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Measuring Blood Pressure at Workplace: The Impact of Antistress Management Training

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SUMMARY

High prevalence of hypertension along with its serious complications in the organs have made this disease an important health problem worldwide. The lack of symptoms is the most important sign of hypertension and the prevalent remedies have not been effective in controlling the disease yet. Meanwhile, monitoring blood pressure at home and at workplace and antistress management may be some of the effective methods. The purpose of the study was to compare the self-measured blood pressure (BP) at home, at work and in outpatient clinics as estimates of true BP, and to determine the effectiveness of antistress management training for normalization of blood pressure levels in workers diagnosed with borderline hypertension.

In quasi-experimental, transversal design with intragroup analysis for pre - post intervention study, 32 male workers who do easy manual jobs were included into the stress management program. Before and after the treatment, the study group of patients had three self-measured readings of BP taken. After the antistress management program, based on the self-measured and ambulance BP values, the real levels of BP were compared as part of a controlled study of stress management training for essential hypertension.

Analyses showed that (a) self-measured BP values at home in the morning and evening were significantly correlated with each other, but these values at work and home did not correlate at pretreatment, (b) the correlation coefficients for SBP readings taken at post-treatment between work and home self-measured BP values were both statistically significant and high (r is less than 0.60), (c) after antistress management training, over time, intraclass correlations of self-measured BPs were significantly higher than those of ambulance and pre-intervention.

Findings indicating that self-measurement is a valuable alternative or supplement to outpatient BP measurement, especially at workplace, could provide a reliable estimate of the level of BP. The antistress management intervention may be effective in lowering and stabilazing BPs for working individuals who perceived symptoms of work-related stress.

Key words: **blood pressure, workplace, self-measurement, antistress management**

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INTRODUCTION

The changing nature of work has placed unprecedented demands on employees, and fuelled concerns about the effect this change is having on the well-being of employees and their work organizations. Economists, social scientists, legislators, and particularly specific occupational groups, such as emergency medical personnel, policemen, firemen, air traffic controllers and teachers, have become increasingly concerned about the potential role of stress as it affects their health, productivity and quality of life with good reason (1, 2). In Serbia, the disability-adjusted life years (DALY) rate for ischemic heart disease (IHD) was higher in comparison with the rates in European regions (6%). The factors most responsible for this IHD burden were smoking, physical inactivity, hypertension and overweight/obesity (3). Preventive programs and measures are insufficient since only one third of this population is being treated (4). In fact, both our understanding of the etiology of cardiovascular disease (CVD) and our ability to manage the epidemic are still limited. Traditional risk factors used in epidemiologic techniques to identify important risk factors explained only part of the risk for CVD (5). In practical terms, this means that these standard risk factors fail to predict many of the new CVD cases. Note that one of main factors - essential hypertension - is practically of unknown etiology. Hypertension is a complex syndrome involving various interconnected factors (6). The interaction of these multiple conditions intensifies the effects of each one resulting in an increased severity of the hypertension and damage to certain organs (7).

Moreover, these traditional risk factors represent relatively "proximate" causes of CVD; each of them, in turn, has a complex set of determinants, many of which are of psychosocial origin. New developments expand and challenge the focus on these traditional, proximate risk factors. One of these is the emergence of research into behavioral factors that might influence the development of CVD.

The link between work stress and CVD is robust, but derived exclusively from observational studies (8, 9). This association could derive in part from detrimental effects on blood pressure (BP) by recurrent autonomic nervous system reactivity to work-related stressors (10-12).

The aim of the present study was to examine the extent to which outpatient, home self-measured, and work self-measured BPs could provide a reliable estimate of the level of BP in other settings. To do this, we analyzed data from a study on stress management training for essential hypertension. Finally, we examined the reliabilities of assessments across multiple readings of self-measured and ambulatory BPs in terms of intraclass correlations for each of the locations (home,work and ambulatory care facility) in phases (pretreatment and posttreatment). We also examined the stability of self-measured and ambulatory BPs in terms of correlations between the estimates made before treatment and those made after treatment.

