



# Physical activity, sleep quality, energy dense nutrient-poor (EDNP) foods intake, with blood pressure among obese teachers

## *Aktivitas fisik, kualitas tidur, asupan energy dense nutrient-poor (EDNP) dengan tekanan darah pada guru obesitas*

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## Abstract

Profession teachers with obesity nutritional status encourage hypertension because they have light physical activity, poor sleep quality, and high energy-dense, nutrient-poor food (EDNP) intake caused by potential occupational risks. This study sought to examine the relationship between physical activity, sleep quality, EDNP intake, and systolic and diastolic blood pressure. This was a study with a consecutive sampling design among female teachers aged 35-54 years in Kudus in March 2022. The total number of respondents with direct offline interviews was 59. Rank Spearman or Pearson test for bivariate analysis, followed by the linear regression test for multivariate analysis. Bivariate tests showed that physical activity ( $p=0,039$ ) and EDNP intake ( $p=0,001$ ) showed a noteworthy correlated with systolic blood pressure. The relationship between sleep quality ( $p=0,039$ ) and EDNP intake ( $p=0,028$ ) was significant for diastolic blood pressure but not for systolic blood pressure. The results of the multivariate test indicated a substantial correlation between physical activity, sleep quality, and EDNP intake on systolic BP ( $p=0,001$ ) and diastolic BP ( $p=0,006$ ) blood pressure. In conclusion, physical activity, sleep quality, and EDNP intake were significantly associated with systolic and diastolic blood pressure.

**Keywords:** BMI, female teacher, lifestyle, systolic and diastolic

## Abstrak

Profesi guru dengan status gizi obesitas mendorong terjadinya hipertensi karena memiliki aktivitas fisik ringan, kualitas tidur buruk, dan asupan EDNP tinggi yang disebabkan dari potensi risiko pekerjaan. Penelitian bertujuan untuk menganalisis hubungan aktivitas fisik, kualitas tidur, dan asupan EDNP terhadap tekanan darah sistolik dan diastolik. Penelitian menggunakan desain *consecutive sampling* pada guru wanita berusia 35-54 tahun di Kudus pada bulan maret 2022. Sebanyak 59 responden diwawancara langsung secara luring. Analisis bivariat menggunakan uji *Pearson* ataupun *Rank Spearman*, dilanjutkan multivariat menggunakan uji regresi linier. Uji bivariat menunjukkan bahwa aktivitas fisik ( $p=0,039$ ), asupan EDNP ( $p=0,001$ ) memiliki hubungan signifikan terhadap tekanan darah sistolik, tetapi tidak dengan diastolik. Terdapat hubungan signifikan kualitas tidur ( $p=0,039$ ), asupan EDNP ( $p=0,028$ ) terhadap tekanan darah diastolik, tetapi tidak dengan sistolik. Uji multivariat menunjukkan hubungan signifikan antara aktivitas fisik, kualitas tidur, dan asupan EDNP terhadap tekanan darah sistolik ( $p=0,001$ ) maupun diastolik ( $p=0,006$ ). Kesimpulan ini adalah aktivitas fisik, kualitas tidur, serta asupan EDNP memiliki hubungan signifikan terhadap tekanan darah sistolik maupun diastolik.

**Kata Kunci:** Guru wanita, sistolik dan diastolik, pola hidup

## Introduction

Obesity is an abnormal or excess fat tissue formation that raises health hazards (Piche & Despres, 2020). Research related to obesity in adults found that a BMI of the Asia Pacific classification  $\geq 25$  kg/m<sup>2</sup> was closely associated with the incidence of hypertension by 2,21 times (Das et al., 2022). An obese woman over 18 years of age was chosen as the first step in the early detection of hypertension risk (Hutagaol & Malinti, 2020). Obesity is an important marker for immediate blood pressure monitoring (Lund et al., 2020). Hypertension, as a silent killer, contributes to complications of vascular disease, stroke, and premature death in obese female subjects (Campbell et al., 2020; Campbell et al., 2022). Hypertension in obese subjects is caused by increased cardiac output (Adam, 2019; Rizona et al., 2020).

