e-ISSN 2527-2950
p-ISSN 2085-4145

JURNAL KEDOKTERAN DAN KESEHATAN INDONESIA

Indonesian Journal of Medicine and Health

Journal homepage: www.journal.uii.ac.id/index.php/JKKI

JKKI

SCIENTIA EST BASIC VITAE

JKKI	Volume -	Number -	pp -	Jogjakarta	ISSN 2085-4145

Published by
Faculty of Medicine
Islamic University of Indonesia

JKKI : JURNAL KE
DAN KESEHATAN
P-ISSN: 2085-4145 | E-ISSN: 2527-2950
Decree No. 164/E/KPT/2021

Editorial Team

Editor-in-Chief

Advisory Editorial Board

Editorial Boards

Managing Editor

Technical Support

Author Guidelines (https://journal.uii.ac.id/JKKI/about/submissions)

ACCREDITATION

(https://sinta.kemdikbud.go.id/journals/detail?id=2137)

This journal has been accredited by the National Journal Accreditation (ARJUNA) Managed by the Ministry of Research and Technology/National Research and Innovation Agency (Kemenristek/BRIN), according to the Decree No. 164/E/KPT/2021

- Aims & scopes (https://journal.uii.ac.id/JKKI/index)
- Submission (https://journal.uii.ac.id/JKKI/about/submissions)
- Manuscript template (https://drive.google.com/drive/folders/1_GrtW56_W-jydMS78JRLbZ3q545QNWqj)
- Publication ethics (https://journal.uii.ac.id/JKKI/Publication_ethic)
- Plagiarism (https://journal.uii.ac.id/JKKI/Plagiarism_check)
- Article processing charges (https://journal.uii.ac.id/JKKI/pages/view/Article_processing_charges)
- Editorial team (https://journal.uii.ac.id/JKKI/about/editorialTeam)
- Indexing (https://journal.uii.ac.id/JKKI/Abstracting_and_Indexing)
- Statistics (https://journal.uii.ac.id/JKKI/statistics?statisticsYear=2022)

Editorial Team

Vita Widyasari
Editor in Chief
Department of Public Health, Faculty of Medicine, Universitas Islam Indonesia
0000-0003-3277-7095 (https://orcid.org/0000-0003-3277-7095)

Novyan Lusiyana
Managing Editor
Department of Parasitology, Faculty of Medicine, Universitas Islam Indonesia
0000-0002-3254-1974 (https://orcid.org/0000-0002-3254-1974)

Ninda Devita
Associate Editor
Department of Microbiology, Faculty of Medicine, Universitas Islam Indonesia
0000-0002-4122-679X (https://orcid.org/0000-0002-4122-679X)

Arini Rizky Wijayanti
Associate Editor
Department of Pathology Anatomy, Faculty of Medicine, Universitas Islam Indonesia
0000-0001-5635-3073 (https://orcid.org/0000-0001-5635-3073)

Read More (https://journal.uii.ac.id/JKKI/about/editorialTeam)

WEB STATISTICS

(https://info.flagcounter.com/WuCQ)

000069104 (https://statcounter.com/)

View My Stats (https://statcounter.com/p12807974/?guest=1)

RECOMMENDED TOOLS

TEMPLATE JOURNAL ARTICLE docx **(https://drive.google.com/drive/folders/1_GrtW56_W-jydMS78JRLbZ3q545QNWqj)**

CONFLICT OF INTEREST pdf **(https://drive.google.com/a/uii.ac.id/uc?authuser=1&id=1I6N6Y-63RwQLMN1f9ou1tRb3OR9DM2Cy&export=download)**

COVER LETTER ARTICLE docx **(https://drive.google.com/uc?id=1I8fmuHXdd2mfBKmMkPL_8408OTxU_Auk&export=download)**

STATEMENT OF ORIGINALITY docx **(https://drive.google.com/uc?id=1p3xumKm2GbBD1Fp-EhdJ4dX-f7_IiL1E&export=download)**

MENDELEY (https://www.mendeley.com/download-mendeley-desktop/)

Published Volumes

2009-2025

2025

2024

2023

2022

2021

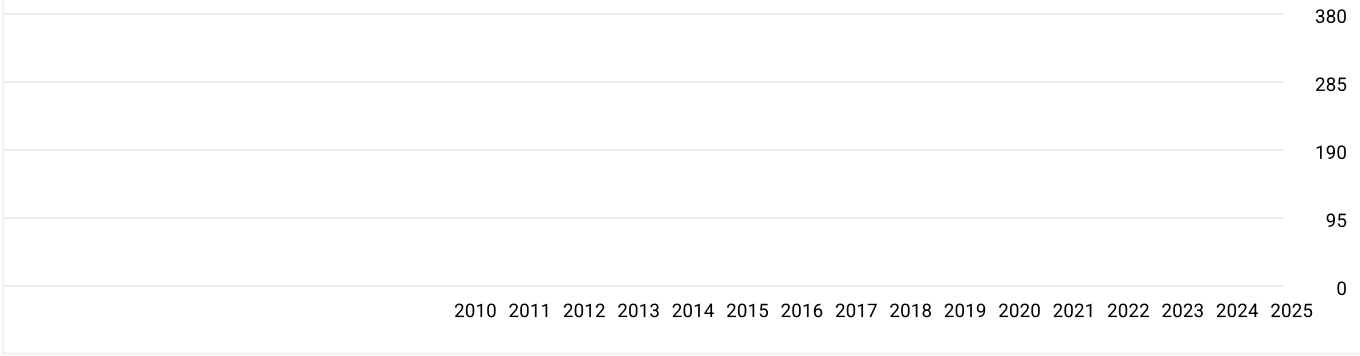
Show more

Keywords

Google Scholar Citation

Updated weekly Scholar (https://scholar.google.com/citations?user=McBFJloAAAAJ&hl=en)

	All	Since 2020
Citations	2181	1610
h-index	21	19
i10-index	53	41



(https://sinta.kemdikbud.go.id/journals/detail?id=26813)

(https://app.dimensions.ai/discover/publication?search_mode=content&search_text=Jurnal%20Kedokteran%20dan%20Kesehatan%20Indonesia&id=1)

(https://journals.indexcopernicus.com/search/publication?id=46621)

JKKI : JURNAL KEDOKTERAN DAN KESEHATAN INDONESIA

Address

Fakultas Kedokteran, Universitas Islam Indonesia
Jl. Kaliurang Km 14,5 Yogyakarta, Indonesia