METHODS

Participants

We recruited participants from two ambulatory care facilities in the Institute of Occupational Health Niš. Thirty - two male workers who do easy manual jobs and whose family physicians had diagnosed them as having borderline hypertension volunteered to participate in the research on behavioral antistress management of essential hypertension. The participants were referred for detailed evaluation because their BP was not well controlled without regular pharmacologic treatment.

We considered patients for this research if (a) the diagnosis was confirmed by three readings of either DBP above or equal 90 mmHg or SBP above or equal 140 mmHg during three consecutive casual BP measurement sessions occurring in the ambulance over a 2- or 3-month period; (b) the physician agreed not to change the patient's medication during the investigation.

The investigation consisted of the following three phases: (a) a pretreatment assessment of BP and physiological and psychosocial hypertension-related variables, (b) stress management training, and (c) a posttreatment assessment identical to the pretreatment assessment.

Patients were then carefully instructed for an interview that assessed several variables related to their hypertension (stressful events, duration of hypertension, etc) and how to self-measure and self-record BP readings correctly and completed practice trials. The patients were asked to measure their BP three times per day for 14 days - two times at home (on getting up in the morning and before bedtime) and once at work. On each occasion, they were to obtain one reading. After the patient rested for 5 minutes, the clinician or themselves made two BP readings at 2-minute intervals. If the difference between the two readings was equal to or below 5 mmHg, the mean of the two readings was considered as BP measurement for the session. If the difference between the two readings was greater than 5 mmHg, a third reading was taken and the mean of all three readings was considered the BP measurement for the session. Also, we instructed each patient how to place the cuff on the arm and use the hand of the opposite arm to inflate the cuff while keeping the cuff arm relaxed at the heart level on a plain surface. The patients were told to refrain from smoking, eating, taking caffeine, or doing physical exercise for at least 30 minutes before measuring their BP.

The antistress management training consisted of four 60-minute sessions as workplace health promotion workshops, in the Institute of Occupational Health Niš. The themes of the sessions were the following: psycho-

education on stress, identification of dysfunctional thinking and behavior, modification of dysfunctional thinking and behavior, time management, communication skills, assertiveness training skills, conflict management styles, developing support networks, physical relaxation techniques and exercise, recommendations for healthy eating habits, mental relaxation, humor therapy, dream therapy, music and art therapy and hobbies (13-15).

Two weeks after the end of the stress management training, the patients underwent a posttreatment assessment identical to the pretreatment assessment mentioned above.

Materials

For ambulatory BP readings, the physicians used a RIESTER DIPLOMAT mercury sphygmomanometer. Each patient was given an digital BP monitor or aneroid sphygmomanometer to record his own BP. To avoid an artificial BP increase as a result of the patient's measurement BP, digital BP monitor and aneroid sphygmomanometer compared with standard ambulatory mercury sphygmomanometer with a tolerance error accuracy of (+ or -) 3 mmHg (16).

Statistical Analyses

Statistical analysis was performed using the S-PLUS software packages version 2000. We used paired-sample t tests, Pearson correlation coefficients, or intraclass correlation coefficients and modification of Feldt's test of the equality of two dependent Cronbach's alpha coefficients to analyze valid data. In this study, we defined a high correlation as one that was equal to or higher than 0.60 and a low correlation as one that was lower than 0.60. To compute intraclass correlations, we substituted the mean squares obtained from analysis of variance (ANOVA), for a random effect model in the formula for calculating single score intraclass correlation coefficients for two-way models.

RESULTS

Thirty-two workers had borderline hypertension at the beginning of the study. More than 40% of the sample in the current study could be considered as participants with white coat hypertension if this condition is defined as ambulatory BP values higher than or equal to 140/90 mmHg.

For demographic and clinical characteristics of the sample, see Table 1.

