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The impact of walking as a physical activity on vitamin D levels and sleep quality

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ABSTRACT

Vitamin D is a fat-soluble compound with antioxidant properties that are important for maintaining the body's mineral balance. Vitamin D can be obtained from exogenous sources (food) or endogenously synthesised by the skin through exposure to the sun's ultraviolet rays. Although it is a vitamin, it is also considered a hormone because it is activated by chemical reactions in the body. The aim of this study was to analyse the effect of walking on vitamin D levels and sleep quality. The research used a quasi-experimental method with a randomised pre- and post-test-controlled group design. In this study, two groups were randomised, the intervention group and the control group. Both groups were pre-tested and then post-tested to find out the difference in average vitamin D levels and sleep quality. Gender, age, BMI, systolic and diastolic blood pressure were not found to be confounding variables. There were no significant changes in the pre- and post-sleep quality scores of the control group. In addition, there was no significant difference in pre-sleep quality and a significant difference in post-sleep quality. However, there is a significant difference in changes in vitamin D levels between the control and intervention groups. There is a significant effect of walking on vitamin D levels and sleep quality.

Keywords: Vitamin D, Sleep, Walking, Physical activity.

INTRODUCTION

Vitamin D is a fat-soluble compound with antioxidant properties that are important for maintaining the body's mineral balance. Vitamin D can be obtained from exogenous sources (food) or endogenously synthesised by the skin through exposure to the sun's ultraviolet rays. Although it is a vitamin, it is also considered a hormone because it is activated by chemical reactions in the body. Vitamin D exists in the form of two biologically linked precursors or prohormones, vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol). Ergocalciferol is derived from plants, while cholecalciferol is derived from animals and is formed by ultraviolet B radiation on 7-dehydrocholesterol. Vitamin D in this form must be converted to active hormones to have a biological effect on mineral metabolism and other physiological functions [1].

25-hydroxyvitamin D (25(OH)D) is generally considered to be the best indicator of vitamin D status in the body. Many factors, including lack of sunlight exposure, lifestyle and skin colour, can influence serum 25 (OH) D levels. Cardiovascular, infectious and sleep disorders can cause vitamin D deficiency. Several studies have reported that vitamin D receptors are expressed in an area of the brain that regulates the sleep-wake cycle, the hypothalamus [2]. Several observational studies have shown an association between vitamin D deficiencies and sleep disorders. One cross-sectional study reported that vitamin D deficiency correlated with poorer sleep quality.

Physical activity is any bodily movement produced by skeletal muscles that results in greater energy expenditure than at rest. Physical activity in an outdoor environment with sun exposure provides benefits both from the physical activity itself and from the synthesis and action of vitamin D in the body [3].

Moderate intensity physical activity indoors (without exposure to direct sunlight) and outdoors (with exposure to sunlight) is a factor that can have a positive effect on vitamin D levels [4].Regular physical activity will also have positive health benefits, making the body's metabolism good and blood circulation smooth, so that a person can sleep peacefully and comfortably.

Many types of physical activity can be done to prevent vitamin D deficiency and overcome sleep disorders, one of which is walking. A 2021 study by Szymon et al showed that Nordic walking was one of the best forms of activity for preventing vitamin D deficiency [5]. A 2015 study by Hsiao et al showed that moderate-intensity walking was effective in improving sleep quality [6].

Walking is a physical activity that is easy to start, does not require special skills, facilities or expensive equipment, and has a low risk of injury [7]. Lack of physical activity among teachers and educational staff is also found at the University of Nusa Cendana. According to an initial survey conducted by the Health Promoting University (HPU) Universitas Nusa Cendana in 2021 on medical check-ups lecturers and administrative staff, it was found that out of 41 respondents including educators and educational staff, as many as 58.5% of respondents did not exercise regularly, and most of them only exercised less than 10 minutes (29.3%) or did not exercise at all (29.3%) every day. 56.1% of respondents exercised only once a week.