Hypertension is associated with increased systolic blood pressure  $\geq 140$  mmHg and diastolic blood pressure  $\geq 90$  mmHg on repeated examinations (Chuang & Liu, 2023). Hypertension in obese subjects is affected by a variety of factors including food consumption, sleep quality, and physical exercise (Sejbuk et al., 2022). Based on studies conducted on adult female participants, the frequency of obesity and hypertension was 54,1% based on the Asia Pacific cut-off (Nurdiantami et al., 2018). The Asia-Pacific cut-off was selected because the obesity BMI is closer to the normal value, making a person more aware of efforts to improve nutritional status (Dai et al., 2020).

Based on the results of the Based Health Research (Riskesmas) 2018, Central Java Province is one of the provinces in Indonesia with a hypertension prevalence of 34,1% and an obesity prevalence of 21,8%, the incidence of hypertension in obese subjects may be relatively high. In 2018, the prevalence of obesity in adult women was 28,69% which was included in the top 10 districts in Central Java, and the prevalence of hypertension was 34,82% (Balitbangkes RI, 2018).

Hypertension can affect all professions, one of which is a teacher. This condition is driven by physical activity, sleep quality, and food intake (Krietsch et al., 2019). Teachers engage in relatively light physical activity since they teach while sitting in class (Cruickshank, 2021). Teachers have the potential for poor sleep quality due to administrative

responsibilities and other factors, such as the addition of a private night tutoring schedule and the creation of accumulated grades that reduce rest time and tend to be not good for body health. Teachers have the habit of leaving breakfast because of working hours in the morning. Teachers also had fewer hours of rest so that the selection of types of food intake was easy to find, such as high sodium and energy-dense and low micronutrient (EDNP) groups. Consumption of the teacher's daily snacks provided by the school includes fried foods, and other energy-dense foods can trigger high blood pressure. Therefore, the teaching profession is at a higher risk for hypertension than other professions (Tindangen et al. 2020; Al Rahmad, 2021). Triggering factors for hypertension include physical activity.

Physical activity is the current trend of disease discussion, shifting toward non-communicable diseases and affecting blood pressure (Schouw et al., 2020; Nasrulsyah et al., 2022). Light physical activity causes the heart muscles in the arterial walls to work harder, increasing blood pressure (Maskanah et al., 2019). Previous studies on adults have revealed a connection between physical activity and the incidence of hypertension. It appears to protect against the increased risk of hypertension in women with sleeping difficulties (Duncan et al., 2021). Of the many physical activity questionnaires, the researcher chose to use The Questionnaire of Baecke et al for the measurement of a Person's Habitual Physical Activity because it is easy to use and has a test value with a high *r*-value 0,54 (Krol-Zielinska et al., 2019). The Baecke questionnaire categorizes work, exercise, and leisure indices to identify the dimensions that underlie a person's physical activity habits (Silvaa et al., 2020).

The degree of sleep has an impact on blood pressure elevation. Poor sleep quality causes changes in the sympathetic nervous system, which can be explained by increased catecholamine release and decreased heart rate (Martini et al., 2018; Mohani et al., 2018). Previous research conducted in Brazil has highlighted the possibility of poor sleep quality among female elementary school instructors (Carla et al., 2018).

Food intake affects blood pressure in obese subjects. Research on adult subjects with hypertension explains a significant relationship

between the intake of animal protein, saturated fat, and sodium and high blood pressure (Bakar et al., 2022). This study focused on energy-dense foods low in micronutrients, known as energy-dense nutrient-poor foods (EDNP), which have a high content of saturated fat, trans fat, sugar, and high sodium (Gallo et al., 2021; Puspitasari et al., 2018).

The aim of research related to incorporating variables of physical activity, sleep quality, and food intake EDNP on systolic and diastolic blood pressure as a contributing factor to hypertension has never been done before. In addition, the selection of subjects devoted to the teaching profession of women aged 35-54 with obesity became the author's interest in this topic.

## Methods

This was an analytical observational study with a cross-sectional design. The research location is the Elementary School (SD) in the Mejobo District, Kudus Regency, Central Java, and was conducted in March 2022 with direct interviews offline. Ethical feasibility was obtained from the Medical/Health Research Bioethics Commission, Faculty of Medicine, Sultan Agung Islamic University, Semarang No.73/III/2022/Commission on Bioethics. The study was conducted during the COVID-19 pandemic; therefore, researchers implemented strict health protocols to minimize the spread of the Omicron virus (Moises et al., 2022).