Contact Info

Telp. (0274) 898444 ext. 2050
Fax. (0274) 898580 ext. 2007
081238884726 (https://wa.me/6281238884726)

Section Original Article

Vitamin D receptor polymorphism associated with obesity in productive age population: A cross-sectional study

https://doi.org/10.20885/JKKI.Vol16.Iss1.art6 (https://doi.org/10.20885/JKKI.Vol16.Iss1.art6)

Yohana
dryohana@trisakti.ac.id (Primary Contact)
Department of Biochemistry, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
https://orcid.org/0009-0006-3019-8064 (https://orcid.org/0009-0006-3019-8064)

Meiyanti
Department of Pharmacology and Pharmacy, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
https://orcid.org/0000-0002-1770-5504 (https://orcid.org/0000-0002-1770-5504)

Monica Dwi Hartanti
Department of Biology, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
https://orcid.org/0000-0001-7542-6434 (https://orcid.org/0000-0001-7542-6434)

Eveline Margo
Department of Physiology, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
https://orcid.org/0000-0002-1614-0804 (https://orcid.org/0000-0002-1614-0804)

Reni Zuraida
Department of Community Medicine, Faculty of Medicine, Universitas Lampung, Lampung, Indonesia
https://orcid.org/0000-0003-1460-6428 (https://orcid.org/0000-0003-1460-6428)

Submitted
July 11, 2024

Accepted
February 21, 2025

Published
April 25, 2025

Abstract

Background: Obesity is influenced by genetic factors, lifestyle, and environmental factors. This increase in obesity gives rise to various chronic disease problems.

Objectives: This study aimed to identify genetic variations of Vitamin D receptors and determine the relationship to obesity in terms of body mass index and body fat percentage in the working group.

Methods: This study is an analytical observational study with a cross-sectional research design approach in the Jembatan Dua area, Angke sub-district, West Jakarta. The research instrument used was a questionnaire to obtain characteristic data, as well as an examination of VDR gene variations rs1544410, rs2228570, rs7975232, and PCR examination to obtain data on gene variation.

Results: The results obtained are as follows: the average age of subjects was 42.24, with 58.1% females. A total of 39 (69.1%) are Javanese. Thirty-one (50%) subjects were included in the category of obesity (BMI> 25), and 41 (66.1%) subjects were obese category based on the body fat percentage. The results of bivariate analysis obtained SNP VDR FoxI gene obtained a significant relationship with body mass index with a p-value of 0.047, while the VDR BsmI gene obtained a statistically meaningful relationship with body fat percentage with a p-value of 0.043.

Conclusion: FoxI and BsmI VDR polymorphisms are associated with body mass index and body fat percentage.

Keywords

polymorphism; Vitamin D; obese; gene

How to Cite

Yohana, Meiyanti, Hartanti, M. D. ., Margo, E., & Zuraida, R. . (2025). Vitamin D receptor polymorphism associated with obesity in productive age population: A cross-sectional study. *JKKI : Jurnal Kedokteran Dan Kesehatan Indonesia*, *16*(1), 47–57. https://doi.org/10.20885/JKKI.Vol16.Iss1.art6

MORE CITATION FORMATS

Download Citation

Endnote/Zotero/Mendeley (RIS) (https://journal.uii.ac.id/JKKI/citationstylelanguage/download/ris?submissionId=35252&publicationId=44665)
BibTeX (https://journal.uii.ac.id/JKKI/citationstylelanguage/download/bibtex?submissionId=35252&publicationId=44665)

Address

Fakultas Kedokteran, Universitas Islam Indonesia
Jl. Kaliurang Km 14,5 Yogyakarta, Indonesia

Contact Info

Telp. (0274) 898444 ext. 2050
Fax. (0274) 898580 ext. 2007
081238884726 (https://wa.me/6281238884726)

JKKI: Jurnal Kedokteran dan Kesehatan Indonesia
Indonesian Journal of Medicine and Health
Journal homepage: https://journal.uii.ac.id/JKKI
P-ISSN 2085-4145 | E-ISSN 2527-2950

Vitamin D receptor polymorphism associated with obesity in productive age population: A cross-sectional study

Yohana,[1]* Meiyanti,[2] Monica Dwi Hartanti,[3] Eveline Margo,[4] Reni Zuraida[5]

[1]Department of Biochemistry, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
[2]Department of Pharmacology and Pharmacy, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
[3]Department of Biology, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
[4]Department of Physiology, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
[5]Department of Community Medicine, Faculty of Medicine, Universitas Lampung, Lampung, Indonesia

Article Info:

Keywords: polymorphism; Vitamin D; obese; gene

Article History:

Received: July 11, 2024
Accepted: February 21, 2025
Online: April 25, 2025

***Corresponding author:**
dryohana@trisakti.ac.id

DOI: 10.20885/JKKI.Vol16.Iss1.art6

Original Article

ABSTRACT

Background: Obesity is influenced by genetic factors, lifestyle, and environmental factors. This increase in obesity gives rise to various chronic disease problems.
Objectives: This study aimed to identify genetic variations of Vitamin D receptors and determine the relationship to obesity in terms of body mass index and body fat percentage in the working group.
Methods: This study is an analytical observational study with a cross-sectional research design approach in the Jembatan Dua area, Angke sub-district, West Jakarta. The research instrument used was a questionnaire to obtain characteristic data, as well as an examination of VDR gene variations rs1544410, rs2228570, rs7975232, and PCR examination to obtain data on gene variation.
Results: The results obtained are as follows: the average age of subjects was 42.24, with 58.1% females. A total of 39 (69.1%) are Javanese. Thirty-one (50%) subjects were included in the category of obesity (BMI> 25), and 41 (66.1%) subjects were obese category based on the body fat percentage. The results of bivariate analysis obtained SNP VDR FoxI gene obtained a significant relationship with body mass index with a p-value of 0.047, while the VDR BsmI gene obtained a statistically meaningful relationship with body fat percentage with a p-value of 0.043.
Conclusion: FoxI and BsmI VDR polymorphisms are associated with body mass index and body fat percentage.

