

Self-measurement of blood pressure in the workplace: An expansion of out-of-office blood pressure measurements to unmask masked hypertension

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Hypertension is the leading risk factor for cardiovascular disease burden including premature death worldwide.¹ Hypertension has many associated risk factors; high dietary sodium intake, excessive alcohol consumption, poor diet, and a sedentary lifestyle are but a few of these risk factors that contribute to the development of hypertension. Optimization of these risk factors has been shown to lower blood pressure which would improve clinical outcomes attributed to the hypertensive process. However, achieving optimal control rates of hypertension at the individual and population levels almost always require a multifaceted approach involving both lifestyle modification and the use of pharmacologic antihypertensive medications.¹ The clinical effects of uncontrolled or poorly controlled hypertension are well-established. These effects result from hypertensive target organ damage, such as cardiac disease (congestive heart failure, myocardial infarction, angina, left ventricular hypertrophy, and arrhythmias), cerebrovascular disease (stroke and cognitive decline), renal disease (chronic renal failure and dialysis), and vascular disease (accelerated atherosclerosis and retinopathy).¹ Despite countless studies showing the importance of strict blood pressure control in helping to prevent many of these conditions, recent National Health and Nutrition Examination Survey (NHANES) data from the United States, a high-income country, have reported a disturbing trend. Data from NHANES showed that hypertension control rates (defined by a systolic blood pressure of < 140 mmHg and a diastolic of < 90 mmHg) gradually increased from 1999/2000 through 2007/2008, reaching a high of between 50% and 60% nationwide. However, hypertension control rates did not

significantly change from 2007/2009 through 2013/2014 and then surprisingly decreased between 2013/2014 through 2017/2018 to approximately 44%.² If hypertension control is defined as a systolic blood pressure of < 130 mmHg and a diastolic < 80 mm Hg, which several recent hypertension guidelines recommend, the hypertension control rate from the 2017/2018 survey is a dismal 19%. This decrease in hypertension control is alarming in that it parallels the ominous recent increase in cardiovascular disease-related events both in high- and low-income countries globally.^{3,4} This alarming data indicate the need for novel strategies which target increasing the awareness, detection, treatment, and control of hypertension in both high- and low-to-middle-income countries. In fact, recently the Surgeon General of the United States issued a report for a “Call to Action to Control Hypertension.” Included in this comprehensive report are three goals: 1. Make hypertension control a national priority, 2. Ensure that the places where people live, learn, work, and play support hypertension control, and 3. Optimize patient care for hypertension control including ways to better identify and treat hypertension.⁵ Pertinent to this commentary, the report strongly recommends increasing out-of-office blood pressure measurements with a variety of methods and in a variety of locations, including in the workplace. This strategy also empowers and increases the direct involvement of the individual. Increasing out-of-office blood pressure measurements will increase the recognition of “true” hypertension (an elevation in blood pressure in both the office and out of the office) and “true” normotension (a normal blood pressure in both the office and out of the office), but also the recognition of

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more complex diagnoses such as white coat hypertension (an elevated blood pressure in the office and a normal blood pressure out of the office) and the newly recognized masked hypertension (a normal blood pressure in the office and an elevated blood pressure out of the office).

Although the exact prevalence of masked hypertension is not known for the general US population, it is estimated to occur in 10% to 30% of persons.⁶ Prevalence may fluctuate based on variables such as geographic region, sex, and race. For example, Wang, et al., estimated 10.6% of US Hispanics, 11.8% of non-Hispanic US whites, and 15.7% of African Americans have masked hypertension.⁷ Although there continues to be debate, white coat hypertension is not strongly associated with an increased risk of cardiovascular events but masked hypertension is increasingly recognized as a high-risk phenotype. Multiple studies have demonstrated that ambulatory or home blood pressures are better predictors of target organ damage and cardiovascular events than medical office blood pressures.⁸ Masked hypertension has been associated with renal and vascular dysfunction,⁹ increased left ventricular mass index,¹⁰ increased carotid intima-media thickness,¹¹ stroke, and myocardial infarction.¹² In fact, most cardiovascular events occur in individuals with non-elevated blood pressure readings in the medical office setting.¹³ Although there is strong evidence masked hypertension increases the risk of target organ damage, current guidelines offer little guidance on the best practices for treatment, in part due to insufficient evidence upon which to base recommendations. Research recommending when, where, and how to perform blood pressure measurements has been particularly lacking.

In the last issue of the journal, the article entitled "Self-measured worksite blood pressure and its association with organ damage in working adults: Japan Morning Surge Home Blood Pressure (J-HOP) worksite study," authored by Tomitani and colleagues, explores the topic of worksite blood pressure monitoring and its potential ability to detect cases of masked hypertension which presumably would be more likely to be associated with stress in the workplace.¹⁴ The study examined the blood pressure of 103 government employees located in the Tochigi Prefecture measured at several times during the workday and at home. At-home readings, taken by each individual, were obtained in the morning, evening, and nighttime (at 2, 3, and 4 am). Workday readings, also taken by each individual, were obtained four times: before starting work, before lunch, after lunch, and before going home. All individually obtained blood pressure readings at home and in the workplace were taken for 14 consecutive days. A formal reading by research staff was also obtained at the worksite clinic. All blood pressures were obtained using the same device: an Omron HEM-5001, which it is important to note, is a "validated" device. Based on the formal clinic readings performed by research staff, the subjects were subdivided into four categories: treated (subjects taking blood pressure medication during the study), untreated (SBP >140 mm Hg or DBP >90 mm Hg while not taking antihypertensive medications), elevated (SBP 120-139 mmHg or DBP 80-90 mmHg while not taking antihypertensive medications), and normal (SBP <120 mm Hg and DBP < 80 mmHg while not taking

antihypertensive medications). The data from these groups were then statistically analyzed. In addition, 77 of the 103 subjects also had cardiac echocardiography performed primarily to determine left ventricular mass index (LVMI).

