on office blood pressure levels. Data are mean ± SD

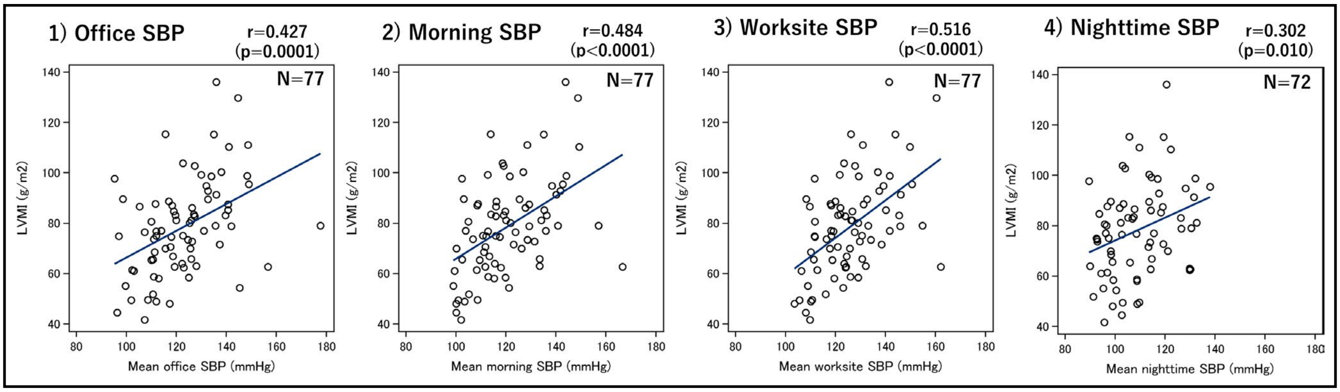


FIGURE 3 Relationships between the left ventricular mass index (LVMI) and office, morning, worksite, and nighttime SBPs

TABLE 3 Association of each blood pressure parameter with left ventricular mass index in separate multivariable regression models

Variable	β	95%CI (lower, upper)	*p*-value
Office SBP	0.263	−0.042, 0.568	.090
Morning SBP	0.374	0.041, 0.707	.028
Worksite SBP average	0.494	0.145, 0.844	.006
Nighttime SBP	0.124	−0.222, 0.469	.477

Abbreviations: β, standard coefficient; CI, confidence interval; SBP, systolic blood pressure.
All models were adjusted by age and sex.

p = .006, morning SBP: p = .028), while this association was not found in nighttime SBP (p = .477) (Table 3). In addition, a stepwise forward selection analysis was performed to assess the association between LVMI and BP variables listed in Table 3. Both stepwise forward model and backward model chose worksite SBP average, sex, and age as variables. The Akaike's information criterion (AIC) for this selected model was 402.6.

When we divided the 77 participants with LVMI data into the non-hypertension group with office BP < 140/90 mmHg (n = 53) and the hypertension group with office BP ≥ 140/90 mmHg (n = 24), the average of LVMI (73.6 ± 16.5 g/m^2 vs. 89.7 ± 20.3 g/m^2, p = .002) and SBP parameters were significantly different between group (Suppl. Table S-2). Among the non-hypertension group, office, morning home and worksite SBPs were significantly correlated with LVMI (r = 0.347; p < .05, r = 0.392; p < .01, and r = 0.404; p < .01, respectively) and no significant correlation was observed in nighttime SBP (r = 0.084, p = .561). There was no significant correlation between the LVMI and any of the BP measures among the hypertension group (Suppl. Figure S-2).

4 | DISCUSSION

We evaluated the profile of self-measured BP at the worksite and at home in working adults using the same HBPM device, and the results of our analyses provide the first demonstration that the working adults' self-measured worksite BP was higher than their office, morning, evening, or nighttime home BP values. When we divided the participants into a non-hypertension group and a hypertension group, this association was observed in the non-hypertension group but not in the hypertension group. In addition, the participants' self-measured worksite BP was significantly associated with their LVMI value, especially in the non-hypertension group, which is a surrogate marker of target organ damage. Elevated worksite BP is therefore clinically meaningful. A strength of this study is that all of each participant's BP readings were self-measured by the same device with an automated measurement function, thus enabling a comparison of BP indices excluding device differences.