INTRODUCTION

Obesity is one of the health problems in the world that can occur from children to the elderly. Based on basic health research data held by Ministry of Health Indonesia in 2018, the prevalence of adult obesity increased in a decade from 10.5% to 21.8% using the body mass index (BMI) category ≥27kg/m^2. The results of this research show that women suffer more obesity than men and the incidence of obesity in various regions in Indonesia varies depending on economic, demographic, and educational factors.[1] Mortality and morbidity rates will increase with obesity. Chronic degenerative diseases will also increase in number such as diabetes mellitus, cardiovascular disease, osteoarthritis, cancer, and stroke. Obesity is characterized by an increase in the amount of energy stored in the body compared to the amount used. The energy stored in the body can be seen from anthropometric indicators such as body weight, height, abdominal circumference, pelvic circumference, and skinfold thickness.[2] A commonly used indicator to categorize obesity is BMI. Based on the Asia Pacific IMT category, IMT can be classified into obese ≥25kg/m^2, overweight 23-24.9 kg/m^2, normal 18.5-22.9 kg/m^2, and underweight ≤18 kg/m^2.

Several studies in Asia suggest that being overweight can be a risk factor for diabetes mellitus, hypertension, and stroke.[3]

Increases and decreases in Vitamin D levels in the body are influenced by several factors, namely external factors and internal factors. External factors such as sun exposure, and food intake. At the same time, internal factors are genetic relationships and skin color. In addition, nutritional status is also related to Vitamin D levels in the blood, both levels and metabolism.[4] One study shows obesity is influenced by vitamin D deficiency. Low levels of vitamin D are associated with metabolic syndrome, autoimmune, cancer, and psychiatric disorders. This study is a continuation of the previous one. A preliminary study in the West Jakarta area aimed to see the picture of risk factors for causing vitamin D deficiency in young adults, it was found that 60.6% of 25(OH)D3 levels of subjects were classified as deficiency, and 33.3% were classified as insufficiency. As much as 93.9% of subjects in this mapping study's 25(OH)D3 levels experienced insufficiency to deficiency.[5] Another study conducted in Angke, West Jakarta found a prevalence of 54% of participants experiencing overweight).[6] Vitamin D is a lipid-soluble hormone so it can be used as a sign of metabolic disorders related to adipose tissue of the body.[7] According to sequestration theory, Vitamin D is a fat-soluble vitamin, so when there is an increase in fat in obese patients, there is an increase in the accumulation of Vitamin D in fat resulting in decreased serum vitamin D levels.[8,9]

Various VD genes can undergo polymorphisms in a singular nucleotide gene level, as found in previously stated cases. In these cases, it can lead to a deficiency of vitamin D, which is caused by dysfunctional VDR. A Singapore study showing a link between BMI and the levels of Vitamin D within the subject underlined the low proportion of Vitamin D adequacy in respondents with an increase in BMI of 35.8%.[10] Meanwhile, a study conducted in Taiwan on workers aged 26-65 years stated different results that there was no relationship between BMI and vitamin D levels, but age and season were important factors for hypovitaminosis D.[11]

Another finding was that variations in *the FokI, ApaI, and TaqI* genes were secondary risk factors for dyslipidemia, hyperglycemia, and hyperparathyroidism, but did not correlate with obesity.[12] There are still differences in research results regarding the relationship between genetic variations in Vitamin D receptors with predisposing factors to metabolic and cardiovascular diseases, especially obesity conditions. The prevalence rate of overweight and hypovitaminosis of vitamin D in the West Jakarta area is quite high, so the purpose of this study is to identify genetic variations of Vitamin D receptors and determine the relationship to obesity in terms of body mass index and body fat percentage in the group of workers in the West Jakarta.

METHODS

This study is an analytical observational study with a cross-sectional. This study involved a group of Dhamamsavana Foundation workers in the Angke Village area, West Jakarta. The included classes for this study were people aged between 20 to 64 years, workers indoors working 8 hours. These subjects had already consented to the study, and are willing to participate in the study. The people excluded from this study are those with a history of malignancy, kidney failure, autoimmune diseases, and limited mobility. This study used consecutive nonrandom sampling techniques.

The sample size used for this study used the infinite population formula: n = Zα 2xpxq / d2, with Zα = 1.96 p = 0.54 q = 1-0.54 = 0.46 d = 0.05 followed by the finite population formula N = no / (1 + n0 / N), so a minimum of 60 samples are needed. Blood samples are taken to check fasting blood glucose levels, vitamin D, HDL, and triglycerides. Physical examination is also carried out in the form of height, weight, BMI, body fat percentage, and blood pressure checks of systole, diastole, and temperature.

Measurement procedure and how it works: The body height of the subjects is measured using a Seca height gauge with an accuracy of up to 0.1 cm. The subjects are measured in an upright position. BMI is calculated as the quotient of body mass. It is calculated as the body mass in kilograms divided by the height of the subjects as square meters (kg/m^2). Systolic (SBP) and diastolic (DBP) blood pressure is measured with a digital sphygmomanometer and calculated as

the average of two consecutive readings. For blood chemistry tests, fasting blood glucose will be sent to the clinical laboratory.

Genetic Analysis

Blood samples were gathered from veins using tubes containing EDTA. Genomic DNA was extracted from 200 µL of each sample using a DNA isolation kit (Zymo Research, Irvine, CA, USA). The extracted DNA samples were then stored in a freezer at -20°C for future analysis. The VDR polymorphism, including ApaI, BsmI, and FokI, was analyzed using RFLP (Restriction Fragment Length Polymorphism) methods by amplifying targeted DNA regions using PCR within a 50 µL reaction volume containing 25 µL of MyTaqTM HS Red Mix (2X) (Meridian Bioscience, Memphis, Tennessee, USA) and 20 µM of each primer.[13] The polymerase chain reaction involves an initial temperature of 95°C for 3 minutes, then, afterward, it is followed by 30 cycles of denaturation at the temperature of 95°C for 30 seconds, After the previously stated process, it is annealed for 30 seconds with a temperature 95°C, before being extended for 1 minute at 72°C, before finally undergoing final extension step for 5 minutes at 72°C.

