

The impact of sleep on ambulatory blood pressure of female caregivers providing home care in Japan: An observational study

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**The impact of sleep on ambulatory blood pressure of female caregivers
providing home care in Japan: an observational study**

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Abstract

Background: Elderly family caregivers are presumed to be susceptible to having various health problems. However, biomedical indicators of health in these caregivers are rarely examined.

Objective: To examine the effect of sleep quality, measured by hours of sleep and the number of times leaving bed, on various blood pressure parameters in elderly caregivers.

Design: Observational study.

Setting: Northern Japan.

Participants: 78 female family caregivers.

Methods: Ambulatory blood pressure was monitored at 30- 60-minute intervals for a 24-hour period. An actigraph was used to determine sleep/wake status. Face-to-face interviews were conducted to obtain home care and demographic information, and self-administered questionnaires were used to collect information on activities in a 24-hour period.

Results: The mean age of the caregivers was 62.5 ± 9.6 years, and the mean hours of sleep were 7.3. Out of 78 caregivers, 19 were on antihypertensive medication. Of the remaining 59, this study found 45.8% to be hypertensive, with the mean maximum systolic pressure exceeding 180 mmHg. The hours of sleep at night and for the 24-hour period were inversely associated with the mean systolic blood pressure. The majority of caregivers on antihypertensive medication also had high blood pressure.

Conclusions: This study suggests the importance of 24-hour ambulatory blood pressure monitoring for elderly caregivers, so as to screen for hypertension as well as to monitor the effectiveness of antihypertensive medication.

Key words: family caregiver, ambulatory blood pressure, actigraph, sleep, nighttime care

What is already known about the topic:

- The majority of research on caregivers has dealt with the mental health aspects of care or the self-reported impacts of the care burden on physical health. Biomedical indicators of health in caregivers have rarely been examined.
- Twenty-four-hour blood pressure monitoring can be used to obtain a differential diagnosis of hypertension.
- Only a few studies have examined changes in 24-hour blood pressure among family caregivers, and the prevalence of hypertension among elderly caregivers is not known.
- Systolic blood pressure during sleep can indicate a risk factor for cardiovascular diseases. However, only a pilot study had examined the association between sleep status and blood pressure in family caregivers.

What this paper adds:

- Among participants who were not on antihypertensive medication, over 40% were found to be hypertensive.
- Caregivers who through this study were newly found to have hypertension had higher mean maximum values of systolic blood pressure and greater fluctuation in systolic blood pressure during a 24-hour period than normotensive caregivers.
- Fewer hours of sleep were associated with higher mean systolic blood pressure during daytime activity as well as higher mean 24-hour systolic blood pressure among the newly found hypertension group.
- The majority of the participants who were on antihypertensive medication still had high mean blood pressure values, which suggests the importance of 24-hour ambulatory blood pressure monitoring.

1. Introduction

In an aging society, the number of elderly people receiving home care and the number of elderly caregivers are rising. Elderly caregivers have to manage their own health and face difficulties in maintaining their quality of life with the added burden of providing care (Ekwall et al., 2007; Huston, 1990). Family caregivers are undoubtedly at increased risk of various health problems; however, the previous research focus has been mainly on the mental health aspect of the care burden (Collins et al., 1994; Covinsky et al., 2003; Jensen and Given, 1991; Lee and Farran, 2004; Song et al., 1997) or the self-reported impacts of the care burden on physical health (Kurtz et al., 2004; Lee et al., 2001; Sisk, 2000). Our literature search identified only a limited number of studies measuring blood pressure among caregivers in the U.S. and in Japan; these are described below.

The effect of chronic stress on the development of hypertension among family caregivers was examined in a prospective study. Shaw et al. (1999) followed 144 caregivers of Alzheimer patients and 47 non-caregiver controls for several years. Office blood pressure was measured every six months and it was found that the incidence of hypertension for caregivers was significantly higher than that for non-caregivers.

As blood pressure tends to increase with age, monitoring the changes in blood pressure over the 24-hour period is recommended (Trenkwalder, 1996). An ambulatory blood pressure monitoring system, which automatically measures and records blood pressure at specified intervals, has been used for family caregivers (Atienza et al., 2001; King et al., 1994; Picot et al., 1999). However, blood pressure was only measured during the day, and the length of the studies was limited to a couple of days.