The calculation of respondents in this study is based on previous studies, and the  $r$  value is 0,4 (Abdurrachim et al., 2016). Based on the above calculations, the sample size obtained was 53. The sample size was corrected by adding 10% of the calculated sample to 59 participants to avoid sample dropouts (Kaliyadan et al., 2019). Subjects were selected using a consecutive sampling technique.

$$n = \left\{ \frac{z\alpha + z\beta}{0,5 \ln(1+r)/(1-r)} \right\}^2 + 3$$

$n$  = required minimum sample size

$Z\alpha$  = The standard normal deviate for  $\alpha$  (1,645)

$Z\beta$  = The standard normal deviate for  $\beta$  (1,28)

$r$  = The expected correlation coefficient (0,4)

The screening began by looking at the inclusion criteria, determining the sex of women aged 35-54 years with obesity nutritional status ( $BMI > 25 \text{ kg/m}^2$ ) in the Mejobo District, Kudus Regency, and willingness to provide informed consent. Respondents were present during the study, could communicate well, were physically and mentally healthy, did not smoke, and did not take drugs affecting blood pressure for at least the last three months.

Exclusion criteria included resignation, illness other than hypertension, or death during the research process. Respondents were required to complete an informed consent form as available to participate in the study and a general personal data form to support the information needed during the research.

The independent variables in this study were physical activity, sleep quality, and food intake of Energy Dense Nutrient Foods (EDNP), while the dependent variables were systolic and diastolic blood pressure. The respondents' data included anthropometry (weight and height), physical activity, sleep quality, nutrient intake from EDNP food sources, and blood pressure. Data on respondents' characteristics, physical activity, sleep quality, and EDNP food intake were collected through direct interviews using a questionnaire. Body weight was measured using a scale with an accuracy of 0,1 kg and a capacity of 150 kg. Height was measured using a GEA No. A 26SM microtoise with an accuracy of 0,1 cm and capacity of 200 cm was used. The respondents were categorized as obese if their body mass index (BMI) was  $\geq 25 \text{ kg/m}^2$  (World Health Organization, 2018). Systolic and diastolic blood pressure data were obtained using a blood pressure device and classification was based on (Joint Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure 2017).

Physical activity data were recorded using the questionnaire developed by Baecke et al. for the measurement of a person's Habitual Physical Activity through direct interviews. This questionnaire contains details of all activities in terms of frequency and duration and has three indexes related to work activities, sports, and activities during leisure time. Types of activities included work activities, household activities (taking care of children, cleaning the home environment), transportation (walking, cycling, using a motorbike), and leisure time activities

(swimming and dancing). The scoring in each indicator was adjusted to the respondent's condition and the sum of the scores for each indicator. The leisure time index on the questionnaire was divided into watching television, walking, or cycling with total points if never (0), rarely (2), sometimes (3), often (4), and always (5). The categorization of total physical activity at work, sports, and leisure time is based on the Baecke index, where a score  $< 7,5$  is categorized as light activity and  $> 7,5$  as moderate activity (Sadeghisani et al., 2016).

Sleep quality data were recorded using the Pittsburgh Sleep Quality Index (PSQI) questionnaire, which consists of seven components as assessment parameters. The total sleep quality score is 0-21, with an interpretation that a score  $\leq 5$  indicates good sleep quality, while a score  $> 5$  indicates poor sleep quality (Made et al., 2021).

The food intake questionnaire was completed using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), which was used to measure nutrient intake. The overall results of the SQ-FFQ questionnaire were grouped into Energy-Dense, Nutrient-Poor Foods (EDNP) groups, namely visible fat, sweeteners, desserts, salty snacks, and others. Calculation of food intake was categorized as frequent if  $\geq 7$  times/week or rarely  $< 7$  times/week (Puspitasari et al., 2018). Energy density was calculated by dividing the total energy by the total weight of the food and drink. Energy density is considered high if it is greater than 1,99 kcal/gram for women. Micronutrient intake in comparison to Indonesia's RDA (Biltoft-Jensen et al., 2022).

Data were processed and analyzed using the Statistical Package for the Social Science (SPSS) 25,0 Windows. The Kolmogorov-Smirnov test was used to determine whether the data were normal. Bivariate analysis using Pearson's test was carried out to show the relationship between physical activity, sleep quality, and EDNP food intake with systolic and diastolic blood pressure, and analysis of sleep quality with physical activity and EDNP food intake. Rank Spearman test was used to analyze the relationship of energy density, energy, protein, carbohydrates, fiber, and sodium to systolic and diastolic blood

pressure. Multivariate analysis of relationships between variables using multiple linear regression tests. The influence of the variable was considered significant at  $p < 0,05$ .