4.1 | Self-measured worksite BP using the HBPM device

The worksite BP self-measured repeatedly on a day-by-day basis by the HBPM device was significantly higher than the morning home BP measured using the same device. Even when comparing the home BP and worksite BP measured during morning, morning worksite SBP was higher than morning home SBP. BP increases have been reported to be affected by psychological stress and exercise.[13,14] It was reported that daytime BP readings assessed by ABPM on working days were higher than those on non-working days within individuals,[7] and another research describes a difference in diurnal BP variation between working and non-working persons.[15] To date, although there has been only one study of worksite BP using HBPM, that study reported the result of only one measurement on one occasion (between 10 a.m. and 4 p.m.) during the working time on a single day.[16]

On the other hand, ABPM can be used to obtain multiple BP readings, but it has some limitations. The ABPM device automatically measures BP in various conditions: eg, sitting, standing and lying positions, at home, and at a workplace. The ambulatory daytime BP values measured by ABPM are influenced by the wearer's physical activity.[17] ABPM is usually used to evaluate a one-day ambulatory BP profile affected by physical activity and psychological stress. Notably, the average worksite BP repeatedly self-measured in the sitting position without the effect of physical activity for several days will increase the accuracy of detecting worksite-stress hypertension. HBPM is a widely available and practical method, especially for younger working adults. For these reasons, we recommend the repeated self-measurement of worksite BP with an HBPM device. Various BP monitoring devices that are lightweight, tubeless, and wearable[18] were recently developed, and these would make it easier to measure and monitor outside-home BP.

4.2 | Worksite BP in the non-hypertension vs. hypertension groups

When the 103 participants were divided into four office BP-based hypertension categories, different BP features between home BP and worksite BP were observed among the groups. In the Normal and Elevated categories (the non-hypertension group), the worksite BP average was the highest of all of the BP measures. In the Untreated and Treated categories (the hypertension group), the morning home BP rose to the same level as the worksite BP average. This category-specific feature may illustrate a progression of hypertension. A morning BP increase has been reported as a strong predictor of stroke and coronary heart disease,[19] and a morning BP-guided approach is considered as a first step toward 24-h BP control.[20,21] However, our findings suggest the possibility that the first step in the progression of hypertension may be preceded by an increase in worksite BP, followed by a morning BP increase which is a well-established risk factor.

In addition, the prevalence of participants with normal office BP and worksite BP in the hypertensive range (ie, masked worksite hypertension) was higher than that of the participants with normal office BP and morning home BP in the hypertensive range (masked morning hypertension) and those with normal office BP and nighttime home BP in the hypertensive range (masked nocturnal hypertension). The early detection of elevated worksite BP would lead to early diagnoses and treatment of hypertension including lifestyle modifications.

4.3 | Definition of the self-measured worksite BP measurement

We asked the participants to self-measure their BP four times (W1-W4) at their worksite to verify the best timing to measure worksite BP. However, a significant difference was observed in DBP but not SBP among the four worksite measurements. In addition, the participants' DBP values were higher before the lunch break [W2] and before leaving the workplace [W4] than after the lunch break [W3], indicating that persistent worksite stress may influence the DBP increase after continuous working. Concerning DBP decrease after lunch, it would be likely explained by postprandial splanchnic vasodilation.