Twenty-four-hour blood pressure monitoring was carried out on 69 black family caregivers with hypertension and 86 control participants (Doshi et al., 2003). The changes in blood pressure within the 24-hour period did not differ significantly between the two groups. Sleep status and sleep interruptions were not measured in the study.

A pilot study in Japan identified three blood pressure change patterns among 19 family caregivers who woke up to give care at night (Nishimura, 1999). The first group included those who experienced a temporary, sharp rise in blood pressure. The second group experienced a sustained rise in blood pressure. The third group did not experience a notable rise in blood pressure.

In our previous study, sleep/wake status and blood pressure in 68 Japanese family caregivers were monitored to examine the differences in the effect of voluntary and involuntary sleep interruptions on changes in blood pressure (Tsukasaki et al., 2005). However, the number of participants was too small for various stratifications.

Quality and duration of sleep are expected to influence the health status of caregivers. Yet, the majority of research has relied on self-reported sleep status, and the actual hours and quality of sleep are rarely examined (Carter, 2002; Carter and Chang, 2000; Gallant and Connell, 1997; Smith et al., 1997; Wilcox and King, 1999). In regard to the type of scales for measuring quality of sleep, the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989) is the most frequently cited. Measured by the PSQI, elderly female caregivers reported a much higher prevalence of sleep problems than healthy women of comparable age, and the prevalence of sleep problems was comparable to that for women with insomnia or with depressive disorders (Wilcox and King, 1999). A high prevalence (95%) of severe sleep problems was also found in caregivers of cancer patients (Carter and Chang, 2000).

A few studies have reported the use of an actigraph to measure sleep status in caregivers: Carter (2003) followed 10 family caregivers for three days; and in a Japanese study, five family caregivers providing care for those on ventilation were monitored for a duration of 8 to 15 days (Ozaki, 1998).

The purpose of the current study was to examine the association between sleep quality, measured by hours of sleep and the number of times leaving bed, and various blood pressure parameters in elderly caregivers, using an ambulatory, non-restrictive, indirect blood pressure monitoring system and an actigraph for a 24-hour period.

2. Methods

The details of data collection and analytical methods were described in our previous study (Tsukasaki et al., 2006).

2.1 Participants

The participants were recruited from 18 institutions providing elderly home care or day services in northern Japan. Since participating in this study was taxing on the participants, convenience sampling was used for selecting institutions having a client load of 100 or more. New or small institutions were excluded. This was to ensure a minimum of five participants from each site, to ease data collection. These 18 institutions are regarded as major home care providers in the region.

The criteria for the selection of participants were: (1) female family members who play the central role in home care, (2) those who are ≥ 40 years old, and (3) those who did not wear a pacemaker. Since the number of male caregivers in the area was small, and ambulatory blood pressure distribution had been reported to differ between males and females (Imai et al., 1993), only female caregivers were included in the study. No incentive was offered for study participation.

2.2 Methods and content of the survey

All participants were asked to select a day that would be representative of their daily life in terms of activities, sleep status, and caregiving, for a survey. Then the researcher made a home visit to provide blood measurement equipment, an actigraph, and a questionnaire. Blood pressure was measured during the following 24-hour period. The participants were asked to wear the actigraph to identify and record sleep/wake status. The survey was conducted between September 2001 and February 2006,

excluding August. The participants each selected a day which they considered a typical day for caregiving activities and sleep. The participants on medication were asked to take their medication as usual.

2.2.1 Interviews and self-reported activity recording for the 24-hour period

The interview items included the following: relationship with the care receiver, age, health condition, medication, duration to date of care provision at home, daily hours spent on care, and the content of care. The information collected regarding the care receiver included gender, age, care need level, presence/absence of dementia, and the use of home care services. A self-administered questionnaire was used to collect information on the caregiver, such as the number of times leaving bed and the associated reasons, and the presence/absence of the feeling of deep sleep.