## Result and Discussion

The attributes of the participants in this study are listed in Table 1. The study sample comprised 59 women. Based on the results of measurements that have been carried out directly include body weight with an average of  $68,76 \pm 6,725$  kg, height  $160,18 \pm 6,014$  cm, age  $44,10 \pm 5,956$ , and nutritional status consisting of obesity grades 1 and 2 according to the cut-off Asia Pacific with a mean value of  $26,75 \pm 1,28$  kg/m<sup>2</sup>. The analysis showed that age had a significant relationship with systolic blood pressure ( $p=0,022$ ), with the largest proportion at age  $> 40$  years, namely 67,79%. In addition, the body weight tended to be in the range of  $> 65$  kg, with a larger proportion (57,6%).

Based on the measurement results, it was known that respondents who were categorized as having hypertension levels 1 and 2 had a percentage that was greater than the prehypertension and normal categories. Based on the results of the interviews, most respondents engaged in light activities (59,32%) because they only sat while teaching and rarely engaged in sports. Poor sleep quality was higher due to the respondent's lack of time to rest due to the demands of work administration. The results showed that Poor sleep quality tended to be  $\geq 43$  years (65,71%). Respondents were more in the energy density category with high EDNP intake because they often consumed snacks high in fat and energy.

Visible fat, such as coconut oil, palm oil, coconut milk, and fried foods, was consumed more by 41 respondents (69,49%). Consumption of sweeteners, such as sugar, syrup, candy, and soft drinks, was more frequent in 74,57%. The consumption of salty snacks was in demand by 55,93% consumed salty snacks, such as cassava chips, potato chips, crackers, extrudates, and popcorn. Another study found that desserts were consumed less frequently by 54,23%, such as sponge cakes, ice cream, chocolate, and other types of cakes.

**Table 1.** Characteristics of the subjects, characteristics of the subjects by blood pressure, physical activity, sleep quality, food intake (energy density), and consumption of EDNP foods by type

Characteristics	Number of Resp. (%)	Mean ± SD
Age (year)	100	44,10 ± 5,956
Weight (kg)	100	68,76 ± 6,725
Height (cm)	100	160,18 ± 6,014
Nutrition status (kg/m <sup>2</sup> )	100	26,75 ± 1,28
Systolic's blood pressure (mmHg)	100	147,95 ± 22,09
Diastolic's blood pressure (mmHg)	100	83,51 ± 6,819
Blood Pressure		
Normal <sup>@</sup>	22	
Pre-hypertension <sup>@</sup>	10,2	
Hypertension 1 <sup>st</sup> degree <sup>@</sup>	33,9	
Hypertension 2 <sup>nd</sup> degree <sup>@</sup>	33,9	
Physical Activity		
Light <sup>*</sup>	59,32	
Medium <sup>*</sup>	40,68	
Sleep Quality		
Good <sup>*</sup>	40,68	
Bad <sup>*</sup>	59,32	
Total energy food intake (kcal)	100	2896,35±192,21
Energy Density		
Low <sup>*</sup>	45,76	
High <sup>*</sup>	54,24	
Visible Fat		
Often <sup>*</sup>	69,49	
Rarely <sup>#</sup>	30,5	
Sweeteners		
Often <sup>*</sup>	74,57	
Rarely <sup>#</sup>	25,42	
Dessert		
Often <sup>*</sup>	45,76	
Rarely <sup>#</sup>	54,23	
Salty Snack		
Often <sup>*</sup>	55,93	
Rarely <sup>#</sup>	44,06	

Obesity class I (25,0-29,9 kg/m<sup>2</sup>) and obesity class II (>30 kg/m<sup>2</sup>).

<sup>@</sup>Classification of systolic and diastolic blood pressure: Normal (<120 mmHg/<80 mmHg), Prehypertension (120-139 mmHg/80-90 mmHg), Hypertension Grade I (140-159 mmHg/90-99 mmHg), Hypertension Grade II (≥ 160 mmHg/≥ 100 mmHg). The total score of light physical activity <7,5 and moderate physical activity (>7,5). The total score of good sleep quality is ≤ 5 and bad is > 5. Energy density is categorized as high if it is 1,99 kcal/gram.