A study that used ABPM revealed that DBP was significantly greater at work than at home.[7] There are few data from prior studies regarding what relates to the DBP variation during work, and the reasons why our participants' DBP was increased at W2 and W4 remain unclear. It might be possible that stress-induced sympathetic nerve activation increases peripheral vascular resistance, resulting in a predominant elevation of DBP. Further studies are needed to clarify the worksite DBP increase. We suggest that the timing of BP measurement at worksites could be set at any time that is convenient, and we recommend obtaining measurements at the end of the working time when the person may have been exposed to a stressful condition all day. An investigation of weekly BP variation in a community-dwelling population indicated that the participants' awake

BP and morning BP surge were greatest on Monday.[22] Weekly or day-by-day worksite BP variation may be observed in working adults because worksite stress would vary every day and differ among individuals. We thus recommend measuring worksite BP repeatedly on a day-by-day basis.

4.4 | BP measures and LVMI

The worksite SBP and morning SBP were significantly correlated with the LVMI, and even after controlling covariates, this association remained significant. In addition, the best-performing model selected from variables, including office, morning, and nighttime SBP, was the model consisted of worksite SBP. Left ventricular hypertrophy (LVH), the core hypertensive organ damage, has been reported to be more closely related to out-of-office BPs than office BP.[23] In a general population, even among normotensives defined by office and 24-hour BP, the nighttime BP measured by ABPM was more closely associated with LVMI and an increase in the plasma brain natriuretic peptide (BNP) level.[24] In older hypertensive individuals in the J-HOP study, nighttime BP measured by the same HBPM device as that used in the present study was associated with the LVMI and cardiovascular events even after adjustment for office BP and morning home BP.[25,26] However, in the present J-HOP worksite study, worksite BP seemed to correlate with the LVMI more strongly than nighttime BP.

In a worksite ABPM study of younger working adults, the correlation of daytime BP during working time with the LVMI was stronger than that of nighttime BP (work SBP: 0.50, sleep SBP: 0.17).[27] In a study of participants with normotension and mild hypertension, the correlation of LVMI with awake BP was stronger than that with sleep BP (awake SBP: 0.41, sleep SBP: 0.32).[23] Thus, in relatively younger working adults with lower office BP and nighttime BP, the higher level of stress-induced worksite BP may be the first contributor to an advance in cardiac overload.

4.5 | Strengths and limitations

This study has several strengths. It was conducted using a validated HBPM device and a standardized home BP measurement protocol which were the same as those of the J-HOP study, which is one of the largest home BP studies of patients with cardiovascular risk.[26] In addition, all of the present BP readings were measured by the same HBPM device, and the readings were automatically recorded in the device's memory. Further, worksite BP was defined as the average of a maximum of 120 readings (four timepoints, three times each for the 14-day measurement period that includes ~ 10 work days), and this provided a more reliable measure of worksite BP than readings from 1-day ABPM.

There are also several possible limitations to our study. First, the study sample size with LVMI data was probably rather small to provide reliable subgroup analyses. Second, office BP measurement was conducted for only one day, whereas home and worksite measurements were conducted for 10 to 14 days. Although one of the limitations is that there was the difference in the number of BP measurement among office, home, and worksite, these BP measurements were performed according to real-world setting. Finally, because we enrolled the employees of one prefectural government and most of them are office workers, the findings may not be generalizable to all working adults. However, data from groups in similar occupational environments (in which no employees are working a night shift or engaging in excessive physical labor) could provide an appropriate focus on worksite-stress-induced increases in BP, as our present findings indicate that self-measured worksite BP is more important to detect the risk of hypertension than home BP measurements in non-medicated working adults.

5 | CONCLUSIONS

Our findings indicate that self-measured worksite BP monitoring with the use of an HBPM device is useful for working-age populations to detect early-stage hypertension and the cardiovascular risk of hypertension. Recently developed lightweight, tubeless, and wearable BP monitoring devices will make it easier to self-measure BP at worksites and could contribute to lifestyle modifications.

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AUTHORS CONTRIBUTION

K. Kario supervised the conduct of the study and data analysis, and had the primary responsibility of writing this paper. N. Tomitani analyzed the data and wrote the Introduction, Methods, Results, and Discussion sections. S. Hoshide reviewed and edited the manuscript. S. Hoshide and N. Tomitani collected the data.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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