RELATIONSHIP BETWEEN BLOOD PRESSURE AND BLOOD GLUCOSE ON VASCULAR BLOOD FUNCTION AND AEROBIC WORKING CAPACITY IN FEMALE NURSE'S SHIFT WORK

(HUBUNGAN TEKANAN DARAH DAN GLUKOSA DARAH TERHADAP FUNGSI PEMBULUH DARAH DAN KAPASITAS KERJA AEROBIK PADA SHIFT PERAWAT WANITA)

Ike Rahmawaty Alie[1*], Yuke Andriane[1], Rizki Perdana[1], Doni Septiadi Rosady[1], Ieva B Akbar[1]

[1]Department Physiology, Faculty of Medicine, Universitas Islam Bandung, Indonesia

*Corresponding author
ikewaty21@gmail.com

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ABSTRACT

Shift work is a rotating work time outside regular working hours, either rotating with the shift work method. Shift work can cause changes in metabolism, immunological status, and oxidative status that cause inflammation due to changes in circadian rhythm. Nurses, primarily female, in provide 24-hour services also have to do shift work. This study aimed to see the relationship between blood pressure and blood glucose to vascular function and aerobic capacity in female nurses working in hospitals. The research method was descriptive-analytic to know the relationship between blood pressure and glucose to blood vessel function as measured by cGMP and aerobic capacity. Through VO_2max, the research sample was selected purposively with inclusion

criteria of having worked as female nurses who had worked for at least six months and were aged 20-40 years. The results show that the fasting blood glucose value had more influence on the cGMP value than the MABP value (r= 0.204 vs. 0.034), although the relationship was weak and very weak. The correlation analysis between fasting Blood Glucose and VO2max and Blood Pressure with VO_2max shows blood pressure is more significant than fasting Blood Glucose on VO_2max (0.105 vs. 0.083) even though the correlation between the two is very weak. It may be because many other factors can influence blood vascular function and aerobic functional capacity.

Keywords: blood pressure; cGMP; fasting blood glucose

ABSTRAK

Kerja Gilir adalah merupakan waktu kerja bergilir di luar jam kerja normal, baik berotasi dengan metode pembagian kerja gilir, kerja gilir ini dapat menyebabkan perubahan metabolism, status imunologis, status oksidatif yang nantinya menyebabkan inflamasi akibat perubahan ritme sirkadian. Perawat sebagian besar wanita dalam memberikan jasa pelayanan 24 jam juga harus melakukan kerja gilir tersebut. Tujuan Penelitian ini adalah melihat hubungan tekanan darah dan Glukosa Darah terhadap Fungsi pembuluh darah dan Kapasitas Aerobik pada perawat wanita yang bekerja di RS Metode penelitian adalah analitik deskriptik untuk melihat hubugan tekanan darah dan glukosa terhadap fungsi pembuluh darah yang diukur mellaui cGMP dan kapasitas aerobic yang diukur melalui VO_2max, Sampel penelitian dipilih melalui purposive dengan kriteria inklusi telah bekerja perawat wanita yang telah bekerja minimal 6 bulan dan berusia 20-40 tahun. Hasil Penelitian menunjukkan bahwa nilai GDP lebih mempunyai pengaruh terhadap nilai cGMP dibanding dengan nilai MABP (r= 0,104 vs 0,034) walaupun hubungannya sangat lemah sedangkan pada tabel analisis korelasi antara GDP dengan VO_2max dan Tekanan Darah

dengan VO_2max maka dapat dilihat bahwa pengaruh tekanan darah lebih besar dari GDP pada VO_2max (0,105 vs 0,083) walaupun korelasi keduanya sangat lemah. Hal ini disebabkan banyak faktor yang dapat memengaruhi fungsi pembuluh darah dan kapasitas aerobik.