<sup>\*</sup>Often if ≥ 7 times/week; <sup>#</sup>Rarely < 7 times/week

**Table 2.** Average nutrients in EDNP foods by type

	VF#	S#	D#	SA#
Energy (kcal)	322,6	175,1	151,9	180,6
Protein (gr)	2,47	0,22	2,69	1,68
Fat (gr)	34,33	0,93	5,07	8,12
Sat. Fat (gr)	21,41	0,43	1,65	1,65
Carb (gr)	3,37	42,93	24,08	24,71
Fiber (gr)	0,25	0,02	0,52	0,94
Sodium (mg)	102,8	9,04	15,84	8,17

#VF (Visible Fat); S (Sweeteners); D (Dessert); SA (Salty Snack)

Fifty-nine obese female respondents had an average nutrient content of low micronutrient energy-dense food intake based on the type consisting of energy, protein, fat, saturated fat, carbohydrates, fiber, and sodium, as presented in Table 2. The largest average nutrient was energy (322,6 kcal), fat (34,33 grams), sodium (102,8 grams) in the type of visible fat, while protein (2,69 grams) in the type of dessert and carbohydrates (42,93%) in the type of sweeteners. The total contribution of

EDNP to food intake was 28,58% of the respondents' total food intake.

Table 3 shows the bivariate analysis of physical activity, sleep quality, and EDNP food intake. Based on the correlation test, physical activity had a significant relationship ( $p < 0,05$ ) with EDNP food intake, whereas sleep quality had no significant relationship ( $p > 0,05$ ) with EDNP food intake.

**Table 3.** Correlation between physical activity, sleep quality, and EDNP intake

Variable	Sleep Quality		Food Intake EDNP	
	r-value	p-value	r-value	p-value
Physical Activity	0,157	0,235	-0,278	0,033
Sleep Quality			0,001	0,993

Pearson correlation test; Significance ( $p < 0,05$ )

Table 4 shows that energy density, total energy, fat, and sodium had a significant relationship ( $p < 0,05$ ) with systolic blood

pressure in a moderate degree of correlation. The nutritional content of EDNP intake, including protein, carbohydrates, and fiber, had a significant relationship ( $p < 0,05$ ) with systolic and diastolic blood pressure. The results of the bivariate test analysis showed that physical activity and food intake of EDNP had a significant relationship ( $p < 0,05$ ) with systolic blood pressure.

Moreover, sleep quality and food intake of EDNP showed a significant relationship ( $p < 0,05$ ) with diastolic blood pressure. In addition, the results of the study indicate that light physical activity tends to increase systolic blood pressure in the range of 156-195 mmHg by 63,8%, while poor sleep quality increases diastolic blood pressure in the range of 80-92 mmHg by 68,75%. Multivariate analysis showed that physical activity, sleep quality, and food intake EDNP had a significant relationship ( $p < 0,05$ ) with systolic blood pressure, with a strong correlation degree, and diastolic blood pressure, with a moderate degree of correlation.

**Table 4.** Correlation of energy density, energy, and macro-micro nutrient of EDNP to blood pressure and relationship between physical activity, sleep quality, and intake of EDNP foods with blood pressure

	Blood Pressure			
	Systolic		Diastolic	
	r-value	p-value	r-value	p-value
Energy density (kcal/gr)	0,566	0,001 <sup>a*</sup>	0,170	0,197 <sup>a</sup>
Energy (kcal)	0,548	0,001 <sup>a*</sup>	0,225	0,087 <sup>a</sup>
Protein (gr)	0,622	0,001 <sup>a*</sup>	0,260	0,046 <sup>a*</sup>
Fat (gr)	0,583	0,001 <sup>b*</sup>	0,233	0,075 <sup>b</sup>
Sat. Fat (gr)	0,547	0,001 <sup>b*</sup>	0,186	0,158 <sup>b</sup>
Carbo (gr)	0,538	0,001 <sup>a*</sup>	0,302	0,002 <sup>a*</sup>
Fiber (gr)	0,581	0,001 <sup>a*</sup>	0,314	0,015 <sup>a*</sup>
Sodium (mg)	0,533	0,001 <sup>a*</sup>	0,121	0,359 <sup>a</sup>
Physical Activity	-0,278	0,039 <sup>a</sup>	0,172	0,191 <sup>a</sup>
Sleep Quality	-0,125	0,346 <sup>a</sup>	-0,269	0,039 <sup>a</sup>
Food Intake-EDNP	0,703	0,001 <sup>a</sup>	0,285	0,028 <sup>a</sup>
PA*, SQ#, FI-EDNP <sup>^</sup>	0,71	0,001 <sup>c</sup>	0,451	0,006 <sup>c</sup>