Differences Between Work and Home Self-measured BP

Blood pressure measurements taken at pretreatment are shown in Table 2. We used paired t tests with Bonferroni's corrected two-tailed levels of significance to find differences between work and home self-measured BPs. For both SBP and DBP, mean work BPs were significantly and consistently higher than mean home-morning, $t(32)=10.52$ and 9.70, respectively, both ps is less than 0.01; home-evening, $t(32)=11.98$ and 11.40, respectively, both ps is less than 0.01. On the other hand, BPs taken at home in the morning, at home in the evening, did not differ significantly from each other (all ps is greater than 0.05) see Table 2.

Correlations Among Self-measured BPs

As the data in Table 3 indicate, home morning and home evening self-measured BP values for both SBPs and DBPs correlated significantly (p is less than 0.001) and highly (r is less than 0.60).

Interestingly enough, for SBP readings taken at posttreatment, the correlation coefficients between work and home self-measured BP values were both statistically significant and high (r is less than 0.60). For DBP readings taken at posttreatment, the correlation coefficients between work and home self-measured BPs were not only low (r is less than 0.60) but also were not statistically significant. This pattern of results suggests that work BPs taken at posttreatment were better estimates of the patients' true levels of BP than those taken at pretreatment.

Differences in Reliability Across Multiple Readings Between Clinic and Self-measured BPs

The intraclass correlation coefficients that represent the reliability across multiple readings of ambulatory and self-measured BPs for each of the settings (home - morning, home - evening, work, and ambulatory care facility) and phases (pretreatment and posttreatment) of BP assessment are displayed in Table 4.

With self-measurements, the intraclass correlations of SBP and DBP were high at both pretreatment and posttreatment, ranging from 0.49 to 0.75. With ambulatory measurements, the intraclass correlations of SBP and DBP were also high at posttreatment (0.92 /0.76 for SBP/DBP), but at pretreatment they were lower (0.37/0.52 for SBP/DBP) than those shown by self-measured BPs. In fact, comparing reliability coefficients by modified Feldt's tests showed that, at pretreatment, the intraclass correlations of self-measured BPs were significantly higher than those of ambulatory BPs.

The differences were consistent for each type of self-measurement and for both systolic and diastolic BPs, except for DBPs taken at home in the evening. At posttreatment, differences between the intraclass correlations of self-measured BPs and ambulatory BPs were not statistically significant, except for two cases (Table 4): the intraclass correlation coefficient of ambulatory SBP was significantly higher than that of self-measured SBP taken at work and that of self-measured SBP considered as a whole (ie, taking into consideration readings from the three nonambulatory settings).

Table 1. *Demographic and clinical data on study participants (n=32)*

Variable	M	SD	Range	Responses (n)
Age (y)	45.37	± 8.87	26-69	32
Duration of hypertension (y)	0.98	±1.10	0-4	32
BMI (kg/m^2)	25.6	±3.2	21-29	32
Number of cigarettes/day	13.30	±17.99	0-50	32
Total cholesterol (mmol/L)	4.87	± 2.14	3-7	32
Triglycerides (mmol/L)	1.79	±1,16	1-3	32

Table 2. *Means, standard deviations, and ranges of blood pressure (BP) measures taken at pretreatment*

Blood pressure N=32	M	SD	Range	t
Systolic				
Work	150.32	8.40	137-170	p<0.01
Home-morning	130.76	12.38	105-156	n.s
Home-evening	129.58	11.23	112-156	n.s
Home	130.17	11.32	111-153	n.s
Diastolic				
Work	99.36	6.93	86-122	p<0.01
Home-morning	84.94	8.47	66-103	n.s
Home-evening	83.20	7.81	66-100	n.s
Home	84.07	7.84	68-101	n.s

Note. Home BP=average of home-morning and home-evening BPs

Table 3. *Correlations between home and work self-measured blood pressure (BP) readings*