2.2.2 Measurement of activity during the 24-hour period and sleep/wake identification

To measure the amount of activity during the 24-hour period, an actigraph (MicroMini, Ambulatory Monitoring Systems, Inc., Ardsley, NY, U.S.) was used. Based on the amount of activity, sleep/wake identification was performed using Cole's algorithm (Cole et al., 1992). The activity survey and actigraph data were used to calculate the following six sleep/wake indicators:

- 1) time in bed during the night (time from bedtime to waking time the next morning)
- 2) nighttime frequency of leaving bed (number of times transiently leaving bed following waking up, during the period in bed during the night)
- 3) total nighttime wake time (total wake time during the period in bed during the night)
- 4) actual nighttime sleep time (deep sleep time during the night)
- 5) actual daytime nap time (deep nap time during the day)

- 6) actual 24-hour total sleep time (sum of the actual nighttime sleep time and actual daytime sleep time).

2.2.3 Twenty-four-hour blood pressure monitoring

An ambulatory, non-restrictive, indirect blood pressure monitoring system was used to monitor blood pressure (ABP 90217, Spacelabs Medical, Issaquah, WA, U.S.; or TM-2431, A&D, Japan). Blood pressure measurements were set at 30-minute intervals from 7:00 to 22:00 and at 60-minute intervals from 22:00 to 7:00 so as to minimize sleep interference. The correlation of variation was obtained by dividing the standard deviation by the mean value.

Subsequently, based on the actigraph data, the following blood pressure indices were calculated:

- 1) blood pressure during daytime activity = mean of blood pressure values during the daytime activity period, excluding values during daytime napping
- 2) blood pressure during nighttime sleep = mean of blood pressure values during the nighttime sleep period, excluding values during the nighttime wake period
- 3) reduction rate during the night = (blood pressure during daytime activity – that during nighttime sleep) / blood pressure during daytime activity x 100

2.3 Analysis methods

The definition of hypertension according to 24-hour ambulatory blood pressure measurements was established by the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VII) (Chobanian et al., 2003).

A participant was operationally defined as hypertensive if any of her mean blood pressure measurements exceeded the following:

- daytime systolic pressure > 135 mmHg
- nighttime systolic pressure > 120 mmHg
- daytime diastolic pressure > 85 mmHg
- nighttime diastolic pressure > 75 mmHg.

The participants were classified into the following three groups according to history of hypertension and their blood pressure values:

- 1) normotensive group (those who have never been diagnosed with hypertension, and none of whose blood pressure measurements met the definition of hypertension)
- 2) newly found hypertension group (those who had never been diagnosed with hypertension, and whose blood pressure measurements met the definition of hypertension)
- 3) treated hypertension group (participants who were already being treated for hypertension)

To compare the characteristics, sleep status, and ambulatory blood pressure among the three groups of participants, an analysis of variance and Bonferroni's multiple comparison, an analysis of covariance using age as a covariate and Bonferroni's multiple comparison, as well as Pearson's χ^2 test were performed. Partial correlation coefficients were calculated to examine the association between sleep-related variables and blood pressure measurements with adjustment for age. SPSS 14.0 (Japanese version) was used for the statistical analysis and $p < 0.05$ was regarded as significant.

2.4 Ethical considerations

This study was approved by the Ethical Committee of Kanazawa University Graduate School of Medical Science (No. 332). It was explained to the participants orally as well as in writing that this study has no

relation to services provided at any of the institutions, that their participation in this study is voluntary, and that the data would be used for this study only. In addition, it was clarified that the purpose of this study is a survey, and therefore, no treatment would be offered.

3. Results

Seventy-nine participants were recruited. However, one participant removed the measurement apparatus during the night because of discomfort, and thus her data was excluded from the analysis. Of the 78 participants, 35 of those not taking antihypertensive drugs were the same individuals as in our previous study (Tsukasaki et al., 2006).

3.1 Characteristics of the participants

The mean age of the 78 participants was 62.5 ± 9.6 years, with a range of 41 to 82. Concerning the relationship with the care receiver, there were 32 wives, 30 daughters-in-law, 12 daughters, 3 mothers, and 1 younger sister. The mean age of the care receivers was 79.5 ± 13.7 years, and 51.3% of them were females. The mean number of household members was 4.0 ± 1.6 , and 21.8% lived in a two-person household. On the day of the survey, 19 participants reported being on antihypertensive medication (treated hypertension group), but the other 59 reported no history of hypertension diagnosis and were not on medication. Of these 59 participants, 54.2% were normotensive (normotensive group), and the remaining 45.8% were hypertensive (newly found hypertension group).