Pearson correlation test; <sup>b</sup>Rank Spearman correlation test; Significance ( $p < 0,05$  shown in bold), <sup>\*</sup>Physical activity; <sup>#</sup>Sleep quality; <sup>^</sup>Food intake-EDNP; multiple regression linear test; Significance ( $p < 0,05$  shown in bold)

The study was conducted with 59 obese female respondents aged 35-54 years in the elementary school teacher profession in the Kudus Regency area. Previous research conducted at the internal medicine polyclinic of RSUD by Dr. Achmad Mochtar Bukittinggi explained that age-35-55 years is significantly

related to the incidence of hypertension (Elvira & Anggraini, 2019). Increasing age was closely related to a higher risk of hypertension due to changes in body anatomy, where the arteries lose flexibility, thus causing the blood vessels to become stiff and narrow. A case-control study conducted in the Rembang Regency showed that

age had a 2,45 times risk for hypertension (Adhikara et al., 2020).

Obesity is a trigger for hypertension due to the disruption of blood flow caused by high fat in the blood (hyperlipidemia), resulting in blood vessel constriction (atherosclerosis). Buildup of atheromatous plaques derived from fat blocks This causes the heart to pump blood more forcefully to meet the body's needs for oxygen and other substances, which raises blood pressure (Amran et al., 2022). A study explained that in all countries, overweight and obesity, using both WHO and South Asian cut-offs, were associated with higher odds of hypertension. For each 5 kg/m<sup>2</sup> increase in BMI, the ORs for hypertension were 1,79 (Hossain et al., 2019).

The analysis showed that the proportion of the teaching profession had higher blood pressure than normal blood pressure. This is in line with research on teachers in Makassar City, which explains that the teaching profession has the potential to experience hypertension due to triggering factors, such as stress, less rest time, and light physical activity (Likawidjaya & Ernawati, 2019). This study found that respondents engaged in more light activity than moderate activities. Respondents with light activity were those who taught while sitting in front of the class. This result was supported by a cross-sectional study that explained that the elementary school teacher profession had lighter activities because they only spent working time sitting and explaining to students in front of class (Familita et al., 2019).

The results of this study indicated that teachers had poorer sleep quality. The results of this study are in line with previous studies, which explained that in the univariate analyses, poor sleep quality was associated with total teaching hours (odds ratio (OR) 1,06; 95% CI: 1,02–1,11) (Musa et al., 2018). Research in Brazil explains that female elementary school teachers are at a higher risk of poor sleep quality due to professional demands, household tasks, and workload. Extensive teachers work both inside and outside of the classroom (Carla et al. 2018; Leksono et al., 2022).

Consumption of energy-dense foods low in micronutrients, often referred to as energy-dense, nutrient-poor foods (EDNP), has a high content of fat, saturated fat, oil, and sodium, which triggers high blood pressure in obese respondents. Obese women tend to consume

visible fat EDNP foods, sweeteners, desserts, and salty snacks, especially in the teaching profession, because there are fewer breaks, so the selection of types of food is easy to find. Food EDNP are often referred to as foods and drinks that are high in fat, added sugars, sodium, and alcohol, and contain low levels of nutrients. In Australia, EDNP foods and drinks include processed meats, fast meals, deep-fried foods, cream, butter, jam, honey, sweetened condensed milk, and blended fat spreads (Biltoft-Jensen et al., 2022).

The intake of EDNP in four categories, visible fat, sweeteners, desserts, and salty snacks, was previously sufficient, but it is necessary to add food groups that trigger an increase in blood pressure, namely, processed foods. Excess UPF (ultra-processed food) can increase the risk of hypertension due to excessive salt, trans, saturated, and free sugar content, low fiber and micronutrient content, and energy density. Processed food groups such as group 3 high UPF (Ultra Processed Food) are processed foods such as canned vegetables, canned fish, candied fruit, and foods made by adding salt, sugar, oil, or other substances (Harris et al., 2021).