Intercorrelated Variables	SBP		DBP	
	Pre	Post	Pre	Post
Home-morning x Home-evening	0.84***	0.95***	0.85***	0.95***
Work x Home morning	0.38**	0.77***	0.20	0.31
Work x Home-evening	0.37***	0.89***	0.20	0.34
Work x Home	0.40**	0.84***	0.21	0.38

*p<0.05; **p<0.01; ***p<0.001

Note. SBP=systolic blood pressure; DBP=diastolic blood pressure.
Pre=pretreatment (n=32); post=posttreatment (n=32);

Table 4. *Intraclass correlations for blood pressure (BP) measurements and comparisons between intraclass correlations of self-measured and ambulatory BP measurements*

Intercorrelated Variables	SBP			
	Pre	W	Post	W
Home-morning	0.70 (0.83)	3,7 (29,31)**	0.73 (0.89)	1,4 (11,20)
Home-evening	0.57 (0.79)	3,0 (29,31)**	0.70 (0.91)	1,1 (11,24)
Work	0.68 (0.86)	4,5 (29,30)**	0.69 (0.75)	3,1 (12,19) *
Ambulatory care facility	0.37		0.92	
	DBP			
	Pre	**W**	**Post**	**W**
Home-morning	0.68 (0.82)	2,7 (29,29)**	0.67 (0.84)	1,5 (14,14)
Home-evening	0.49 (0.61)	1,2 (29,29)	0.75 (0.80)	1,2 (14,15)
Work	0.63 (0.82)	2,7 (29,29)**	0.66 (0.76)	1,0 (14,14)
Ambulatory care facility	0.52		0.76	

*p<0.05; **p<0.01

Note. Intraclass correlations based on three BP self-measurements, each the average of two readings, are shown in brackets. Pretreatment (Pre) n=32; posttreatment (Post) n=32. In each column, self-measured BP intraclass correlations (shown in brackets) are compared with the ambulance BP intraclass correlations shown in the same column; W=modified Feldt's test of the equality of two dependent reliability coefficients; degrees of freedom are shown in parentheses in the W column.

DISCUSSION

The JNC-VI (17) and VII (18), the WHO-ISH Guidelines (19), the ESH-ESC 2003 Guidelines (20), and the JSH 2000 Guidelines (21) all provide reference values for home BP.

Home BP values averaged for a certain period indicate hypertension when 135/80 mmHg and over (21) and definite hypertension when 135/85 mmHg and over (17). Normotension is defined as less than 125/80 mmHg (18) and definite normotension is defined as less than 125/75 mmHg (21).

Evidence for such work-stress effects comes from ambulatory BP studies, which show increased blood pressure levels in subjects with high work stress (9, 11, 22-25). Most studies have asked participants to measure their BP before going to work in the morning or after coming home in the evening, but self-measured readings at home may not necessarily provide a good guide to the level of pressure during the workday (26-28). Surveillance of the workplace to determine the prevalence of hypertension or elevated blood pressure is important especially in light of the evidence that workplace factors play a significant role in the etiology of essential hypertension (28, 29). Worksite screenings are the only way to identify those groups of individuals with normal clinic BP and elevated worktime BP, the "false negatives" - who are at a high risk for a hypertension-related morbid event. A considerable body of research concerning the use of behavioral procedures in the treatment of essential hypertension has developed since the mid-1970s (28, 30).There is increasing evidence that standard measurements of BP taken in the ambulatory care facility may not be a reliable estimate of an individual's average level of BP over a prolonged time (true BP level) and that pressure measured outside the ambulatory care facility or clinic, either by self - measurement or by ambulatory monitoring, may improve the reliability of such an estimate (22, 31).

Ambulatory measures of BP in hypertensive patients were consistently higher than BP measured by the patient at home. In spite of this observation, evidence that self - measurement may provide a better index of the true level of BP than ambulatory readings has been recently reported (32).

Several studies suggest that the predictive value of self-measurement for hypertensive cardiovascular morbidity may be superior to clinic and ambulance readings because self-measured BPs are more closely correlated with 24-hour ambulatory monitoring and hypertensive target organ damage (33-35). Information has been published on the reliability of self-measured readings over timeself-measures seem to be more stable than ambulatory readings (36, 37).