The commonly reported health problems in the care receivers were dementia (33 care receivers), sequelae of cerebral infarction (23), diabetes mellitus (14), Parkinson's disease (5), and cerebral hemorrhage (5). The majority of care receivers were of low mobility and high dependence, requiring considerable care. As for home care services, home visit nursing was used by 59 care receivers, day services or day care by 41, home bathing

services by 25, and home helper services by 19.

3.2 Characteristics of the participants according to the three blood pressure/treatment groups

The characteristics of the three blood pressure/treatment groups are shown in Table 1. Age distributions significantly differed among the three groups, with the normotensive group being younger than the other two groups. The hours spent on care reported by the participants themselves were slightly more in the newly found hypertension group but were not statistically significant because of high standard deviations. The number of participants who reported little assistance from other family members was the highest in the newly found hypertension group. None of the participants were obese (BMI < 25). The ratio of smokers to non-smokers did not significantly differ among the three groups.

Insert Table 1 here.

3.3 Sleep status and nighttime care status

The mean hours in bed at night for the 78 participants was 7.3 ± 1.5 hours with an actual total nighttime wake time of 1.2 ± 1.1 hours and an actual nighttime sleep time of 6.1 ± 1.4 hours. The mean number of times leaving bed at night was 1.3 ± 1.3 . The hours of actual daytime nap time were 0.7 ± 0.7 hours, with a mean actual 24-hour total sleep time of 6.8 ± 1.5 hours. The percentage of participants who reported the absence of the feeling of a deep sleep was 25.6%, and the percentage of those who used hypnotics within the preceding month was 7.7%. Of all the participants, 39.7% provided nighttime care, and the content of this care was mostly changing the care recipient's diapers on the bed.

3.4 Sleep status compared among the three blood pressure/treatment

groups

As shown in Table 2, differences in sleep status among the three groups were not statistically significant. Analysis of covariance using age as a covariate could not be performed because age was not significant in the regression.

Insert Table 2 here.

3.5 Twenty-four-hour ambulatory blood pressure

Figure 1 shows the distribution of systolic blood pressure during daytime activity and nighttime sleep in the three blood pressure/treatment groups. The percentage of participants exceeding the standard blood pressure values for daytime activity and for nighttime sleep was 44.4% for the newly found hypertension group and 57.9% for the treated hypertension group.

Insert Figure 1 here.

3.6 Differences in the 24-hour ambulatory blood pressure measurements among the three blood pressure/treatment groups

The analysis of variance showed significant and substantial differences in all the parameters of mean blood pressure measurements among the three groups (Table 3). The mean maximum value of systolic blood pressure for the two hypertensive groups exceeded 180 mmHg. With age adjustment, the newly found hypertension and the treated hypertension groups had significantly higher systolic blood pressure parameters than the normotensive group, except for the range (Table 3). Age was not a covariate in the diastolic blood pressure parameters. The other notable finding was that the newly found hypertension group had higher ranges of systolic and diastolic blood pressure than the other two groups.

Seasonal variations in blood pressure values were explored. The cold season in the region is from December to February. The mean blood pressure differed little between winter and non-winter seasons; all the mean blood pressure values in the winter season were only 1 to 1.5 mmHg lower than in the non-winter season (data not shown). The distribution of the surveys carried out in winter was approximately 50% in each of the three groups.

Insert Table 3 here.

3.7 Association between sleep status and 24-hour ambulatory blood pressure

To analyze the relationship between sleep status and 24-hour ambulatory blood pressure, the partial correlation was calculated using age as a control variable. In the normotensive group, no significant correlation between sleep status and blood pressure was observed (Table 4). In the newly found hypertension group, shorter actual nighttime sleep time was associated with increased 24-hour systolic blood pressure with age adjustment ($r=-0.43$, $p<0.05$). In addition, shorter actual 24-hour total sleep time was significantly associated with increased 24-hour systolic blood pressure as well as increased systolic blood pressure during daytime activity (Table 4).

In the treated hypertension group, increased time in bed during the night was associated with a lower coefficient of variation of diastolic blood pressure with age adjustment (Table 4). A higher nighttime frequency of leaving bed was correlated with a greater reduction in nighttime systolic blood pressure, and increased actual nighttime sleep time was correlated with a lesser rate of reduction in nighttime diastolic blood pressure (Table 4).