***Kata kunci**: cGMP; gula darah puasa; tekanan darah*

INTRODUCTION

The definition of shift work is that hours are rotating work time outside regular working hours, either rotating by the rotational division of labor method or permanent for 24 hours. [1,2] Shift work is commonly associated with mismatches between endogenous circadian rhythm timing systems and behavioral cycles, including sleep cycles, wake cycles, and feeding cycles.[3]

The SCN regulates leptin, plasma glucose, glucose tolerance, corticosteroids, and cardiovascular function circadian rhythms through neural and, or humoral signals to tissues.[4] Lack of sleep increases ghrelin levels and decreases leptin levels which can increase appetite.[5] Sleep disorders are associated with shift work and can cause circadian rhythm mismatches. It has been identified as the leading cause of metabolic dysregulation and cardiovascular effects, detrimental to shift workers.[6] Increased body weight and fat in the abdominal area were found in workers with night shift rotation, namely nurses and midwives.[6,7,8]

Changes in circadian rhythm are caused by this shift work cause hormonal and metabolic changes that increase blood pressure and blood sugar so that later it affects the function of blood vessels and results in a person's work capacity. Studies showed that when subjects ate and slept for about 12 hours outside of their usual phase, they exhibited decreased leptin, increased glucose, increased insulin, reversed daily cortisol rhythms, increased mean arterial pressure, and reduced sleep efficiency. This study demonstrates the detrimental cardiometabolic implications of circadian rhythm disturbances.[9]

These changes can affect the blood vessels as the first line to receive metabolic changes. It involves the blood vessels and affects their function. Vascular function Assessment can be represented by examining Cyclic Guanosine Monophosphate (cGMP) as a marker of endothelial dysfunction. It is associated

with its function as a second messenger stimulated by Nitric Oxide, which activates protein kinase G.[10] cGMP affects several vascular cell types and regulates vasomotor tone, endothelial permeability, and growth. Cell and differentiation, as well as platelet and blood cell interactions. Aberrant cGMP production and signaling impairment accompany many vascular disorders such as hypertension, atherosclerosis, coronary artery disease, and complications of diabetes.[11,12]

Inappropriate workloads create various risks of injury, so proper work capacity measurements at night are needed due to changes in the environment and the workers themselves. In night workers, there is a change in work capacity due to changes in the circadian rhythm. The tool to measure that has been used to measure work capacity is by measuring the maximum oxygen consumption of the worker.[13] The purpose of this study was the relationship of blood pressure and blood glucose to blood vessel function and aerobic capacity in female nurses who work in hospitals.

METHOD

This study used a cross-sectional study with purposive sampling of nurses who worked in hospitals. Inclusion criteria were female nurses aged 20-40 years with a length of stay in hospital more than six months and who had no previous cardiovascular disease and diabetes.

The research population of this study was nurses in the inpatient ward and polyclinic of Al-Ihsan Bandung, West Java, Indonesia. Two groups of eleven nurses consisted of six shift and five non-shift nurses with twenty-eight blood samples were analyzed. The Research Ethics Committee approved the ethical clearance for the University of Indonesia (No. 19121964).

The subjects' blood pressure examination was asked to sit comfortably in a room with adequate lighting. The researcher/examiner then guided the issue to conduct the test procedure, starting with the blood pressure calculation and using a stethoscope. Later, the subject's blood pressure results were read and recorded. The examination was repeated twice if the examiner was still unsure of the results and asked the subject to repeat the procedure.

Examination of cGMP used ELISA examination technique with kitt from R & D System USA. The study standard range was 75–219 pmol/mL with a minimum detection of 0.56–3.06 (mean; 1.14 pmol/mL). HRP) on rabbit polyclonal antibodies. The polyclonal antibody became bound to the goat anti-rabbit antibody coated onto the microplate during incubation. After washing to remove excess

conjugate and unbound samples, a substrate solution was added to the wells to determine the activity of the bound enzyme. Color development was stopped, and absorbance was read at 450 nm. The intensity of the color was inversely proportional to the concentration of cGMP in the sample.