In this study, we compared home and work self-measured BPs as estimates of participants' three BPs in clinically borderline hypertensive patients. It is clear that home and work self-measured BPs estimate different mean levels of BP. Specifically, the work BPs were higher than self - measured BPs, regardless of whether patients measured their BP at home in the morning, at home in the evening, and regardless of whether the patients had sustained or white coat hypertension. Although portable devices allow self-measurement of BP in the workplace or during daily activities, in practice such measurements are difficult. In the future, development of accurate and reliable wrist-cuff devices may permit BP measurement under stressful circumstances. The importance of measurements in the workplace or under stressful circumstances was emphasized by Pickering (38), and by Belkic, Landsbergis, Schnall with contributors (22-25, 28, 29). Elevation of BPin the workplace or under stressful conditions mediates white coat normotension or masked hypertension. In findings have been published by other investigators (10) an imbalance between extrinsic effort and reward at work of the subjects was associated with an average increase in SBP by 4 mm Hg. Similar to other ambulatory studies (22, 39, 40) we found a significantly higher BP during work time compared with leisure on the workdays at home in the morning and evening.

In any case, it is clear that the standard values based on ambulatory measurements during work time for defining hypertension are not transferable to self - measured BPs. This is very important, given that the results of the present study also suggest that self-measured work BP values are better estimates of patients' true levels of BP than ambulatory BP values or that self -measured BP values show better generalizations across settings, better reproducibility over two months.

In this study, self-measured BPs taken at one setting at home in the morning showed high and significant correlations with self-measured BPs taken at home in the evening.This result was consistent across settings and independent of whether SBPs or DBPs were analyzed and whether pretreatment or posttreatment BPs were considered. Similar findings have been reported by other investigators (41,42). For example, Kleinert et al. (41) found that the correlation coefficient between home BPs taken during morning hours and those taken during evening hours was 0.91 for SBP and 0.63 for DBP. However, in the present study, both SBP and DBP correlation coefficients fell within the same order of magnitude (0.84 and 0.95, respectively). The correlations between posttreatment home and work self-measured SBPs, are significant and higher (0.77 and 0.89) relatively to pretreatment BPs (0.38 and 0.37). These results suggest that the beneficial effects of antistress management can be mediated by regulation of SBP. The current evidence shows that subjects with chronic work stress have increased 24-hour SBP levels that are not simply caused by increased BP during work time. DBP was not found to be different in the high-work stress group, not even during work time. This finding has been reported before, but most of the previous studies (22, 39, 43) did show DBP effects, although always less pronounced than SBP effects. However, the effects of imbalance between effort and reward at work were not specific to work time, ie., SBP was higher in the high imbalance group even during leisure time and the non-working day. Other studies provide additional data on sleep BP and show a work stress effect to be present even at night (22, 23).

Finally, we found that the reliability across multiple readings of self-measured BPs was high, with intraclass correlations ranging from 0.50 to 0.75 for both SBP and DBP at both pretreatment and posttreatment assessments. In sum, the high and significant intraclass

correlations of self-measured BPs and their high and significant correlations with other self-measured BPs taken at different settings suggest that self-measured BPs are stable over time, reliable across multiple readings, and consistent across settings; they are, therefore, a good estimate of participants' usual BP levels.

Our results indicate that, at pretreatment, ambulatory BPs were not related to self-measured BPs at home or at work, especially in case of DBP pressure. At posttreatment, however, the correlations between ambulatory and self-measured BPs were higher and more significant. This pattern is consistent with previous data indicating that, after the third visit, ambulatory BPs tend to lower and become more similar to home self-measured BPs (44, 45). In fact, our results support that at pretreatment, the intraclass correlations of ambulatory BPs were lower than those of self-measured BPs. By contrast, at posttreatment, these differences disappeared. Reliability over time (two months) shows that patients after stress management training significantly lowered and stabilized their self-measured BPs, unlike these values at prettreatment.