For ApaI polymorphism (g.59979G > T; rs7975232), a 745-bp PCR product was generated and digested with 1 U of FastDigest ApaI (Thermo Scientific, Hudson, NH, USA) at 37°C for 5 minutes. No cleavage site for the restriction enzyme was present for the A-allele, resulting in a 745 bp product. Conversely, individuals harboring the 'a-allele' exhibited cleavage products measuring 531- and 214-bp. In the case of BsmI polymorphism (A > G; rs1544410), an 870-bp fragment was amplified and treated with BsmI restriction enzyme (New England BioLabs), leading to variable fragment lengths indicative of different alleles. The allele 'B' was identified when an 870 bp product was present, indicating the absence of a cleavage site. Conversely, allele 'b' was identified using the fragments measured as 460, 234, and 176 bp, respectively. FokI polymorphism (C > T; rs10735810) involved amplification of a 273-bp product that was subjected to enzymatic cleavage using FastDigest FokI (Thermo Scientific, Hudson, NH, USA) at 37°C, producing characteristic fragment patterns. The assignment of alleles 'F' or 'f' was predicated upon the presence of a 273 bp fragment (F-allele), or the identified fragments of 198 and 65 bp fragments (f-allele), respectively. Heterozygous individuals (Ff) displayed products measuring 273, 198, and 65 bp concurrently. DNA fragments were cleaved and separated with 2% agarose gel electrophoresis to then be visualized using Blue light illumination following staining with Floro+green (1st Base, Singapore, Singapore). Enzyme and primer sequences were provided in Table 1.[14]

Table.1 Enzyme restriction sequences

Enzyme	Primers sequences	Genotype
ApaI	Forward: 5′- AGA GCA TGG ACA GGG AGCAAG-3′	AA, Aa, aa
	Reverse: 5′-AGAGCATGGACAGGGAGCAAG-3	
BsmI	Forward: 5′- AACCAGCGGGAAGAGGTCAAGGG-3′	BB, Bb,bb
	Reverse: 5′- CAACCAAGACTACAAGTACCGCGTCAGTGA-3′	
FokI	Forward: 5′- GATGCCAGCTGGCCCTGGCACTG-3′	FF,Ff,ff
	Reverse: 5′- ATGGAAACACCTTGCTTCTTCTCCCTC-3	

Statistical methods

The data (age, blood pressure, fasting glucose, HDL, triglyceride, and level of vitamin D) will be tested for normality, normal data will be presented as mean +/- SD, abnormal data will be presented as median (min, max), and categorical data (gender, ethnic, body mass index, percentage body fat, genotype VDR) will be presented as n (%). The bivariate test analyses the main hypothesis (VDR polymorphism vs BMI and fat percentage) using the Chi-square test if it meets the requirements or the Fisher test if it does not meet the requirements. Statistical analysis using software SPSS 25.0

Ethical statement

This research has passed the ethical review Number 002/KER/FK/2024 from the Research Ethics Commission of the Faculty of Medicine, Universitas Trisakti.

RESULTS

An overview of the characteristics of the subject of study can be seen in Table 2. Based on Table 2, the average age of subjects was 42.24, female as much as 58.1%. A total of 39 (69.1%) are Javanese. Blood pressure obtained average values of 121.82 ±17.51 mmHg for systolic and 78.24 ±11.01 for diastolic. Based on body mass index of 31 (50%) included in the category of obesity (BMI> 25) and 41 (66.1%) based on body fat percentage included in the category of obesity. The SNP of the VDR gene of most subjects had an Ff genotype of 34 (54.8%) for FoxI, 42 (67.7%) of the Bb genotype for BsmI, 34 (54.8%) of the Aa genotype for ApaI and 60 (96.8%) of the TT genotype for TaqI.

Table 2. Subject Characteristics (n=62)

Variable	n(%)	mean± SD
Gender		
Man	26 (41.9)	
Woman	36 (58.1)	
Ethnic group		
Javanese	39 (62.90)	
Sundanese	13 (20,97)	
Betawi	2 (3.22)	
Batak	3 (4.84)	
Minang	5 (8.07)	
Age		42.24 ± 8.82
Blood pressure		
Systolic		121,82 ± 17,51
Diastole		78,24 ± 11,01
Fasting glucose		89.33± 13.39
HDL (high-density lipoprotein)		53,42 ± 13,36
Triglyceride		120,76 ± 78,46
Body mass index		
Obese	31 (50)	
Not obese	31 (50)	
% Body Fat		
Obese	41 (66.1)	
Not obese	21 (33.9)	
Level Vitamin D	16.50 ±6.54	
GDR		
FoxI genotype		
FF (homozygote)	12 (19.4)	
Ff (heterozygote)	34 (54.8)	
ff	16 (25.8)	
BsmI genotype		
BB (homozygote)	10 (16.1)	
Bb (heterozygote)	42 (67.7)	
bb	19 (16.1)	

Table 2. Subject Characteristics (n=62) (continued)

Variable	n(%)	mean± SD
ApaI (rs7975232) **genotype**		
AA (homozygote polymorphic)	12 (19.4)	
Aa (heterozygote polymorphic)	34 (54.8)	
aa	16 (25.8)	
TaqI genotype		
TT (homozygote polymorphic)	60 (96.8)	
Tt (heterozygote polymorphic)	0 (0)	
tt	2 (3.2)	

Table 3. Bivariate Analysis of Association of VDR Gene SNPs with Body Mass Index (n=62)

SNP VDR	Body mass index			OR	95% CI	p
	Not obese n (%)	Obese N (%)	Total n (%)			
FoxI						
FF (Reference)	6 (19.4)	6 (19.4)	12 (19.4)			0.047*
Ff	15 (48.4)	19 (61.3)	34 (54.8)	5.06	0.91-28.15	
ff	10 (32.3)	6 (19.4)	16 (25.8)	0.67	0.07-6.11	
BsmI						
BB (Reference)	4 (12.9)	6 (19.4)	10 (16.1)			0.781
Bb	22 (71.0)	20 (64.5)	42 (67.7)	0.67	0.16-2.71	
bb	5 (16.1)	5 (16.1)	10 (16.1)	0.67	0.11-3.92	
ApaI						
AA (Reference)	6 (19.4)	6 (19.4)	12 (19.4)			0.832
Aa	16 (51.6)	18 (58.1)	34 (54.8)	0.71	0.19-2.76	
aa	9 (29.0)	7 (22.6)	16 (25.8)	0.17	0.17-3.02	
TaqI						
TT	29 (93.5)	31 (100)	60 (96.8)			0.151**
Tt	0	0	0			
tt	2 (6.5)	0	2 (3.2)	0.88	0.10-15.33	

CI: confidence interval; OR: odds ratio; *p<0.05; ** fisher

The results of bivariate analysis showed that SNP of the FoxI VDR gene obtained a significant relationship with body mass index, with a p-value of 0.047 (Table 3), while the BsmI VDR gene obtained a statistically meaningful relationship with body fat percentage, with a p-value of 0.043 (Table 4). Figure 1 presents representative gel electrophoresis results of PCR products digested with *FokI*, *BsmI*, and *ApaI* enzymes, clearly showing the banding patterns corresponding to different genotypes.

