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# The Relationship between Sleep Duration and Hypertension in Adult Women: A Community-based Study on Rural Population

Mohammad Fahrizal Fanani,<sup>1</sup> Eka Prasetya Budi Mulia,<sup>2</sup> Fitriana Kusuma Wardhani,<sup>1</sup>  
 Pipit Mei Sari,<sup>3</sup> Olivia Josephine Wijaya,<sup>3</sup> Cokorda Agung Paramadika,<sup>1</sup>  
 Danna Novriandhika,<sup>4</sup> Dwi Aprilawati,<sup>5</sup> Wahjuni Pudjiastuti<sup>6</sup>

<sup>1</sup>Department of Medical Program, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

<sup>2</sup>Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

<sup>3</sup>Department of Neurology, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

<sup>4</sup>Department of General Surgery, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

<sup>5</sup>Department of Public Health and Preventive Medicine, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

<sup>6</sup>Department of Public Health, East Java State Public Health Training Center, Lawang, Malang, Indonesia



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## Address for correspondence:

Dr. Eka Prasetya Budi Mulia,  
Department of Cardiology  
and Vascular Medicine, Faculty  
of Medicine, Universitas  
Airlangga, Surabaya, Indonesia  
Phone: +6231 5501601  
E-mail: eka.prasetya.budi-  
2017@fk.unair.ac.id

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## ABSTRACT

**Objectives:** Sleep deprivation may increase sympathetic nervous system activity, which, in turn, could result in an increase in blood pressure. However, data examining the relationship between sleep duration and hypertension from rural populations remain to be limited. This study aimed to determine the relationship between sleep duration at night and hypertension among adult women in rural Indonesia.

**Methods:** Community-based study was conducted on adult women from a rural population in Malang, East Java, Indonesia. Data was collected via interviews to obtain their sociodemographic information and sleep pattern. Blood pressure was measured using a mercury sphygmomanometer.

**Results:** In total, 105 adult women were enrolled in this study. The prevalence rate of hypertension was found to be 63 (60.0%). The prevalence rate of subjects who sleep less than 7 hours per night was 54 (51.4%). Hypertension was observed in 46 (73.0%) of the participants who slept less than 7 hours, while hypertension was observed in 17 (27.0%) of the participants who slept more than 7 hours ( $p < 0.001$ ).

**Conclusion:** Hypertension was associated with short sleep duration among the rural adult women. These results underscore the potential importance of sufficient sleep in reducing the frequency of hypertension.

**Keywords:** Adult, women, hypertension, rural population, sleep

## INTRODUCTION

Hypertension, better known as high blood pressure, is described as an abnormal increase in blood pressure (systolic and/or diastolic blood pressure).<sup>[1]</sup> In Indonesia, the number of people with hypertension has seen a steady increase. The country's national data from the basic health survey showed that 25.4% of the adult population over 18 suffered from hypertension in 2013; then, it increased to 34.1% in 2018.<sup>[2]</sup>

Blood pressure can be influenced by various factors, including physical activity, body position, environmental temperature, and the activity of the autonomic nervous system.<sup>[3]</sup> Based on a study by Tochikubo et al., lack of sleep can increase sympathetic nervous system

activity, which, in turn, could result in an increase in blood pressure.<sup>[3]</sup> Meanwhile, a study conducted by Gottlieb et al. found that the amount of sleep can be associated with a higher prevalence of hypertension, especially if it is less than 6 hours.<sup>[4]</sup> From the first National Health and Nutrition Examination Survey, sleeping less than or equal to 5 hours per day was associated with a significantly increased risk of hypertension among study subjects aged 32–59 years old.<sup>[5]</sup>

Previous epidemiological studies have already mentioned that short sleep duration is a risk factor for hypertension. However, studies examining adult women in the rural part of Indonesia regarding this health concern remain limited. Thus, the objective of this study was to determine the relationship between sleep duration adequacy and hypertension among adult women in a rural area in Malang, East Java, Indonesia.

## METHOD

This population-based study using a cross-sectional design was conducted on April 01 and April 30, 2013 among adult women aged 30 years or older in Toyomarto Village, Singosari District, Malang Regency, East Java, Indonesia.

Lemeshow formula was used to calculate sample size. Using anticipated population proportion of hypertension (using results of a preliminary survey in local hypertension prevalence) of 42.86%, confidence interval of 95%, and 10% margin of error, the minimum sample size required was 95. The sampling technique used in this study is consecutive sampling method. All subjects who met the eligibility criteria were included in this study.

Mercury sphygmomanometer and questionnaire were utilized in this study. Sphygmomanometer validity was standardized by Surabaya Health Facility Security Center. To test inter-observer agreement reliability, kappa statistic was used. Blood pressure measurement was done in one visit and it was measured twice for five minutes apart. Blood pressure measurements were conducted in a sitting position after five minutes of rest. A third measurement was made if there was a difference of more than 10 mmHg for either systolic or diastolic blood pressure between the first two measurements. The average of the two blood pressure readings was used for analysis.