The blood sampling method was taken from venous blood. Blood sampling was carried out by trained personnel from the laboratory using safety and security standards for research subjects. Measurement of VO_2 max measured the pulse at rest in the following way: Respondents were asked to rest for 20 minutes. Their pulse was calculated using a device attached to the chest, counted for one full minute, repeated three times, and then averaged. Then it is entered into Measuring the maximum pulse rate, namely: 220-age is entered into the formula VO2max = 15 x (HR max/HR rest).

RESULT

From the inclusion criteria and sample calculations, 40 research subjects were obtained: female nurses who work shifts at Al Ihsan Hospital, West Java, and Muhammadiyah Hospital, Bandung, with the following characteristics.

Table 1. Characteristics of research subjects

Characteristics	Total (n=40)	%
Age (Year)		
20-25	4	10
26-30	17	42.5
>31	19	47.5
Work duration		
<5 year	9	22.5
6-10 year	20	50
11-15 year	11	27.5
Unit		
ER	5	12.5
Inpatient	32	80
ICU	3	7.5
Blood pressure (mmHg)		
Sistolik		
Normal	39	97.5
Above normal	1	2.5
Diastolik		
Normal	39	97.5
Above normal	1	2.5
IMT (kg/m2)		
Under	3	7.5
Normal	17	42.5
Over	20	50
Fasting blood glucose (g/dL)	38	95
Normal	2	5
Above normal		

From the data on the characteristics of the research respondents, it was found that there were 19 nurses working shifts or 47.5% aged over 35 years, 17 people aged 26-30 years, and four people aged 20-25 years. Most nurses or as many as 20 people have worked for six to ten years, nine people worked under five years, and over ten years as many as 11 people. A total of 32 nurses work in the inpatient room, only five people work in the ER, and three people work in the ICU.

From the blood pressure examination results, almost all nurses or as many as 39 people had normal systolic blood pressure. Only one person had systolic blood pressure above normal as much as one person. Similarly, only one person had a diastolic pressure above normal diastolic blood pressure, while 39 people had a normal diastolic pressure. On examination of body mass index, as many as 17 people have a normal BMI; three people are below average while the BMI is more than 20 people.

In blood tests for fasting blood sugar on nurses who work shifts, most or as many as 38 people have normal fasting blood sugar levels, and only two people are abnormal/above 100 mg/dL.

The following table compares the average systolic and diastolic blood pressure, average fasting blood glucose, cGMP, and aerobic functional capacity through Vo2max measurements on female nurses who work shifts at Al Ihsan Hospital, West Java, Indonesia.

Table 2 Average systolic and diastolic blood pressure, average fasting blood glucose, cGMP, and aerobic functional capacity in nurses working shifts at Al Ihsan Hospital, West Java, Indonesia.

Data	Mean	SD/Min-Max
Blood pressure (mmHg)		
Sistolik	110.37	8.43 (90-130)
Diastolik	73.75	6.07 (60-85)
MABP	85.71	6.33 (70-96.7)
Fasting Blood Glucose (g/dL)	83.15	10.97(54-102)
cGMP (pmol/mL)	14.28	15.77 (1.4-67.7)
Aerobic Capacity (mg/kg/menit)	35.15	3.18 (28.45-44.77)

Table 2 that the mean systolic, diastolic, and MABP blood pressure, the mean systolic blood pressure is 110.37 ± 8.43, the highest value is 130 mmHg, and the lowest value is 90 mmHg, the average diastolic blood pressure is 73.75 ± 6.07 with a minimum at 60 mmHg and maximum value at 85 mmHg. In contrast, the MABP calculation obtained an average of 85.71 ± 6.33 with a minimum of 70 and a maximum of 96.7. All mean values of systolic, diastolic, and MABP blood pressure were within normal limits.