With these unexpected findings, the relationship between the timing of antihypertensive medication intake and sleep status was investigated in 19 participants with treated hypertension. Eight of the participants took the

medicine after supper, and seven out of the eight participants had a shorter nighttime sleep time and a higher mean number of times leaving bed (≥ 2 times). Of the 11 participants who did not take antihypertensive medication after supper, 6 showed a short actual nighttime sleep time and a high frequency of times leaving bed.

When we visually examined the actigraph data, periodic arousals which might be caused by hourly blood pressure measurements were not observed.

Insert Table 4 here.

4. Discussion

The current study shows the high prevalence of masked hypertension among elderly people in Japan, using a 24-hour ambulatory blood pressure monitoring device. Twenty-seven participants who were newly found to be hypertensive through this study had considered themselves normotensive prior to the survey date, as they had not been diagnosed with hypertension at annual physical checkups. This suggests that annual physical checkups measuring casual blood pressure may not be sufficient to screen for hypertension among elderly caregivers, and conducting 24-hour blood pressure measurements at home is necessary to identify hypertensive caregivers. In addition, a mean maximum value of systolic blood pressure exceeding 180 mmHg in those who have not been diagnosed as hypertensive by office blood pressure measurement is of great concern. These individuals are experiencing greater changes in blood pressure, and a high range of blood pressure within a 24-hour period would affect carotid artery alterations (Shintani et al., 2007).

The high blood pressure values in participants who were on antihypertensive medication are also of concern. A new international study has revealed that treated hypertension patients with higher systolic blood pressure during sleep were at increased risk of cardiovascular events (Boggia et al., 2007). Thus, it is necessary to conduct 24-hour blood pressure

monitoring in order to screen high-risk individuals for cardiovascular events.

The current study found an inverse association between hours of sleep and 24-hour systolic blood pressure among participants with newly found hypertension. Although our study has a cross-sectional design, its findings are in line with previous studies. The effect of sleep interruptions on blood pressure was examined in an Italian study which monitored 36 moderate hypertensive participants without medication (Lusardi et al., 1999). The day following the monitoring, the amount of epinephrine excretion in urine was higher when participants had experienced sleep interruptions, and blood pressure and heart rate were increased (Lusardi et al., 1999).

Even in healthy participants, sleep deprivation seems to increase the risk of hypertension. In another study, 18 healthy adult men were monitored to measure changes in blood pressure when obtaining between 8.0 and 3.6 hours of sleep, and the mean blood pressure was significantly higher when the hours of sleep were fewer (Tochikubo et al., 1996). The study suggested that sleep deprivation seems to stimulate the sympathetic nervous system, which leads to increased blood pressure.

Our findings are also supported by a longitudinal study in the U.S., which showed that sustained sleep deprivation is a risk factor for developing hypertension (Gangwisch et al., 2006). In the first National Health and Nutrition Examination Survey, 4,810 participants were followed for up to 10 years and it was found that less than five hours of sleep was a significant risk factor for high blood pressure (Gangwisch et al., 2006). These studies indicate that normotensive participants who obtain fewer hours of sleep are at high risk of developing hypertension.

In contrast with the newly found hypertension group, the inverse association between sleep hours and blood pressure was not observed in the treated hypertension group. A detailed analysis showed that a high proportion of those who woke up to provide care had taken medication in the evening. Although further research is necessary to confirm our finding, it appears that high blood pressure at night may be controlled by taking medication in the evening.

Noise exposure at night has been shown to be associated with a rise in blood pressure in a recent multinational study (Haralabidis et al., 2008). The types of noise investigated were aircraft, traffic, and indoor noise such as snoring (Haralabidis et al., 2008). In our study, the noise level in the household was not measured. As the region in our study is far from major industrial areas, there were no nighttime aircraft noises, and no major traffic noise was noted. Snoring in the participants and in the other family members was not measured. It is unlikely that the distribution of those who snore differed among the three groups. Nevertheless, in future research, noise exposure needs to be examined.

Automated blood pressure measurements at night may disturb sleep. A previous study used 15-minute intervals for the night-time measurements (Haralabidis et al., 2008). In our study, the actigraph data confirmed that no one was awoken every hour. Thus it can be concluded that the blood pressure measurement itself had little impact on the sleep status of the participants who completed the study.