As per the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7), hypertension is defined as having a systolic blood pressure level of 140 mmHg and/or diastolic blood pressure level of  $\geq 90$  mmHg.<sup>[1]</sup> Duration of sleep was defined

as either inadequate ( $< 7$  hours per night) or adequate ( $\geq 7$  hours per night).

This study was excluded pregnant subjects, suffered from a severe physical or mental illness that made them unresponsive or made blood pressure measurements impossible to accomplish, had a previous history of hypertension, and refused to be subject.

Data obtained from the survey were analyzed using the SPSS 23.0 program. Continuous variables were presented as mean and standard deviation. Categorical variables were presented as frequency and percentage. Chi-square test was used in the bivariate analysis to identify the relationship between sleep duration and hypertension. A *p*-value of less than 0.05 was considered significant.

## RESULTS

In total, 105 adult women were enrolled in this study. Mean age of all subjects was  $43.6 \pm 7.5$  years. Socio-demographic features of the participants are summarized in Table 1.

The mean systolic and diastolic blood pressure of all subjects were  $138.8 \pm 21.6$  mmHg and  $91.2 \pm 12.6$  mmHg, respectively. Mean systolic and diastolic blood pressure according to age groups are summarized in Table 2.

**Table 1.** Socio-demographic features of the participants

	n (%)
Age groups	
32-40 years	44 (41.9)
41-50 years	40 (38.1)
51-59 years	21 (20.0)
Occupation	
Housewife	68 (64.8)
Merchant	17 (16.1)
Labourer	9 (8.6)
Craftswoman	5 (4.8)
Farmer	4 (3.8)
Others	2 (1.9)
Comorbidities	
Diabetes mellitus	7 (6.7)
Dyslipidemia	6 (5.7)
No comorbidities	92 (87.6)
Sleep duration (hours)	
$< 7$ hours	54 (51.4)
$\geq 7$ hours	51 (48.6)

While 54 (51.4%) of the participants had less than 7 hours sleep duration per night, 51 (48.6%) had 7 hours or more sleep duration. The frequency of hypertension was 63 (60.0%). Relationship between sleep duration and hypertension is summarized in Table 3.

## DISCUSSION

This study showed that hypertension was associated with short sleep duration in adult women. At the age of 60 and over, hypertension could be attributed to degenerative processes, as the body's condition is expected to decline. Several mechanisms underlying hypertension among the elderly have already been identified and explained in scientific literature. Some of these mechanisms identified are endothelial dysfunction, increased oxygen delivery to tissues, increased concentrations of active metabolites, and increased myogenic constriction.<sup>[6]</sup>

In a study conducted by Rahajeng and Sutinah, it was determined that the prevalence rate of hypertension in the 34–54 years age group was 45.2%.<sup>[7]</sup> From the first National Health and Nutrition Examination Survey, the amount of sleep less than or equal to 5 hours per day was associated with a significantly increased risk of hypertension among study subjects aged 32–59 years old.<sup>[5]</sup>

This study only took women subjects due to the significant effect of gender on blood pressure. Premenopausal women have lower arterial pressure than men of the same

age. Compared with premenopausal women, postmenopausal women have higher blood pressure, giving the impression that ovarian hormones control blood pressure.<sup>[8]</sup> Estrogen can reduce blood pressure in women through several mechanisms. First, estradiol estrogen can function as a vasodilator, decreasing peripheral resistance. Second, estrogen functions to prevent vascular responses to lesions and, in turn, prevent endothelial damage. Third, estradiol has a cardioprotective effect by controlling myocyte cells and fibroblasts. Fourth, estradiol is also vital in the kidneys, as it protects the kidneys from injury to keep the body in a state of normotension. Fifth, estradiol can also affect the sympathetic nerves, decreasing the sympathetic basal tone, thereby strengthening the antihypertensive action of estradiol. Meanwhile, progesterone is known to exhibit activities that support the functions of estrogen.<sup>[8]</sup>

Of the 105 subjects interviewed, 51.4% of participants had less sleep (<7 hours), whereas 48.6% of participants had enough sleep ( $\geq$ 7 hours). These results indicate that sleep deprivation and adequate sleep time are almost the same in the rural population. Sleep disorders can be caused by several things, including poor physical or mental health, obesity, and low social and economic classes.<sup>[9]</sup>

Of the 105 participants, a total of 60.0% were determined to suffer from hypertension. This result demonstrates that the prevalence of hypertension among women in rural areas is quite high, thus highlighting that hypertension remains a significant health problem in Indonesia. As per the country's basic health survey, it was determined that 25.4% of the adult population over the age of 18 suffered from hypertension in 2013; it was noted to increase to 34.1% in 2018.<sup>[2]</sup>