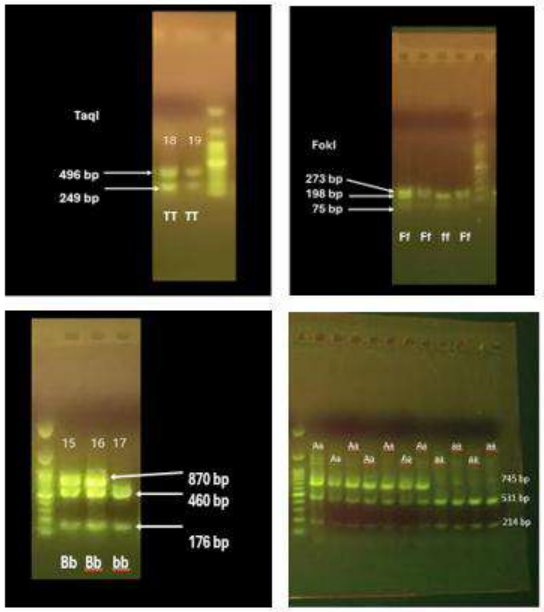


Figure 1. Restriction Fragment Length Polymorphism VDR

Table 4. Bivariate Analysis of SNP Relationship of VDR Gene with Body Fat Percentage (n=62)

SNP gen VDR	Body Fat Percentage			OR	95% CI	p
	Not Obese n (%)	Obese n (%)	Total n (%)			
FoxI						
FF (reference)	4 (19)	8 (19.5)	12 (19.4)			0.937
Ff	11 (52.4)	23 (56.1)	34 (54.8)	3.78	0.78-18.13	
ff	6 (28.6)	10 (24.4)	16 (25.8)	1.2	0.19-7.44	
BsmI						
BB (reference)	1 (4.8)	9 (22)	10 (16.1)			0.043*
Bb	18 (85.7)	24 (58.5)	42 (67.7)	1.37	0.30-6.32	
bb	2 (9.5)	8 (19.5)	10 (16.1)	0.43	0.07-2.68	
ApaI						
AA (reference)	4 (19)	8 (19.5)	12 (19.4)			0.96
Aa	12 (57.1)	22 (53.7)	34 (54.8)	0.3	0.56-1.62	
aa	5 (23.8)	11 (26.8)	16 (25.8)	0.8	0.12-5.20	
TaqI						
TT	20 (95.2)	40 (97.6)	60 (96.8)			0.624
Tt	0 (0)	0 (0)	0 (0)			
tt	1 (4.8)	1 (2.4)	2 (3.2)	0.5	0.03-8.42	

OR: odds ratio; CI: confidence interval; *p<0.05

DISCUSSION

The levels within the subjects of this study have an average of 16.50 ng/ml, and can be categorized as vitamin D deficient, this may be because the average employee works indoors so that less outdoor activities and inadequate exposure to natural sunlight. Low exposure to sunlight is the main cause of reduced vitamin D intake, which leads to deficiency of vitamin D. Vitamin D has various physiological roles in the body such as hemostatic calcium and phosphate, regulating the process of proliferation and differentiation of the human cells, immune system and also affecting the effectivity of the cardiovascular system. Vitamin D deficiency conditions are found

to affect a variety of acute and chronic diseases. Vitamin D deficiency is associated with various metabolic disorders. These include cases of type 2 diabetes, common obesity, and other kinds of metabolic syndromes as well.[15]

The findings of this study suggest a potential association between VDR gene polymorphisms, particularly FoxI VDR gene SNPs, and BMI. This suggests that the presence of VDR genetic variation may potentially hold influence over the regulation of body fat distribution, and the body weight. It seems reasonable to suggest that vitamin D plays an important role in calcium and phosphate metabolism, as well as in several other biological functions, including the modulation of immune and inflammatory responses. These functions may affect body weight regulation. [16,17] Furthermore, vitamin D plays an important role in body weight regulation and energy metabolism, as it is understood that VDR is expressed in various tissues, including the liver, muscle, and adipose tissue, all of which are involved in energy metabolism. This study offers further insight into the potential influence of VDR gene polymorphisms on the body's response to vitamin D, which may in turn affect BMI. The observed association between VDR FoxI SNPs and BMI suggests that these genetic variations could be considered potential genetic markers for predicting the risk of obesity or weight loss.[16,18,19]

This study lends further support to the findings of previous studies, which have indicated that VDR may play a role in regulating body weight and body composition. It seems that individuals with VDR gene polymorphisms may tend either a lower or a higher BMI, depending on the specific gene variation in question. It seems that the interaction between genes and environmental factors, such as exposure, may depend on the type of variation involved. Additionally, some studies have suggested that the interaction between the VDR gene and environmental factors, such as dietary vitamin D intake and sun exposure, may potentially influence BMI.[19,20]

One study in China suggests that there may be a potential association between FokI polymorphism and increased susceptibility to metabolic syndrome in the pediatric age group. [21] There is some evidence to suggest that the VDR polymorphism may be associated with increased BMI. This could be due to the location of genes that are more related to vitamin D receptor function, which may affect gene transcription activity, mRNA stability, or interactions with co-factors that are important in metabolic processes. Furthermore, it is possible that changes in receptor structure due to these polymorphisms could alter the affinity or binding effectiveness of vitamin D, which could then affect various metabolic pathways, including those involved in body weight regulation and body fat distribution.[22,23] It seems likely that the interaction between VDR polymorphisms and several environmental factors such as vitamin D intake, sun exposure, and lifestyle may contribute to BMI variability and be associated with the onset of several diseases.[24,25]

The Chinese study found that VDR SNP variations did not correlate with BMI and WC, but these VDR variations were related to triceps skin fold thickness and body fat percentage. In the GT Apal genotype is associated with higher cholesterol and LDL levels. The VDR variant has an important influence on adipose and adipose network activity in Han China.[2] VDR is expressed in the adipose tissues, examples include 3-TC-LI adipocyte, the SAT and VAT presence in humans, the human preadipocytes, and the other differentiated adipocytes as well. This adipose tissue has various functions for lipid synthesis, fatty acid transport, and adipokine secretion [21]. The study by Fang found that there is no relationship between VDR SNP and BMI or WC, the difference can be influenced by different ethnic backgrounds. The increase in body fat percentage is linked with the presence of the T allele of Fokl and the T allele of Apal, meanwhile, the cases of triceps skin fold thickness are linked with the G allele of rs2239179 and the T allele of Apal.[2]

