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Research Article

Relationship Blood Pressure and Exercise with Vitamin D Levels in Employees

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Abstract

In Indonesia prevalence of vitamin D deficiency is 63%, so although Indonesia is a tropical country on the equator, it doesn't guarantee vitamin D levels. Vitamin D deficiency can cause bone deformity and the risk of various chronic diseases such as diabetes, autoimmune diseases, arthritis, cancer, obesity, the distraction of lipid profile, metabolic syndrome, hypertension, and cardiovascular diseases can be increased. Increases blood pressure in globally remains the leading cause of death. In Indonesia, hypertension prevalence reached 47.8% with 70% of them suffering from undiagnosed hypertension. About 50-90% of vitamin D is mainly synthesized in the skin after exposure to UVB whereas only a minor part is derived from dietary sources. Exercise in the morning can help synthesize vitamin D. Because of that, the aim of this study is to research the relationship between blood pressure and exercise with vitamin D levels. The study was conducted on 63 employees with range aged 19-60 years in February 2021 at USAKTI Faculty of Medicine, East Jakarta. The research design used in this study was an observational analytic with cross-sectional approach and analyzed by chi-square test. This research presents a significant relationship between blood pressure with vitamin D levels ($p=0.044$), meanwhile exercise doesn't have any significant relationship with vitamin D levels ($p=0.565$). This study shows vitamin D can impact blood pressure, while vitamin D source not only from sun exposure but can be taken from food or supplements.

Keywords: blood pressure, exercise, vitamin D levels

INTRODUCTION

Over 1 billion world population are suffering from vitamin D deficiency with 50% of the population suffering from vitamin D insufficiency. ¹ Based on data from WUS, the prevalence of vitamin D deficiency in various countries in Europe, America, and Asia including Malaysia, Singapura, Thailand, Vietnam, India, Japan, and Hongkong are varies from 42% to 90%.² Data in Indonesia showed that vitamin D deficiency is around 63%, so it can be said that although Indonesia is a tropical islands in equator line, but it can't guarantee the status of vitamin D levels.^{2,3}

Human can make vitamin D3 naturally in response to sun exposure, especially UVB radiation so it can become endocrine hormone precursors. Along with parathyroid hormone, vitamin D has a role in calcium-phosphate homeostasis and cofactor for enzyme-like lipase and ATPase.⁴ Vitamin D plays an important role in the absorption of calcium, magnesium, phosphate, and bone metabolism and helps to maintain neuromuscular function.^{5,6} Although bone, small intestine and kidneys are the main organs that a response to vitamin D, but there are still many vitamin D effects in the body through vitamin D receptor (VDR). VDR is a steroid hormone receptor that can bind 1,25(OH)D with high affinity and mediates the regulation of gene transcription. Some of VDRs are located in

the heart, smooth muscle blood vessels, endothelial, abdomen, brain, skin, gonad, and various cells of the immune system.⁽⁵⁾ Recently, some studies showed that VDR plays a role in the renin-angiotensin-aldosterone system (RAAS), so it can affect blood pressure regulation. Vitamin D deficiency can be caused bone abnormalities and increased the risk of various chronic diseases, such as diabetes mellitus, cardiovascular diseases due to hypertension, obesity, lipid profile disorder, cancer, autoimmune disease and metabolic syndrome.^{2,5,7}

Globally, increased blood pressure still remains the leading cause of death. In 2014, around 1.39 billion people suffered hypertension and 10.4 million deaths per year due to hypertension. ⁸ In Indonesia, the prevalence of hypertension reaches 47.8% with 70% of them suffering from undiagnosed hypertension. Even now, it seems that many young people are suffering from hypertension, although most of them are still suffered by elderly. ⁹ Institute for Health Metrics and Evaluation (IHME) (2017) said that 23.7% of the 1.7 million deaths in 2016 were caused by hypertension and based on Riskesdas data (2018), it showed that the hypertension prevalence rate in the population over 18 years old is 34.11%.¹⁰

Regular exercise in the morning can increase vitamin D levels. Around 50% to 90% of vitamin D is obtained through

absorption by skin that is exposed to sunlight and only 10% is obtained from foods. Direct sunlight exposure to the skin with an exposed area of about 40% in 20 minutes can prevent vitamin D deficiency. Morning exercise around 07.00 am to 10 am can help the vitamin D forming. Vitamin D is produced from 7-dehydrocholesterol which it found in the skin or from food sources such as fish, milk, butter, egg yolks, meat, etc. Through the help of UVB from sunlight with 290-320nm wavelength will convert provitamin D3 into active vitamin D. Vitamin D deficiency can be caused by various factors, such as increasing 25(OH)D degradation, low intake food or supplements containing vitamin D, malabsorption, celiac disease, gaster area operation, and less exposure to sunlight.^{1,8,11,12,13}

The research conducted by Yosephin et.al. to fertile women found that sunlight exposure and doing regular exercise in the morning for 30 minutes three times a week for 12 weeks can help lowers blood pressure and improve vitamin D levels.¹¹ Study conducted by Hermawan et.al., showed that vitamin D intake had the effect to lowering blood pressure in the elderly who suffer from hypertension.¹⁴ Shu and Huang's research showed that vitamin D intake caused decreased blood pressure in Asia.¹⁵ As well as research conducted by Farapti et.al, showed decreased blood pressure in the elderly after taking vitamin D supplementation.¹⁵ But, Forman et.al., the study showed that there is no relationship between vitamin D intake from foods or supplements with hypertension, and Bahrami et.al., also said that only decreased diastolic pressure in adult patients with coronary artery disease.¹⁵

Various clinical trial results showed that vitamin D has inconsistent effects on blood pressure with various health conditions across all ages. Based on that, the researchers intend to examine the relationship between blood pressure and exercise habits with vitamin D in employees.