MATERIALS AND METHODS

This study used a quasi-experimental research method with a randomised pre- and post-test control group design. In this study, 2 groups were randomised: the intervention group and the control group. Both groups will be pre-tested and then post-tested to find out the difference in average vitamin D and sleep quality between the control and intervention groups. Samples will be taken using the purposive sampling technique and calculated using the formula for calculating sample size with a known population (N) that meets the inclusion criteria. Explain the research to the respondent. Obtain consent from the respondent by completing a consent form and a characteristic sample questionnaire. Taking weight and height measurements. Carried out baseline measurements of vitamin D levels and sleep quality in the study sample. The research sample in the treatment group underwent physical exercise by walking 3 times a week for 4 weeks. Each session lasted 40 minutes and was monitored using the Pacer pedometer application installed on the treatment group's smartphone.

Meanwhile, the research sample in the control group did not receive any intervention. On the last day of walking, both the treatment and control groups had their vitamin D levels and sleep quality measured again. Vitamin D was measured professionally at the Prodia laboratory in Kupang, Indonesia. Retrieval and processing of data on vitamin D results and sleep quality from the treatment and control groups. Data were processed using the Statistical Package for Social Science (SPSS) for Windows version 22 with a confidence level of 95%.

Ethical approval was obtained from the Ethics Committee of the Faculty of Medicine, Universitas Nusa Cendana Kupang. The patient or the patient's family to be included in the study is done in writing (informed consent). All costs related to the research are the responsibility of the researcher. The patient's identity data will be kept confidential and will not be published without permission.

RESULTS AND DISCUSSION

Sample Characteristics

The sample used in this study was 30 people from the Faculty of Medicine and Veterinary Medicine, the Faculty of Law, the Faculty of Public Health, the Faculty of Education and Science, and the Institute for Research and Community Service, Nusa Cendana University. This study collected data on the characteristics of the sample, namely age, gender, BMI, systolic and diastolic blood pressure.

Table 1. Characteristics of the sample

Variable	GROUPS		*p*
	Intervention	Control	
Gender			
Male	10 (66.7%)	9 (60%)	1.000¥
Female	5 (33%)	6 (40%)	
Age	44.07 ± 7.87	38.53 ± 7.38	0.057§
BMI	28.77 ± 6.41	29.38 ± 7.06	1.000‡
Systolic	131.13 ± 10.12	124.53 ± 13.76	0.146§
Diastolic	85.33 ± 9.51	81.13 ± 8.56	0.077‡

*Note: *Significant (p < 0.05); ¥Chi square; §Independent t; ‡Mann Whitney*

Table 1 shows that there was no significant difference between the control and intervention groups in the variables of gender, age, BMI, systolic and diastolic blood pressure. This means that these variables are not confounding variables in this study.

Table 2: The results of the McNemar test for sleep quality before and after sleep quality

Groups	Sleep Quality Pre-Test	Sleep quality Post Test		*p*
		Poor	Good	
Intervention	Poor	1 (8.3%)	11 (91.7%)	0.001*
	Good	0 (0%)	3 (100)%	
Control	Poor	6 (885.7%)	1 (14.3%)	1.000
	Good	0 (0%)	8 (100)%	

*Note: *Significant (p < 0.05)* Table 2 shows the significant changes in the intervention group's pre- and post-sleep quality scores. There were no significant changes in the pre- and post-sleep quality scores of the control group.

Table 3: Differences in pre-sleep quality and post-sleep quality based on the intervention and control groups

Variable	Groups		*p*
	Intervention	Control	
Pre-test Sleep quality			
Poor	12 (80%)	7 (46.7%)	0.130
Good	3 (20%)	8 (53.3%)	
Post-test Sleep quality			
Poor	1 (6.7%)	6 (40%)	0.040*
Good	14 (93.3%)	9 (60%)	

*Note: *Significant (p < 0.05)*

Table 3 shows that based on the chi-squared test in the intervention and control groups, the results showed that there was no significant difference in pre-sleep quality and a significant difference in post-sleep quality.

Sleep Quality

The results of this study suggest that there is a significant effect of walking on sleep quality. This is consistent with the research by Weny Amelia et al. in 2020, which concluded that there

was a significant effect of walking exercise on sleep quality in breast cancer patients undergoing chemotherapy [8]. The results of this study are also consistent with research by Feifei Wang and Szilvia Boros in 2020, which showed that regular walking exercise could improve sleep quality in a sample of young adults in Hungary [9].