The results of the analysis in this study showed that respondents often consumed sweet foods/drinks (74,57%) compared to visible fat (69,49%), salty snacks (55,9%), and desserts (45,76%). These results align with research in the United States, which states that the consumption of sugary and fizzy drinks is 32% per day among adult women. Consumption of EDNP food by as much as 86% of adults cannot be separated from the types of cakes, salty snacks, and sweets (Cohen et al., 2020). The consumption of sugary drinks is directly associated with hypertension (Farhangi et al., 2020; Wuhl, 2018). Moreover, excessive consumption of sugary foods or drinks can stimulate the pancreas to produce more insulin, thereby contributing to fat accumulation. The fat becomes plaque and reduces the elasticity of blood vessels, increasing blood pressure (Frak et al., 2022). A cohort study in China showed that dietary preferences for soft or sugared drinks increase the risk of hypertension. Soft or sugared beverages are associated with elevated levels of insulin resistance, calorie intake, and serum triglyceride levels, all of which are highly correlated with hypertension (Wang et al., 2022).

This study also explained that the consumption of EDNP food sources was obtained by providing snacks at the school. Moreover, the habit of spending leftover food, especially for teacher respondents who still have children aged in elementary school because they tend not to finish their meals, get bored easily, and get full quickly. Energy-dense foods with low micronutrients are high in energy and fat content. The highest energy content in visible fat foods comes from nine calories per gram of fat, which makes them full easily. However, this is different from sweeteners and desserts, which have a higher simple carbohydrate content, which gives them a faster feeling of hunger, thus making respondents continue to consume food and increase their energy stores in the form of fat (70-80%) (Vickle et al., 2020). The consumption of large amounts of fat and sugar increases the risk of atherosclerosis, which can increase blood pressure. Fat in the form of plaque causes increased resistance in blood vessel walls and has an impact on increasing the heart rate and blood flow volume, thus increasing blood pressure (Cahyati et al., 2018).

The analysis results showed that salty snacks were often consumed (55,93%). A cross-sectional study mentioned the consumption of salty snacks or foods high in sodium as the main factor affecting a person's blood pressure (Putri, 2018). The intake of foods with a high content of excess sodium in the blood vessels can hold water, resulting in increased blood volume and triggering blood vessel pressure, thereby increasing the work of the heart. Excess sodium in the blood causes blood vessel erosion and artery diameter shrinkage (Cahyati et al., 2018).

Based on the intake of energy-dense foods that are low in micronutrients, the average food energy density of obese participants in the teaching profession was categorized as high. Research on adults in Saudi Arabia has shown that energy density can affect a person's blood pressure (Alzubaidi et al., 2020). This study showed that the average energy of 28,58% basal energy was derived from energy-dense foods low in micronutrients in obese female respondents. This proves that excess energy intake is stored in the form of fat and increases the risk of developing hypertension. Supporting research has shown that obesity has a 2,869 times higher risk of developing hypertension than individuals with normal nutritional status

(Akbar & Isfandiari, 2018). Similar studies have stated that obesity has a 2,23 times risk of hypertension than those who are not obese (Asyfh et al., 2020). The prevalence of hypertension increases by 87%, and high BMI levels are associated with obesity (Landi et al. 2018). The mechanism of hypertension with obesity is through the downstream effects of hypothalamic leptin signalling and the activation of specific melanocortin receptors located on sympathetic neurons in the spinal cord. The physiological consequences of sympathetic activation include activation of the renin-angiotensin system, sodium retention, circulation expansion, and increased blood pressure (Lu & Akanji 2020).

Respondents consumed energy-dense foods low in visible fat micronutrients as well as desserts, which are known to have high fat and saturated fat contents. This fact was also explained by research in America that the hidden fat content comes from sweet foods, such as dessert types. Foods high in carbohydrates contain two sources of energy, namely fat and carbohydrates, which can trigger blood pressure (Canale et al., 2021). Moreover, sodium consumption in obese respondents can increase blood pressure with high plasma renin and aldosterone activity and negligible sodium excretion in the urine. Besides, it has been proven that 1 g/day was able to increase by 0,4 mmHg in systolic blood pressure (Fuchs & Whelton, 2020). The consumption of fatty foods with more saturated fat and energy-dense processed foods can increase the risk of hypertension (Wangdi & Jamtsho, 2020).