It seems that there might be a link between the BsmI SNP polymorphism in the VDR gene and body fat percentage. This could be due to some factors, including the location of the BsmI SNP in an area that affects the vitamin D receptor in functionality and expressionality. It is thought that the VDR gene intronic region is where the BsmI SNP is located, which could potentially affect the mRNA splicing process and VDR protein expression. It is thought that variations in the splicing process may result in the production of different vitamin D receptor isoforms, which could potentially lead to variations in biological activity. It is thought that variations in BsmI SNPs may

affect the binding affinity of vitamin D to the receptor, which could potentially influence the transcriptional activity of genes regulated by VDR. This could have implications for the regulation of genes involved in body fat distribution and fat metabolism. It is also possible that BsmI polymorphism may affect the stability of mRNA, which could in turn affect the amount of VDR protein present in adipose cells.[26,27]

Polymorphism ApaI and BsmI genotypes showed significant differences in WC, WHR, body fat percentage, TG, and HDL-C levels, implying that these specific VDR genotypes are linked particularly to the lipid profile and distribution. Dyslipidemia, encompassing hypertriglyceridemia and low HDL-C, constitutes a facet of metabolic syndrome. Vitamin D's potential impact on lipid metabolism has been a subject of interest. Numerous epidemiological investigations have explored the nexus between vitamin D levels and dyslipidemia. Vitamin D status has a positive correlation between vitamin D with serum HDL-C levels, along with a negative correlation with TG within the context of lipid regulation, adipose tissue takes on a pivotal role. It is noteworthy that this tissue expresses the VDR along with enzymes involved in vitamin D metabolism and associated signaling pathways, thus emerging as the principal reservoir for vitamin D storage.[28–30]

It seems that genetic variation in the form of BsmI polymorphism may influence leptin levels in the body. The adipocyte cells produce the Leptin hormone, which affects energy metabolism and is thought to regulate appetite. It seems possible that the VDR gene polymorphism may affect how vitamin D interacts with adipose tissue, affecting leptin production. It is reasonable to suggest that leptin plays an important role in energy regulation and body weight management. It is also reasonable to suggest leptin levels affect body mass index (BMI) and body fat percentage. It is thought the hypothalamus in the brain affects leptin's function to inhibit appetite and increase energy expenditure. In individuals with a normal body weight, there is a fluctuation in leptin levels by the body's fat reserves. However, in individuals who are obese, leptin levels are typically elevated, yet they may experience leptin resistance, which is when the body does not respond effectively to leptin signals. This can result in disturbances in the regulation of appetite and energy expenditure. Furthermore, leptin resistance in obese individuals can contribute to the difficulty in losing weight despite high leptin levels.[31–34]

Vitamin D deficiency can cause an increased risk of diabetes mellitus.[35] VDR gene variations that have been known to have a relationship with obesity are *FokI (rs 2228570), BsmI (rs1544410), ApaI (rs7975232),* and *TaqI* (rs 731236). Expression of mRNA and proteins from VDRs such as BsmI is associated with an increased incidence of obesity.[26] Several studies provide pro and con results on the relationship of VDR gene polymorphism with obesity. The results of the study of Tobias et al. showed that vitamin D 25 OH levels were lower in subjects with more weight and obesity compared to subjects with normal and less weight.[36] This is associated with a very slow vitamin D release rate, caused by body fat, which will lead to low serum 25(OH)D levels.

Studies in Iranian populations are known to show a relationship between variations in *ApaI* and obesity, and become one of the risk factors for obesity. However, the *TaqI* gene was found to have no meaningful association with obesity. [25] Rayinda et.al found the *BsmI* gene has a connection to insulin resistance and the lack of vitamin D within the body. However, this had no association with the occurrence of obesity cases in tropical populations. The study also suggested that *the FokI gene* has been associated with an increased incidence of diabetes mellitus in Asian populations.[27] The *FokI* gene was found to be associated with increased blood glucose levels and BMI of more weight and/or obese in Turkey.

The findings that this study had shown have the potential bring contribution toward developing an effective strategy for the control of obesity and body weight. VDR polymorphisms have been shown to influence vitamin D metabolism, highlighting the significance of consuming nutritional and vitamin D supplementation approaches and other environmental factors. However, there are still limitations of this study, including the absence of certain crucial environmental factors, such as sun exposure, dietary habits, and vitamin D supplementation.

CONCLUSION

Based on this study, the polymorphisms of Vitamin D receptors are associated with body mass index (BMI) and the percentage of body fat. FoxI and BsmI were associated with obesity and body weight. Other strategies are needed to prevent obesity such as physical activity, dietary restriction, and vitamin D supplementation. Further studies are needed to explore other VDR gene polymorphisms as the larger sample.

CONFLICT OF INTEREST

The authors should make a conflict-of-interest disclosure statement or a declaration that they do not have any conflicts of interest. They should disclose at the time of revision any financial arrangement they may have with a company whose product is pertinent to the submitted manuscript or with a company making a competing product. Such information will be held in confidence - while the paper is under review - and will not influence the editorial process.

ACKNOWLEDGMENTS

The authors declare that there is no conflict of interest in this study.

DATA AVALABILITY

Data sharing does not apply to this article.

SUPPLEMENTAL DATA

None.

AUTHOR CONTRIBUTIONS

Conceptualization: Y, M. Data curation: Y, M, MD, EM. Format analysis: M, EM, RZ. Methodology: Y, M, MDH writing of the original draft: Y. Writing of review and editing: M, MD, RZ.

DECLARATION OF USING AI IN THE WRITING PROCESS

We are using the Grammarly application for English grammar and Mendeley for arranging references.

LIST OF ABBREVIATIONS

VDR= Vitamin D Receptor; SNP= Single Nucleotide Polymorphism; WC= Waist Circumference; BMI= Body Mass Index

REFERENCES

1. Ayuningtyas D, Kusuma D, Amir V, Tjandrarini DH, Andarwati P. Disparities in obesity rates among adults: Analysis of 514 districts in Indonesia. Nutrients. 2022;14(16):1-18. DOI:10.3390/nu14163332
2. Shen F, Wang Y, Sun H, et al. Vitamin D receptor gene polymorphisms are associated with triceps skin fold thickness and body fat percentage but not with body mass index or waist circumference in Han Chinese. Lipids in health and disease. 2019;18(1):97. DOI:10.1186/s12944-019-1027-2
3. Lim JU, Lee JH, Kim JS, et al. Comparison of World Health Organization and Asia-Pacific body mass index classifications in COPD patients. International Journal of COPD. 2017;12:2465-2475. DOI:10.2147/COPD.S141295
4. Shah D, Gupta P. Vitamin D deficiency: Is the pandemic for real? Indian Journal of Community Medicine. 2015;40(4):215-217. DOI:10.4103/0970-0218.164378
5. Santoso AH, Yanti D, Silaban L, Charissa O. Pemetaan awal kadar 25 (OH) D dan faktor risiko defisiensi vitamin D pada dewasa muda di Jakarta Barat. Tarumanegara Medical Journal. 2023;5(1):16-25. DOI: 10.24912/tmj.v5i1.23706
6. Yohana Y, Meiyanti M, Margo E, Kartadinata E. Evaluasi pengukuran glukosa darah puasa dan

asam urat pada lanjut usia di Kelurahan Angke, Jakarta Barat. Jurnal Dharma Bhakti Ekuitas. 2023;7(2):123-130. DOI:10.52250/p3m.v7i2.644