CONCLUSION

Psychosocial risk factors at work should be taken into account during individual CHD risk assessment and management, and they have implications for public health policy and research.

In summary, self-measured BPs are better estimates of true BP than ambulatory BPs because they reflect, to a greater extent, the patients' BPs in several settings, are more stable over a few months, and are more reliable across multiple readings. Providing differences between self-measured and ambulatory BPs are evident in both white coat and sustained hypertensive individuals. These findings for BP self-measurement indicate that self-measurement is a valuable alternative or supplement to ambulatory BP measurement, especially at workplace.

On the other hand, self-measurement of BP at workplace and home improves the reliability of the estimate of an employee's usual BP including efficacy of antihypertensive treatment.

This study has shown that antistress management intervention is effective in lowering and stability BPs for working individuals who perceived symptoms of work-related stress and are actively seeking help to cope with the situation in today's accelerated changes in circumstances of working life. The antistress management programme seems feasible for occupational and general practitioners.

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MERENJE KRVNOG PRITISKA NA RADNOM MESTU: UTICAJ ANTISTRES MENADŽMENT PROGRAMA

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Sažetak

Visoka prevalencija arterijske hipertenzije, zajedno sa ozbiljnim komplikacijama na brojnim organima, čini ovu bolest važnim zdravstvenim problemom širom sveta. Nedostatak simptoma je vodeće obeležje hipertenzije, a opšte važeće terapijske mogućnosti nisu uvek efikasne u kontroli bolesti. Stoga se čini da kontrola krvnog pritiska kod kuće, na radnom mestu i antistres menadžment mogu biti neke od efikasnih metoda.

Cilj ovog istraživanja bio je da se poređenjem samokontrolisanih vrednosti krvnog pritiska kod kuće, na poslu i u ambulantnim uslovima procene stvarne vrednosti krvnog pritiska i ustanovi efekat antistres menadžment osposobljavanja u normalizaciji nivoa krvnog pritiska u grupi radnika sa graničnom hipertenzijom. U kvazi eksperimentalnoj transverzalnoj studiji dizajna sa intragrupnim analizama pre i nakon intervencije, 32 radnika, muškog pola, koji obavljaju lake fizičke poslove, pohađalo je antistres menadžment obuku. Pre obuke ispitanici su tri puta svakodnevno merili i beležili vrednosti krvnog pritiska. Nakon antistres programa, na osnovu samokontrolisanih i ambulantnih vrednosti krvnog pritiska, vršena je procena stvarnih vrednosti krvnog pritiska kao deo kontrolisane studije antistres menadžmenta za esencijalnu hipertenziju. Analize pokazuju da su: (a) vrednosti krvnog pritiska pri samokontroli, kod kuće, ujutro i uveče u signifikatnoj korelaciji, a da samokontrolisane vrednosti na poslu i kod kuće nisu u značajnoj korelaciji pre tretmana, (b) koeficijent korelacije za sistolni krvni pritisak između samokontrolisanih vrednosti na poslu i kod kuće, nakon antistres menadžment programa je statistički signifikantan i visok (r manje od 0,60), (c) nakon antistres menadžment osposobljavanja, tokom vremena, interklasne korelacije među samokontrolisanim vrednostima krvnog pritiska su signifikantno veće od vrednosti izmerenih u ambulanti i samokontrole pre antistres intervencije.

Rezultati pokazuju da je samokontrola krvnog pritiska dragocena alternativa ili dopuna ambulantim merenjima, naročito kada se radi o samokontroli na radnom mestu, čime se može obezbediti pouzdana procena nivoa krvnog pritiska. Antistres menadžment intervencije mogu da budu efikasne u normalizaciji i stabilizaciji krvnog pritiska zaposlenih koji pate od simptoma u vezi sa stresom na poslu.

Ključne reči: **krvni pritisak, radno mesto, samokontrola, antistres menadžment**