Table 4: Differences in Vit. D pre-test, post-test, and differences based on treatment

Variable	Groups		p
	Intervention	control	
Pre-test	26.23 ± 7.06	23.47 ± 6.67	0.202‡
Post-test	36.44 ± 11.71	27.21 ± 7.97	0.018§*
p	<0.001¶*	0.001†*	
Difference	10.21 ± 7.69	3.75 ± 2.21	0.006‡*

*Note: *Significant ($p < 0.05$); ‡Mann whitney; §Independent t; †Wilcoxon; ¶Paired* t

Table 4 shows significant differences in pre- and post-vitamin D levels in the intervention and control groups. Table 3 also shows that there is a significant difference in the change in vitamin D levels between the control and intervention groups.

Physical activity such as walking increases the heart rate, causing the heart to beat faster, which leads to an increase in blood pressure. An increase in blood pressure reduces the amount of cortisol in the blood that is transported to the brain. It also increases the oxygen supply to the muscles and brain, helping to trigger the release of endorphins in the brain. Endorphins can suppress the production of the hormone cortisol (stress hormone). They suppress pain signals that enter the nervous system by activating the pain management system and relaxing the body [10].

The endorphin hormone releases three main neurotransmitters: norepinephrine, dopamine and serotonin. Norepinephrine is secreted from the terminals of neurons whose cell bodies are located in the brainstem and hypothalamus. Typically, norepinephrine-secreting neurons in the locus coeruleus of the pons send nerve fibres to a wide area of the brain and help regulate general activity and mood. Dopamine is secreted by neurons originating in the substantia nigra and influences brain processes that control movement, emotional response and the ability to feel pleasure and pain. Meanwhile, serotonin is secreted by nuclei that originate in the median raphe of the brainstem and project to various areas of the brain and spinal cord, particularly to the dorsal root of the spinal cord and the hypothalamus. Serotonin helps regulate a person's mood and regulates sleep. These three neurotransmitter components have effects that can improve mood, cope with stress and control anxiety, which is a factor in sleep disorders, thus improving sleep quality [11-12].

Vitamin D

The results of this study suggest a significant effect of walking on vitamin D levels. These results are consistent with the study by Szymon et al, which showed that 12 weeks of Nordic walking resulted in changes in blood levels of vitamin D in the study subjects. The studies reviewed showed that an intervention of six weeks of regular Nordic walking in postmenopausal women resulted in a significant decrease in vitamin D levels. Pilch et al. suggested that the intense energy expenditure during the exercise could influence the reduction in vitamin D levels. As a result, the demand for vitamin D by muscle cells will increase [13,14].

Vitamin D is important for calcium absorption in the gut, which also affects the immune, cardiovascular and musculoskeletal systems. Exposure to sunlight in the external environment allows the synthesis of this vitamin, with the consequent process of acquiring bone tissue through mineralisation. According to current knowledge, the skin is the only organ capable of producing vitamin D, which is also absorbed from the diet [15-16].

A systematic review by Mochcovitch et al. suggested that regular physical activity may be effective in improving anxiety symptoms in older people; however, they concluded that further research is needed to determine the modalities, frequency, duration, and intensity to optimise the beneficial effects of these activities on anxiety in the study population. However, the authors did not mention physical activity with sun exposure for vitamin D synthesis, as seen in the study by Al-Eisa et al, who reported an increase in individual physical performance associated with vitamin D and calcium levels as factors in preventing muscle fatigue. Vitamin D adequacy is associated with physical activity, which provides better neuromuscular performance, including an increase in type II muscle fibres, and enhances the regulatory role of the immune system. Indoor environments, more pigmented skin and excessive use of exercise equipment contribute to vitamin D deficiency [17].

CONCLUSION

Based on this study, it can be concluded that walking exercise has a significant effect on vitamin D levels and sleep quality.

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CONFLICT OF INTERESTS

There is no conflict of interest found during this study

ETHICS

This study has received ethical approval from the Health Research Ethics Commission of the Faculty of Medicine, University of Nusa Cendana.

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