7. Vranić L, Mikolašević I, Milić S. Vitamin D deficiency: Consequence or cause of obesity? Medicina (Lithuania). 2019;55(9). DOI:10.3390/medicina55090541
8. Khan SM, El HajjChehadeh S, Abdulrahman M, Osman W, Al Safar H. Establishing a genetic link between FTO and VDR gene polymorphisms and obesity in the Emirati population. BMC Medical Genetics. 2018;19(1):1-9. DOI i:10.1186/s12881-018-0522-z
9. Fronczek M, Osadnik T, Banach M. Impact of vitamin D receptor polymorphisms in selected metabolic disorders. Current Opinion in Clinical Nutrition and Metabolic Care. 2023;26(4):316-322. DOI:10.1097/MCO.0000000000000945
10. Man REK, Li LJ, Cheng CY, Wong TY, Lamoureux E, Sabanayagam C. Prevalence and determinants of suboptimal vitamin D levels in a multiethnic asian population. Nutrients. 2017;9(3):1-12. DOI:10.3390/nu9030313
11. Wang LK, Hung KC, Lin YT, et al. Age, gender and season are good predictors of vitamin D status independent of body mass index in office workers in a subtropical region. Nutrients. 2020;12(9):1-13. DOI:10.3390/nu12092719
12. Gokhan Bagci, Can Huzmeli FC. Vitamin D receptor polymorphisms in overweight/obese chronic kidney disease patients undergoing hemodialysis. Turk J Nephrol. 2023: [Epub Ahead of Print]. DOI: 10.5152/turkjnephrol.2023.23369
13. Djurovic J, Stojkovic O, Ozdemir O, et al. Association between FokI, ApaI and TaqI RFLP polymorphisms in VDR gene and Hashimoto's thyroiditis: Preliminary data from female patients in Serbia. International Journal of Immunogenetics. 2015;42(3):190-194. DOI:10.1111/iji.12199
14. Rasoul MA, Haider MZ, Al-Mahdi M, Al-Kandari H, Dhaunsi GS. Relationship of four vitamin D receptor gene polymorphisms with type 1 diabetes mellitus susceptibility in Kuwaiti children. BMC Pediatrics. 2019;19(1):1-13. DOI:10.1186/s12887-019-1448-0
15. Karonova T, Grineva E, Belyaeva O, et al. Relationship between vitamin D status and vitamin D receptor gene polymorphisms with markers of metabolic syndrome among adults. Frontiers in Endocrinology. 2018;9(AUG):1-7. DOI:10.3389/fendo.2018.00448
16. Park JE, Pichiah PBT, Cha YS. Vitamin D and metabolic diseases: Growing roles of Vitamin D. Journal of Obesity and Metabolic Syndrome. 2018;27(4):223-232. DOI:10.7570/JOMES.2018.27.4.223
17. Banjabi AA, Al-Ghafari AB, Kumosani TA, Kannan K, Fallatah SM. Genetic influence of vitamin D receptor gene polymorphisms on osteoporosis risk. International Journal of Health Sciences. 2020;14(4):22-28.
18. Agliardi C, Guerini FR, Bolognesi E, Zanzottera M, Clerici M. Autoimmunity: A narrative review. Biology. 2023;12(916):1-16. DOI: 10.3390/biology12070916
19. Argano C, Mirarchi L, Amodeo S, Orlando V, Torres A, Corrao S. The role of vitamin D and its molecular bases in insulin resistance, diabetes, metabolic syndrome, and cardiovascular disease: State of the art. International Journal of Molecular Sciences. 2023;24(20):1-26. DOI:10.3390/ijms242015485
20. Mahmoud R, Kimonis V, Butler MG. Genetics of obesity in humans: A clinical review. International Journal of Molecular Sciences. 2022;23(19):1-15. DOI: 10.3390/ijms231911005
21. Wang D, Su K, Ding Z, Zhang Z, Wang C. Association of vitamin D receptor gene polymorphisms with metabolic syndrome in Chinese children. International Journal of General Medicine. 2021;14:57-66. DOI:10.2147/IJGM.S287205
22. Araújo EP dos S, Lima SCV da C, Galdino OA, Arrais RF, de Souza KSC, de Rezende AA. Association of CYP2R1 and VDR polymorphisms with metabolic syndrome components in non-diabetic Brazilian adolescents. Nutrients. 2022;14(21). DOI:10.3390/nu14214612
23. Liu Y, Guo X, Huang SY, et al. Evaluation of association studies and a systematic review and

meta-analysis of VDR polymorphisms in type 2 diabetes mellitus risk. Medicine (United States). 2021;100(28):E25934. DOI:10.1097/MD.0000000000025934