Fasting blood glucose values obtained a normal mean of 83.15 ± 10.97 g/dL with a minimum value of 54 g/dL and a maximum of 102 g/dL. The average value of cGMP was 14.28 ± 15.77 pmol/mL, with the highest value at 67.7 pmol/mL and the lowest value at 1.4 pmol/mL. At the same time, the aerobic capacity obtained an average of 35.15 ± 3.18 ml/kg/minute with a maximum value of 44.77 ml/kg/minute and a minimum value of 28.45 ml/kg/minute.

Table 3 shows the relationship between fasting blood glucose and blood pressure on blood vessel function using cGMP measurements.

Table 3 Relationship between fasting blood glucose and blood pressure on blood vessel function in nurses working in shifts

Data	cGMP means (pmol/mL)	p
Fasting Blood Sugar (g/dL)	15,06 (3,7-47.82)	
<70	14.48(1.4-67.7)	
70-100	8.8 (0)	**0.897**
>100		
Blood pressure (MABP= mmHg)	15.36 (2.9-47.8)	
<80	13.68 (1.63-67.7)	**0.975**
80-90	14.57 (1.4-55.9)	
91-100		

Significant if p < 0.05

In Table 3, the analysis results on fasting blood sugar examination with cGMP showed a non-significant difference of p = 0.897 in the three groups used the difference in the average cGMP assessed through the Kruskal-Wallis test (the data distribution was not normal). The data shows that a decrease in cGMP levels accompanies an increase in blood sugar.

In statistical calculations using Kruskal-Wallis to see blood pressure with an average cGMP, there were non-significant results for the three groups, p=0.975. And when viewed, MABP in the range of 80-90 mmHg is the lowest level of cGMP compared to the two groups. Table 4 shows the relationship between fasting blood glucose and blood pressure on aerobic capacity using VO_2 max measurement.

Table 4 The Relationship between fasting blood glucose and blood pressure on aerobic capacity in nurses working shifts

Data	Aerobic Capacity ml/kg/ minute	p
Fasting Blood Sugar (g/dL)	34.42±2.31	**0.715**
<70	34.48 ±2.65	
70-100	34. 63± 1.5	
>100		
Blood Pressure (MABP)/ mmHg		
<80	33.37±2.65	
80-90	35.44± 2.53	**0.158**
90-100	33.77± 1.25	

Significant if p < 0.05

In Table 4, the results of the analysis of fasting blood sugar examination with VO_2max show a non-significant difference of p = 0.715 in the three groups showing the difference in the average cGMP (the one-way ANOVA test with normal data distribution). From the data, there was an increase in fasting blood sugar and aerobic capacity. (34.42 vs 34.48 vs 34.63).

In the same statistical calculation to see blood pressure with the average cGMP, there were non-significant results for the three groups, p=0.158. The result of the MABP blood pressure data 80-90 mmHg was the optimal blood pressure with the highest VO_2max value. The correlative analysis was carried out between GDP and cGMP and Blood Pressure (MABP) and cGMP using Spearman analysis (because the data distribution is not normal). The following table is obtained:

Table 5. Results of correlation analysis of GDP with cGMP and blood pressure (MABP with cGMP)

Data	cGMP value (pmol/mL)
GDP value(g/dL)	r = 0.283
	p = 0.522
	n = 40
MABP value (mmHg)	r = -0.034
	p = 0.834
	n = 40

Significant if p < 0.05

The correlative analysis was carried out between GDP and VO_2 max and Blood Pressure (MABP) with VO_2 max using Pearson analysis. The following table is obtained:

Table 6. The results of correlation analysis of GDP with VO_2 max and blood pressure (MABP with VO_2max

Data	VO_2 max value (ml/kg/menit)
GDP value (g/dL)	**r = 0.083**
	p = 0.610
	n = 40
MABP value (mmHg)	r = 0.105
	p = 0.518
	n = 40

The table above shows that the GDP value has more influence on the cGMP value than the MABP value (r = 0.283 vs 0.034) although the relationship is weak and very weak. The table of correlation analysis between GDP and VO_2 max and blood pressure with VO_2 max shows that blood pressure was more significant than GDP on VO_2max (0.105 vs. 0.083), although the correlation between the two was very weak.