Seasonal variations in the mean blood pressure values were not observed, although blood pressure values are expected to be higher in winter than in spring or fall. We speculate that the caregivers tend to stay indoors in winter. Further, the definition of hypertension based on 24-hour ambulatory blood pressure is not differentiated by season.

An objective measurement of sleep/awake status is essential for determining daytime and nighttime blood pressure values. The actigraph is a highly valid measurement tool to determine sleep/awake cycles (Cole et al., 1992; Sadeh et al., 1995), and a pilot study in the U.S. reported that actigraphy was superior to personal sleep records in determining blood pressure dipping status (the drop in nighttime blood pressure) in 24-hour ambulatory blood pressure monitoring (Eissa et al., 2001). Furthermore, self-reported sleep time tends to be shorter than that measured by an actigraph (Carter, 2003).

Actigraphs have been used in a couple of studies to measure the hours of sleep in family caregivers for more than one day. Ozaki (1998) surveyed five

family caregivers providing care for ventilated patients at home for 8 to 15 days. The mean hours of sleep per night were 7.02, while the mean hours of deep sleep were 6.1. The mean number of times leaving bed was 2.5. Carter (2003) followed 10 family caregivers of terminal stage cancer patients for three days. Actigraph data showed that the mean hours of sleep ranged from 4.83 to 5.55. These studies suggest that hours of sleep in family caregivers are affected by the type of health condition of the care receivers.

4.1 Implications for nursing practice

The current study shows a high prevalence of hypertension among elderly caregiver study participants who considered themselves normotensive prior to the day of the survey. This suggests that measuring office blood pressure is not sufficient for elderly caregivers, and 24-hour ambulatory blood pressure monitoring is highly recommended.

For hypertensive caregivers, measuring 24-hour ambulatory blood pressure is also highly recommended (Boggia et al., 2007). As the mean systolic blood pressure during sleep increases, the risk of cardiovascular events will increase. If the mean systolic blood pressure during sleep remains high, additional medication in the evening may be necessary. However, it is possible that not all caregivers will consider the blood pressure measurement apparatus to be comfortable to wear. Development of a smaller blood pressure measurement device with automated recording is necessary in order to disseminate the 24-hour monitoring practice.

Sleep deprivation has been associated with several adverse health outcomes such as diabetes and cardiovascular disease in various populations, both of which can cause mortality (Gangwisch et al., 2006; Knutson et al., 2007; Sigurdson and Ayas, 2007). Even though our study is cross-sectional, the inverse association found between hours of sleep and systolic blood pressure is supported by previous studies. It is recommended that care managers arrange an appropriate level of support in order for caregivers to get enough hours of rest and sleep.

4.2 Limitations of the study

Wearing the blood pressure measurement apparatus and the actigraph was demanding for participants, and the measurement period was limited to 24 hours. The day selected by the participant may not have turned out to be a typical day for them in terms of hours of sleep and content of care, even though we requested them to select a typical day. In addition, the number of participants was too small to stratify by the severity of hypertension, type or dosage of antihypertensive medication, smoking, or drinking. A much larger sample is suggested for future research to adjust for these variables.

This is a cross-sectional survey. A prospective study is necessary to monitor the effects of aging and sleep status on blood pressure measurements. In addition, male caregivers were not examined in this study. However, the number of male participants who provide care for their parents and spouses is slowly increasing. The difference in the ambulatory blood pressure distribution between sexes is known (Imai et al., 1993). Therefore, male caregivers need to be recruited for future research.

As we used convenience sampling, low-income families may be underrepresented in our study. If this is the case, we speculate that there would be a higher prevalence of hypertension and more pronounced disparity in blood pressure values because low-income families are exposed to higher levels of stress than middle-income families.

5. Conclusions

An ambulatory, non-restrictive, indirect blood pressure monitoring system was used to monitor blood pressure for a 24-hour period in 78 elderly family caregivers in northern Japan. Nineteen were on hypertensive medication. Of the remaining 59, 45.8% were found to be hypertensive according to the study results, showing a high mean maximum systolic blood pressure with a greater range of blood pressure. Fewer hours of sleep

were associated with higher systolic blood pressure in the newly found hypertension group after adjustment for age. The participants who were on antihypertensive medication had high blood pressure measurements, suggesting a suboptimal level of blood pressure control when providing care. The study suggests the importance of measuring 24-hour ambulatory blood pressure in elderly caregivers to screen for hypertension and to monitor the effectiveness of blood pressure control measures.