The results obtained demonstrated the average worksite systolic blood pressure was higher when compared to the clinic blood pressure obtained by research staff which almost reached statistical significance (129.1 +/- 14.3 vs. 125.1 +/- 16.6 mmHg, $p = 0.06$). In addition, in the total group, the average worksite systolic blood pressure was significantly higher when compared to the home morning systolic blood pressure (129.1 +/- 14.3 vs. 124.4 +/- 16.4 mm Hg, $p = .026$). Even more striking was the difference between the average worksite systolic blood pressure and the nighttime blood pressures (129.1 +/- 14.3 vs. 111.5 +/- 14.2 mmHg, $p < 0.001$); the difference of 17.7 +/- 14.3 mmHg was about three and a half times higher than the difference between the average worksite and home morning systolic pressures of 4.8 +/- 15.4 mmHg. SBP did not change significantly between the four workplace readings ($p = .724$). Further analysis was then performed on the various blood pressure subgroups. Interestingly, the average worksite blood pressure was higher than the home morning blood pressure in those individuals with a clinic blood pressure of <140/90 mm Hg (both the "normal" and "elevated" blood pressure groups combined) (systolic blood pressure: 121.4 +/- 9.4 vs. 115.1 +/- 10.4 mm Hg, $p < .001$ and diastolic blood pressure: 76.0 +/- 7.7 vs. 72.4 +/- 8.4 mm Hg, $p = .013$). However, this difference was not seen in those with a blood pressure of > 140/90 mm Hg or in those taking antihypertensive medications (potentially defining "true" hypertensives). These data could be interpreted that workplace systolic blood pressure measurements may detect "masked" hypertension that would typically remain undiagnosed if only home and office blood pressure readings were obtained.

Also, worksite systolic blood pressure significantly correlated to LVMI obtained by cardiac echocardiography ($r = .516$, $p < .0001$).

This manuscript addresses two timely and important topics, namely expanding out-of-office blood pressure measurements to include the workplace and potentially enhancing the diagnosis of "masked" hypertension. As mentioned above, data from earlier in this decade suggest that approximately 10-30% of people with normal in-office blood pressures have masked hypertension.⁶ Masked hypertension increases the risk of major adverse cardiovascular events and all-cause mortality (HR: 1.7 and 1.85, respectively).¹⁵ Therefore, it behooves the medical community to become more attentive to the diagnosis and treatment of this hypertension phenotype. The methods utilized by the authors in this study could easily be adapted into clinical practice given that it is highly recommended that patients who already check their blood pressure at home check again with a validated device. With the advent of cordless and more discrete blood pressure cuffs, one could easily and discreetly check blood pressure during the first several hours of the workday.

The study does have limitations primarily in relation to the generalizability of the data. The population studied is relatively limited in that there were only 103 subjects. These subjects all worked in a governmental office setting where there were no significant amounts

of manual labor, thus potentially excluding the generalizability to laborers and other occupations. Furthermore, the demographics and underlying medical conditions of the subjects also limit generalizability. 80% of the study participants were male and thus only 20% female. Only 20% of the participants had a pre-existing diagnosis of hypertension. In contrast, the labor workforce labor force in the United States is comprised of 41.9% women and women are entering the workforce at an increasing rate globally.¹⁶ The prevalence of hypertension in the United States is approximately 45.4% among adults when using the criterion of $\geq 130/80$ mmHg.¹⁷ Even using the criterion of $\geq 140/90$ mm Hg, the global prevalence of hypertension is approximately 30%. Finally, the clinic blood pressure was only measured on one occasion whereas the self-measured blood pressures both at work and at home were done for 14 consecutive days. To the credit of the authors, these limitations were noted in the manuscript.

In summary, the overall control rate of hypertension in the United States has recently declined for the first time in decades and cardiovascular-related clinical events are increasing.² Therefore, politicians, public health officials, providers, and the general population need to become more cognizant of the need to diagnose and treat hypertension. This also includes being aware of the need for out-of-office blood pressure measurements obtained by either or both ambulatory blood pressure devices or home blood pressure measurements, which not only increases the awareness of hypertension but also engages each individual to detect cases of masked hypertension. The manuscript of Tomitani and colleagues offers insight into the expansion and the potential benefits of obtaining workplace blood pressure measurements, one of which may include detecting individuals with masked hypertension. While further research in this area is clearly warranted, it may facilitate a greater population-based approach to hypertension and spur the medical community to take further bold steps and strategies which would result in improving the awareness, detection, and control of hypertension and decrease the disease burden of cardiovascular diseases.

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CONFLICT OF INTEREST

None.

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