Hypertension can be attributed to various factors, including age, sex, physical activity, smoking habits, salt intake, diabetes mellitus, dyslipidemia, and insufficient sleep.<sup>[10–12]</sup> In this study, the frequency of hypertension was found to be significantly higher in those who slept less than 7 hours compared to those who slept longer than 7 hours. These results are in line with other studies which associated sleep deprivation with hypertension.<sup>[5,13]</sup> A study by Gangwisch et al. found that sleep deprivation is associated with a significantly increased risk of hypertension among study subjects aged 32–59 years old.<sup>[5]</sup> Li et al. mentioned that among people aged 18–44 years, having inadequate sleep was significantly correlated with hypertension in Northeast China.<sup>[13]</sup>

A pathophysiological process that underlies the relationship between short sleep duration and hypertension is

**Table 2.** Mean systolic and diastolic blood pressure according to age groups

Age group	n (%)	Blood Pressure (mmHg)	
		Systolic	Diastolic
32-40 years	44 (41.9)	131.1 $\pm$ 19.9	87.5 $\pm$ 12.5
41-50 years	40 (38.1)	142.7 $\pm$ 19.6	93.3 $\pm$ 11.2
51-59 years	21 (20.0)	147.6 $\pm$ 24.2	94.9 $\pm$ 13.8

Data is presented as mean $\pm$ standard deviation.

**Table 3.** Relationship between sleep duration and hypertension

	Hypertension	Non-Hypertension	X <sup>2</sup>	p
Sleep duration				
<7 hours	46 (73.0)	8 (19.0)	29.383	<0.001
$\geq$ 7 hours	17 (27.0)	34 (81.0)		

Data is presented as n (%).  
Chi-square test.

longer exposures to elevated sympathetic nervous system activity. Sympathetic nerve activation through  $\beta_1$  receptor in the heart can increase heart rate and contractility by increasing sinoatrial nodal, atrioventricular nodal, and ventricular muscular firing.<sup>[14]</sup> Furthermore, sympathetic nerve activation acting through  $\beta_1$ -adrenergic receptors in the kidneys would stimulate the release of renin and the activation of the renin-angiotensin-aldosterone system (RAAS). The RAAS would then regulate renal sodium handling and blood pressure. As a result, systolic and diastolic blood pressures are increased.<sup>[15]</sup> Lack of enough sleep would also result in increased physical and psychological stress. Increased exposure to stress will then reduce renal salt-fluid excretion. Long-term exposure to lack of sleep duration will cause structural changes, including arterial and left ventricular remodeling, gradually changing the cardiovascular system to operate at elevated pressure equilibrium.<sup>[5]</sup> In addition, disrupted circadian rhythmicity and autonomic balance caused by short sleep duration may contribute to hypertension.<sup>[13]</sup> This study has several limitations. The authors could not control other risk factors such as genetics, diabetes mellitus, dyslipidemia, salt intake, caffeine consumption, and contraceptive use, but keep in mind that hypertension is a multifactorial disease that can be influenced by many factors. The study subjects are less heterogeneous as the data collection was carried out during the day, ensuring that the subjects we met are only women who do not work or whose jobs can be done at home (e.g., being an entrepreneur). Primary data collection techniques in interviews are very subjective, and recall bias may happen because information (sleep duration and sleep quality) is based on subjects' self-reported measures.

## CONCLUSION

As per our findings, it was determined that the prevalence rate of hypertension was high among women in the rural area. Among these participants, it was noted that hypertension was associated with inadequate sleep duration. These results thus underscore the potential importance of sufficient sleep duration for reducing hypertension incidence and prevalence.

### Disclosures

**Peer-review:** Externally peer-reviewed.

**Conflict of Interest:** None declared.

**Funding:** No funding to declare.

**Ethics Committee Approval:** This study was approved by Ethics Commission of Faculty of Medicine Universitas Airlangga (Approval date: Apr 26, 2013, and Approval number:264). This study

was conducted according to Helsinki Declaration of 1975 as revised in 2000. Written informed consent was taken from study subjects who agreed to participate in this study. Data that reveal patients' personal information were omitted. Subjects diagnosed with hypertension were referred to the nearest primary health center to get further treatment.

**Authorship Contributions:** Concept – M.F.F., E.P.B.M., F.K.W.; Design – M.F.F., E.P.B.M., P.M.S.; Supervision – D.A., W.P.; Materials- M.F.F., E.P.B.M., O.J.W., C.A.P.; Data collection &/or processing – M.F.F., F.K.W., P.M.S., O.J.W., C.A.P., D.N.; Analysis and/or interpretation – M.F.F., E.P.B.M., C.A.P., D.N., D.A., W.P.; Literature search – E.P.B.M., F.K.W., P.M.S., O.J.W.; Writing – M.F.F., E.P.B.M., F.K.W., P.M.S., D.N.; Critical review – M.F.F., E.P.B.M., D.A., W.P.

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