DISCUSSION

From the characteristics of the research respondents, it was found that 19 female nurses worked shifts aged between 31-35 years, 17 people aged 26-30 years, and only four people aged 20-25 years. Twenty nurses have worked for six to ten years, nine people worked for under five years, and for over 11 years as many as eight people. A total of 32 nurses work in the inpatient room, only five people work in the ER, and three people work in the ICU.

The data show that age and length of work do not affect the placement of nurses. It was found that in the ICU and ER the average nurse's age was over 30 years. It was also found that the average length of work was more than five years (data in the appendix).

In Badri's study[14], there was a significant relationship between workload and work environment with nurses' work stress ($p<0.05$), especially in ICU and ER workers. The ICU and ER have heavier workloads than other units. According to Ansari's [15] on dental nurses, the characteristics of age above 34 years and working period of more than ten years had the most work stress. In other words, age and length of work are expected to be considered when nurses are placed in hospitals.

From the blood pressure examination results, 39 nurses had normal systolic blood pressure and only one person had systolic blood pressure above normal as much as a person. On diastolic blood pressure examination, 39 nurses were normal below 80 mmHg, and only one nurse had diastolic blood pressure above normal. On examination of the body mass index, as many as 18 nurses have a normal BMI. Two people are below normal, while the BMI is more than 20 nurses. From the data analysis, it was found that respondents who had systolic blood pressure above normal, had a BMI above 25, and those who had a BMI above 25 kg/m2, had a MABP above 80 mmHg many as 16 people. Research states that BMI has a relationship with blood pressure, namely the Dua[16] study in female adults with $p = 0.03$. Landi[17]'s study also stated that BMI had a strong relationship with hypertension, while Tesfaye[18] stated that the average BP level increased with increasing BMI.

In blood tests for fasting blood sugar, most or as many as 38 nurses had normal fasting blood sugar levels. Only two nurses abnormally above 100 mg/dL and two who had fasting blood sugar above normal had normal BMI and blood pressure. Mentioned in Yin[19]'s study examined factors that influence fasting blood glucose and genetics, lifestyle, and environmental factors, including daily food intake.

The mean systolic, diastolic, and MABP blood pressure, the mean systolic blood pressure was 110.37 ± 8.43, the highest value was 130 mmHg, and the lowest value was 90 mmHg, the average diastolic blood pressure was In 73.75 ± 6.07 with the minimum value at 60 mmHg and the maximum value at 85 mmHg. At the same time, the MABP calculation obtained an average of 85.71 ± 6.33 with a minimum value of 70 and a maximum value of 96.7.

All mean values of systolic, diastolic, and MABP blood pressure were within normal limits. It shows that nurses at Al Ihsan Hospital have normal blood pressure, possibly because they are still under 35 years old and have a BMI of 50% below 25 kg/m2.

Based on BMI calculation, it was found that 20 people, or 50% of the sample had a BMI above 25 kg/m2. Choi and Lorenzo[20,21] stated that the prevalence of obesity was higher in shift workers than non-shift workers, while body fat distribution did not differ between the two groups. Shift workers had a higher BMI than day workers, and shift work was associated with BMI, regardless of age and duration of work. As mentioned by Peplonska[22] Cumulative night shift work shows a significant relationship with BMI increasing by 0.477 kg/m2 per 1000-night shifts and by 0.432 kg/m2 per 10.000- night shift hours. Current and cumulative night work was associated with obesity (BMI≥30kg/m2), with OR=3.9 (95%CI:1.5-9.9), in women reporting eight or more-night shifts per month. This increase in BMI is related to changes in eating patterns at night