There was a significant relationship between physical activity and EDNP intake. Research conducted in the UK on adult respondents with obesity explains that there is a strong relationship between physical activity and food intake, where high activity can reduce fat storage in adipose tissue (Moson & Cummins, 2018). Another study found that physical activity has no relationship with sleep quality. This information was not aligned with a cross-sectional study carried out in Manado, which discovered a 2,5 OR relationship between physical exercise and sleep quality (Baso et al., 2018). The gap in research findings is thought to be related to the limitations of the method of measuring physical activity, which only uses interviews with subjective questionnaires.



However, this method was used to test validity and reliability and divide physical activity into three groups: sports, work, and leisure. In addition, researchers minimized respondent bias by clearly explaining the steps for filling out the questionnaire to obtain more objective data.

This study showed a relationship between physical activity and systolic blood pressure but not diastolic blood pressure. The results showed that the proportion of light physical activity among respondents with elementary school teaching professions was greater; thus, performing physical activities such as jogging, running, gymnastics, or cycling on holidays is advisable. Research on obese adult respondents explained that increased physical activity could reduce systolic and diastolic blood pressure (Oyuntugs et al., 2020). The difference in research results was due to the minimal level of answer accuracy. Teacher respondents with an obese nutritional status tend to underestimate their food intake and vice versa (Dinah et al., 2017).

In contrast, sleep quality had a significant relationship with diastolic blood pressure but not with systolic blood pressure. The National Sleep Foundation explains that the recommended quality of sleep for adults is 7-9 hours of sleep at night and 1-2 hours during the day without the addition of the two sleep times. Both the number (hours slept) and quality (depth) of sleep contribute to adequate sleep quality (Seow et al. 2020).

In a cross-sectional survey using multiple logistic regression analysis, individuals who slept poorly had a 1,80-fold higher risk of hypertension than those who slept well (Wu et al., 2019). Research in Italy suggests that poor sleep quality affects the cardiovascular system (Del et al., 2021). A study conducted in America with adult female respondents explained that sleep quality is related to systolic and diastolic blood pressure, which is similar to the results of those at the Bahu Manado Health Center, Indonesia (Brooke et al., 2018). The differences in the results of this study are due to differences in the conditions of teacher respondents in Indonesia, and teachers abroad prioritize the science and technology advancement system and spend more time facilitating and accompanying students to perform outdoor learning (Robert, 2018).

Multivariate analysis showed that physical activity, sleep quality, and food intake were significantly associated with systolic and diastolic blood pressure. This is because these three variables are cardiovascular risk factors. This study supports the theory that physical activity and sleep quality are interrelated. Sufficient physical activity improves sleep quality. High physical activity positively affects sleep quality, whereas fatigue resulting from physical activity results in more sleep time to stabilize energy balance (Baso et al., 2018). Sleep quality is also closely related to the food intake factors of individuals with obesity. The relationship between short sleep duration in adults and the incidence of obesity can be explained by several mechanisms. The duration of sleep in small amounts results in greater energy intake. A cross-sectional study showed that obese subjects had significantly shorter sleep duration ( $5,5 \pm 1,6$  hours,  $p \leq 0,0001$ ). Sleep disorders and poor sleep quality cause several changes in the metabolism and endocrine system of the body.

Moreover, stress response hormones, such as ghrelin, cortisol, and leptin, are upregulated in sleep-deprived individuals. These hormones play a major role in maintaining the energy balance at the cellular level and influence food preferences, leading to increased food intake (Al-Rashed et al., 2021). The research limitation was that only high energy-dense, nutrient-poor food (EDNP) intake caused hypertension, but there are still many relation food groups such as three in class UPF (Ultra Processed Food).

## Conclusion

According to the findings of this study, physical activity and EDNP food intake had a significant relationship with systolic blood pressure in female teachers aged 35-54 years. EDNP have a significant relationship with diastolic blood pressure and sleep quality. EDNP had a significant relationship with systolic and diastolic blood pressure in a multivariate test of physical activity, sleep quality, and food intake.

Future research suggests adding food groups, such as three from group UPF (Ultra Processed Food) and types of food processed in Indonesian.

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