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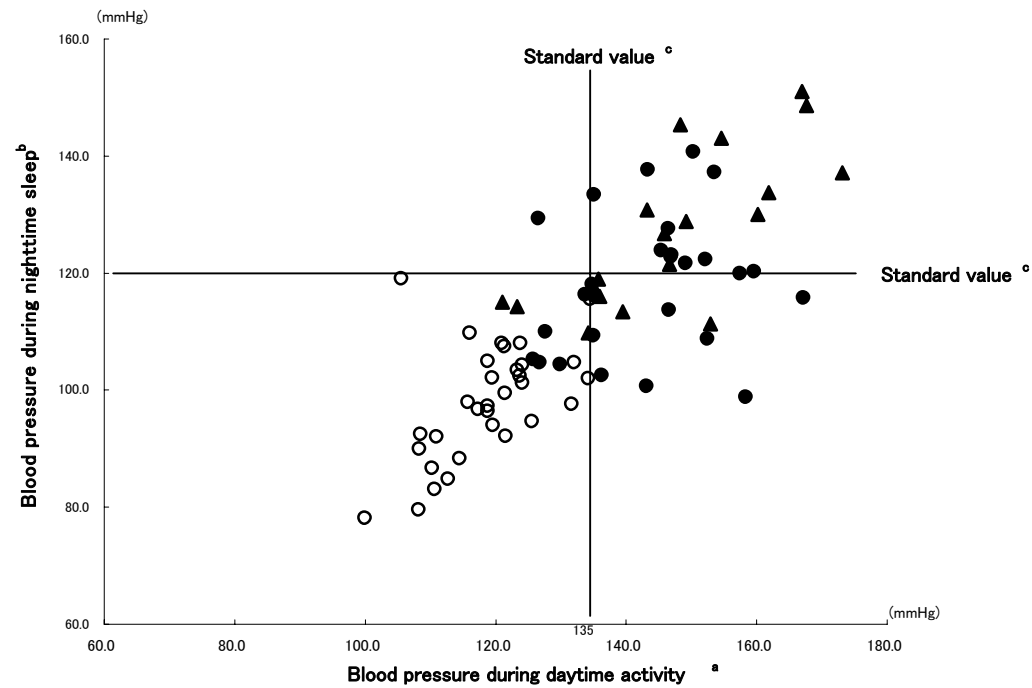


Figure 1: Distribution of systolic blood pressure during daytime activity and nighttime sleep in the three blood pressure/treatment groups

a Mean values during daytime activity after excluding values during daytime naps

b Mean values during actual nighttime sleep after excluding values during nighttime wake periods (including bed-leaving periods)

c Standard values established by JNC VII

○ normotensive group (n=32)

● newly found HT group (n=27)

▲ treated HT group (n=19)

Table 1 Characteristics of each blood pressure/treatment group

	Group 1: normotensive group ^a (n=32)	Group 2: newly found HT group ^b (n=27)	Group 3: treated HT group (n=19)	ANOVA		χ^2
Age (years)	58.1±9.9	63.7±8.8	68.0±7.0	**	Group 1 < Groups 2 & 3	–
Duration of home care (months)	50.5±41.2	75.0±90.0	66.5±59.1	n.s.	–	–
Hours providing care/day	5.3±5.7	9.4±8.9	6.4±6.6	n.s.	–	–
Absence of other caregivers at home	6 (18.8%)	13 (48.1%)	8 (42.1%)	–	–	*
Characteristics of care receivers						
Gender	females (56.3%), males (43.8%)	females (55.6%), males (44.4%)	females (36.8%), males (63.2%)	–	–	n.s.
Age (years)	77.5±14.6	78.7±15.2	84.0±8.9	n.s.	–	–
Dementia	15 (46.9%)	9 (33.3%)	9 (47.4%)	–	–	n.s.

mean±SD. *p<.05. **p<.01. n.s. = non significant

^aCaregivers with both normal systolic and normal diastolic blood pressure during daytime and nighttime <as per standard values of the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VII)>

^bNon-medicated caregivers with either systolic or diastolic blood pressure during daytime activity and at nighttime \geq the standard value of JNC VII