MATERIAL AND METHODS

This research was analytic observational study with crosssectional design. The aim was to find the relationship between blood pressure and exercise with vitamin D levels in employees, which was held on February 2021. The research subjects were calculated using an infinite-finite population

formula with the prevalence in Indonesia was 63% with the accuracy level was 0.05. Based on this calculation, we got 63 subjects. The subjects were collected by consecutive nonrandom sampling method. The inclusion criteria were men and women aged 19-60 years old, willing to participate and signed informed consent. Exclusion criteria were consuming alcohol, hypertension drugs or antioxidants, having a history of malignancy, smoking, liver or kidney dysfunction, history of hospitalization in the last 1 month.

Data was collected by filling out a questionnaire, which before filling out, the subjects were given an explanation beforehand. The questionnaire contains information that includes identity (name, age, gender, ethnicity, and regular exercise habits). Exercise habits are asked to do at least walking in the morning for at least 30 minutes, 3 times a week.¹⁷ The subject's blood pressure was measured using a digital sphygmomanometer which was already calibrated. Measurements were taken in a calm situation, sitting position, and the measurements were taken three times and then the average was taken. The results are declared hypertension if the systolic blood pressure is ≥ 140 mmHg and /or diastolic blood pressure is ≥ 90 mmHg.⁸

Two milliliters of blood samples were collected in a plain vial, aseptically for vitamin D levels examination using the ELISA method. The levels of vitamin D 30-100 ng/ml were indicated sufficient/normal, whereas below that there was a deficiency.¹² This research obtained ethical clearance from the Research Ethics Commission of the Faculty of Medicine, Trisakti University under no. 170/KER/FK/XII/2020.

RESULTS

The univariate analysis was used to determine the distribution of subject's characteristics in the form of gender, age, ethnicity, morning routine exercise habits for at least 30 minutes, blood pressure, and vitamin D levels. Data table 1 shows that of 63 subjects, 26 (41.3%) subjects were male, and thirty-seven subjects (58.7%) were female. The mean patients were aged 42.14 ± 8.78 years. The majority 39 (61.91%) didn't do the morning routine exercise. On blood pressure examination, it was found that 16 (25.40%) had hypertension. The mean vitamin D levels were 16.5 ± 6.68 with 53 (84.13%) below the normal value.

Table 1: Distribution of features characteristics of the subjects (n=63)

Characteristic	n (%)	Mean \pm SD
Sex		
Male	26 (41.3 %)	
Female	37 (58.7 %)	
Age (years)		42.14 \pm 8.78
Morning routine exercise		
< 3 x/week	39 (61.91 %)	
\geq 3 x/week	24 (38.09 %)	
Blood pressure		
< 140/90 mmHg	47 (74.60 %)	
\geq 140/90 mmHg	16 (25.40 %)	
Vitamin D 25-OH levels		16.5 \pm 6.68
\geq 30ng/dl	11 (17.46 %)	
< 30ng/dl	52 (82.54 %)	

Statistical analysis used chi-square test to determine the relationship between blood pressure and exercise with vitamin D levels. Based on table 2, there was a positive significant relationship between blood pressure with vitamin

D levels ($p = 0.044$). Meanwhile, the relationship between morning routine exercise with vitamin D levels wasn't found in this study ($p = 0.565$).

Table 2: Relationship between blood pressure, exercise and vitamin D level

Characteristic	Vitamin D Levels		p value
	>30 ng/dl	≤30 ng/dl	
	n	n	
Blood pressure			
≥140/90mmHg	10 (21.3%)	37 (78.7%)	0.044 [€]
<140/90mmHg	1 (6.3%)	15 (93.7%)	
Morning routine exercise			
≥3x/mgg	3 (3.8%)	21 (20.2%)	0.565 [€]
<3x/mgg	7 (6.2%)	32 (32.8%)	