The fasting blood glucose values obtained a normal mean of 83.15 ± 10.97 g/dL with a minimum value of 54 g/dL and a maximum value of 102 g/dL. Based on the blood glucose examination, it was found that the results of fasting blood glucose were normal in nurses. It was in the condition that there were no factors that could increase blood glucose, such as too much food, such as food or snacks with more carbohydrates than usual, inactivity, or not enough insulin. Oral diabetes medication, side effects from other drugs, such as steroids or antipsychotic drugs, illness, stress, short-term or long-term pain, menstruation, and dehydration[23] Roestamadji research[24] stated a significant difference in fasting blood sugar between shift workers and non-workers. It was due to shifting work changes in circadian rhythms associated with tissue metabolism and hormone secretion.

The average value of cGMP was 14.26 ± 16.6 pmol/mL, with the highest value at 67.7 pmol/mL and the lowest value at 1.64 pmol/mL. The cGMP values indicate the function of the blood vessels, which means an increase in Nitric oxide in the blood, which indicates that the blood vessels are functioning correctly due to the above functions of NO when its production is impaired or its bioavailability is reduced, the following can occur: vasoconstriction (e.g., coronary vasospasm, increased systemic vascular resistance, hypertension), thrombosis due to platelet aggregation and adhesion to the vascular endothelium, inflammation due to upregulation of leukocyte

molecules and endothelial adhesion, hypertrophy, and stenosis of blood vessels. Things that can reduce NO levels clinically include hypertension, obesity, dyslipidemia (especially hypercholesterolemia and hypertriglyceridemia), diabetes (both type I and II), heart failure, atherosclerosis, aging, and smoking.[25]

Aerobic capacity or VO_2max was obtained at an average of 34.48 ± 2.5 ml/kg/minute with a maximum value of 40 ml/kg/minute and a minimum of 28.45 ml/kg/minute. Aerobic capacity shows a person's fitness. The VO2max measurement results on female nurses who work in shifts indicate that the VO2max value is still in the average category even though six people are in the excellent fitness category on age.[26] Rahmawaty's study [27] also showed a significant change in construction shift workers who worked shifts at night on BMI and blood pressure p.0.01, but there was no significant change in the working VO_2max.

In Table 4, the analysis results using Kruskal-Wallis showed that fasting blood sugar with cGMP showed a non-significant difference p=0.283 in the three groups of nurses, and between blood pressure and the average cGMP were also non-significant results for the three groups, p=-0.034. When assessed by correlation, it was found that the GDP value had more influence on the cGMP value than the MABP value on cGMP (r= 0.283 vs. 0.034), although the relationship was weak and very weak. According to Klabunde25, factors that affect NO expenditure include blood pressure, obesity, dyslipidemia, diabetes, heart failure, atherosclerosis, age, and smoking.

From the calculations, it was found that there was a negative correlation between the average cGMP and the average MABP. It follows the theory that a decreased cGMP will cause vasoconstriction in blood vessels so that MABP will increase in reverse.

In Table 5 the one-way ANOVA on fasting blood sugar examination with VO_2max showed a non-significant difference of p = 0.936 in the three groups. In comparison, for blood pressure with an average cGMP, there were also no significant results for the three groups p = 0.104. From the correlation between GDP with VO2max and Blood Pressure with VO2max, it can be seen that the effect of blood pressure is more significant than GDP on VO2max (0.114 vs 0.036) although the correlation between the two was very weak. It is known that the factors that can affect VO2 max are mainly gender, age, genetics, and height.[28,29,30]

CONCLUSION

The GDP value has more influence on the cGMP value than the MABP value,

although the relationship is weak. From the correlation table analysis between GDP and VO2max and Blood Pressure, it can be seen that blood pressure is more significant than GDP on VO2max (the correlation between the two is very weak).

CONFLICT OF INTEREST

The authors reported no potential conflict of interest

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