€ = chi-square test; $p < 0.05$

DISCUSSION

This study shows that vitamin D has been able to reduce blood pressure. Vitamin D can reduce blood pressure through various mechanisms, these include inhibiting the expression of the renin gene, maintaining parathyroid hormone levels and calcium homeostasis, dilation of blood vessels, and decreased sympathetic nerve activity.¹⁵ Vitamin D can reduce blood pressure through vascular resistance and RAAS. Increased vitamin D levels can lead to a decrease vascular resistance in overall when the skin goes through extensive vasodilatation, resulting in an increase in nitric oxide in the skin's blood vessels.^{11,12,15} The effect of vitamin D through RAAS is by suppressing renin activity. Vitamin D receptor (VDR) is found in various body tissues, which can modulate various genes, such as inhibiting renin synthesis. Vitamin D can inhibit the expression of COX-2 in the macula densa cells in the kidneys, which this enzyme plays a very important role in the process of converting arachidonic acid into prostaglandins. In the absence of prostaglandins in macula cells that will be produced, will cause the absence of prostaglandins that should be captured by prostaglandin receptors in the juxtaglomerular cells, so the impact was renin can't be produced, ultimately the RAAS can't be activated and can't increase blood pressure. However, if a person is deficient in VDR or hyper-reninemia can be caused increased blood pressure.^{11,12,14,18,19}

One of the vitamin D functions is to maintain blood calcium homeostasis, so when there is a deficiency of vitamin D, it will cause changes in blood calcium levels, which will increase parathyroid hormone. Increased levels of the parathyroid hormone will cause RAAS disorders, atherosclerosis, and increased heart contractility which can increase the risk of cardiovascular disease.^{14,15,19} There is an effect in blood vessels by the high levels of the parathyroid hormone through angiotensin II release which can cause vasoconstriction, so that the peripheral resistance will increase. Also, increased parathyroid hormone levels can cause an increase of endothelin-1 levels and IL-6, so the endothelium becomes inflamed, and atherosclerosis occurs through vascular endothelial growth factor (VEGF).^{20,21} Besides that, it had a sclerotic effect to smooth muscle cells.²²

Other effects of vitamin D can regulate GuanylylCylase (GC)A in vascular smooth muscle cells, stimulated production of

cGMP so which can cause vasodilatation which it can lower blood pressure.^{23,24} Vitamin D can also suppress T-effector cell activity so it can decrease the activity of the sympathetic system which can lower blood pressure.²⁴

Vitamin D has an effect on various organs in the body. Other than the small intestine, kidneys, and parathyroid glands, it also has effects on certain tissues and organs such as cardiovascular, skeletal muscle, the immune system which has a response to vitamin D, blood vessels' smooth muscle, endothelial and immune cells, including CD-4⁺T cells through VDR. VDR can tightly bind to vitamin D3 becomes active and interacts with retinoid X receptor (RXR) which will regulate gene transcription so that it can regulate calcium homeostasis, blood pressure, and cardiovascular and skeletal muscle function.²⁴

Research by Pike and Meyer concluded that VDR had an active mechanism on target genes through the activation of VDR which is activated by $1,25(\text{OH})_2\text{D}_3$ so which can modulate gene expression (transcription) at a single gene locus and at the tissue level.⁵ Chen et.al, stated that there is a gene that is responsible for causing hypertension induced by vitamin D deficiency. Each gene with a genomic position bind to an active VDR or is indirectly regulated by vitamin D3 or VDR signals that lead to an increase or decrease in transcription involved in the regulation of blood pressure and can be affected by vitamin D deficiency causing hypertension.²⁴

A study conducted by Hermawan, et al. who gave vitamin D preparations to the elderly with hypertension showed decreased blood pressure in the elderly.¹⁴ Another study by Qi et.al., said that vitamin D deficiency was associated with the risk of hypertension. A study in Asia by Shu and Huang showed blood pressure in the peripheral decreased after vitamin D supplementation.¹⁵

There is no relationship between morning routine exercise with vitamin D levels ($p=0.565$). Although Indonesia is a tropical island where it is easily exposed to sunlight so humans can make vitamin D3 naturally by changing 7-dehydrocholesterol which can be found in the skin, it turns out that it doesn't always guarantee a person's vitamin D levels.⁷ Lack of outdoor activities or longer periods of working indoors and the social lifestyle of Asian people who avoid being exposed to the sun such as the use of clothing materials that

are difficult to absorb sunlight or wearing closed clothes, using body protection, such as hats, umbrellas, sunscreens cause lack of exposure to the sunlight so it causes a lack of natural vitamin D formation. Although food sources such as fish, butter, egg yolks, meat, margarine, yogurt, cod liver oil, etc can become vitamin D, apparently it isn't enough for a person.^{2,7,11,12,25,26,27} Besides that, skin tone can impact the absorption of sunlight, which dark skin color makes a person take a longer time to form vitamin D.¹² Same results were obtained by several studies which said that employees who work more in the room are at risk of developing vitamin D deficiency due to lack of sun exposure and lack of opportunities to do morning exercise. Besides that, the subject's majority are females (58.7%) and most of them are Muslim using a hijab as protection and wear a closed dress which can cause a lack of sun exposure.

CONCLUSIONS

Blood pressure and vitamin D levels were found positive significant relationship, which indicated that higher vitamin D levels can help to reduce high blood pressure. Meanwhile, there wasn't found the relationship between morning routine exercise with vitamin D levels.

CONFLICT OF INTEREST

The authors do not have any conflict of interest to declare.

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