24. Rebelos E, Tentolouris N, Jude E. The role of vitamin D in health and disease: A narrative review on the mechanisms linking vitamin D with disease and the effects of supplementation. Drugs. 2023;83(8):665-685. DOI:10.1007/s40265-023-01875-8
25. Ostadsharif M, Rashidi F. Association of ApaI polymorphism of VDR gene with obesity in Iranian population. Biomedica. 2021;41(4):2-34. DOI:10.7705/biomedica.5898
26. Khattab Y, Reda R, El-Gaafary M, Zeitoun Y, Abo-Shady R, Abdelhady W. BsmI gene polymorphism of vitamin D receptor in obese Egyptian male medical students and its relationship with vitamin D deficiency. Egyptian Journal of Medical Human Genetics. 2022;23(1). DOI:10.1186/s43042-022-00275-z
27. Rahmadhani R, Zaharan NL, Mohamed Z, Moy FM, Jalaludin MY. The associations between VDR BsmI polymorphisms and risk of vitamin D deficiency, obesity and insulin resistance in adolescents residing in a tropical country. PLoS ONE. 2017;12(6):1-14. DOI: 10.1371/journal.pone.0178695
28. Jorde R, Grimnes G. Vitamin D and metabolic health with special reference to the effect of vitamin D on serum lipids. Progress in Lipid Research. 2011;50(4):303-312. DOI: 10.1016/j.plipres.2011.05.001
29. Landrier JF, Karkeni E, Marcotorchino J, Bonnet L, Tourniaire F. Vitamin D modulates adipose tissue biology: possible consequences for obesity? The Proceedings of the Nutrition Society. 2016;75(1):38-46. DOI:10.1017/S0029665115004164
30. Bennour I, Haroun N, Sicard F, Mounien L, Landrier JF. Vitamin D and obesity/adiposity—A brief overview of recent studies. Nutrients. 2022;14(10):1-16. DOI: 10.3390/nu14102049
31. Xu Y, Lou Y, Kong J. VDR regulates energy metabolism by modulating remodeling in adipose tissue. European journal of pharmacology. 2019;865:172761. DOI:10.1016/j.ejphar.2019.172761
32. Picó C, Palou M, Pomar CA, Rodríguez AM, Palou A. Leptin as a key regulator of the adipose organ. Reviews in Endocrine and Metabolic Disorders. 2022;23(1):13-30. DOI: 10.1007/s11154-021-09687-5
33. Obradovic M, Sudar-Milovanovic E, Soskic S, et al. Leptin and obesity: Role and clinical implication. Frontiers in Endocrinology. 2021;12(May):1-14. DOI: 10.3389/fendo.2021.585887
34. Sundari LPR, Purnawati S, Tunas IK, Weta IW. Low 25 hydroxyvitamin D and high leptin level as risk factors of metabolic syndrome in obese women. Current Research in Nutrition and Food Science. 2022;10(3):1161-1168. DOI: 10.12944/CRNFSJ.10.3.29
35. Gariballa S, Al-Bluwi GSM, Yasin J. Frequency of vitamin D receptor gene polymorphisms in a population with a very high prevalence of vitamin D deficiency, obesity, diabetes and hypertension. Biomedicines. 2023;11(4). DOI:10.3390/biomedicines11041202
36. Tobias DK, Luttmann-Gibson H, Mora S, et al. Association of body weight with response to vitamin D supplementation and metabolism. JAMA Network Open. 2023;6(1):e2250681. DOI: 10.1001/jamanetworkopen.2022.50681

Vitamin D receptor polymorphism associated with obesity in productive age population: A cross-sectional study

by dr.Yohana, et.al

Submission date: 29-Apr-2025 09:17AM (UTC+0700)
Submission ID: 2305823617
File name: OA4_Vitamin_D_Receptor_Polymorphism_Draft_1_ed_VW_1_2.pdf (369.34K)
Word count: 6070
Character count: 30836

JKKI: Jurnal Kedokteran dan Kesehatan Indonesia
Indonesian Journal of Medicine and Health
Journal homepage: https://journal.uii.ac.id/JKKI
P-ISSN 2085-4145 | E-ISSN 2527-2950

Vitamin D receptor polymorphism associated with obesity in productive age population: A cross-sectional study

Yohana,[1]* Meiyanti,[2] Monica Dwi Hartanti,[3] Eveline Margo,[4] Reni Zuraida[5]

[1]Department of Biochemistry, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
[2]Department of Pharmacology and Pharmacy, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
[3]Department of Biology, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
[4]Department of Physiology, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
[5]Department of Community Medicine, Faculty of Medicine, Universitas Lampung, Lampung, Indonesia

Article Info:

Keywords: polymorphism; Vitamin D; obese; gene

Article History:

Received: July 11, 2024
Accepted: February 21, 2025
Online: April 25, 2025

***Corresponding author:**
dryohana@trisakti.ac.id

DOI: 10.20885/JKKI.Vol16.Iss1.art6

Original Article

ABSTRACT

Background: Obesity is influenced by genetic factors, lifestyle, and environmental factors. This increase in obesity gives rise to various chronic disease problems.
Objectives: This study aimed to identify genetic variations of Vitamin D receptors and determine the relationship to obesity in terms of body mass index and body fat percentage in the working group.
Methods: This study is an analytical observational study with a cross-sectional research design approach in the Jembatan Dua area, Angke sub-district, West Jakarta. The research instrument used was a questionnaire to obtain characteristic data, as well as an examination of VDR gene variations rs1544410, rs2228570, rs7975232, and PCR examination to obtain data on gene variation.
Results: The results obtained are as follows: the average age of subjects was 42.24, with 58.1% females. A total of 39 (69.1%) are Javanese. Thirty-one (50%) subjects were included in the category of obesity (BMI> 25), and 41 (66.1%) subjects were obese category based on the body fat percentage. The results of bivariate analysis obtained SNP VDR FokI gene obtained a significant relationship with body mass index with a p-value of 0.047, while the VDR BsmI gene obtained a statistically meaningful relationship with body fat percentage with a p-value of 0.043.
Conclusion: FokI and BsmI VDR polymorphisms are associated with body mass index and body fat percentage.

INTRODUCTION

Obesity is one of the health problems in the world that can occur from children to the elderly. Based on basic health research data held by Ministry of Health Indonesia in 2018, the prevalence of adult obesity increased in a decade from 10.5% to 21.8% using the body mass index (BMI) category ≥27kg/m^2. The results of this research show that women suffer more obesity than men and the incidence of obesity in various regions in Indonesia varies depending on economic, demographic, and educational factors.[1] Mortality and morbidity rates will increase with obesity. Chronic degenerative diseases will also increase in number such as diabetes mellitus, cardiovascular disease, osteoarthritis, cancer, and stroke. Obesity is characterized by an increase in the amount of energy stored in the body compared to the amount used. The energy stored in the body can be seen from anthropometric indicators such as body weight, height, abdominal circumference, pelvic circumference, and skinfold thickness.[2] A commonly used indicator to categorize obesity is BMI. Based on the Asia Pacific IMT category, IMT can be classified into obese ≥25kg/m^2, overweight 23-24.9 kg/m^2, normal 18.5-22.9 kg/m^2, and underweight ≤18 kg/m^2.

Several studies in Asia suggest that being overweight can be a risk factor for diabetes mellitus, hypertension, and stroke.[3]

Increases and decreases in Vitamin D levels in the body are influenced by several factors, namely external factors and internal factors. External factors such as sun exposure, and food intake. At the same time, internal factors are genetic relationships and skin color. In addition, nutritional status is also related to Vitamin D levels in the blood, both levels and metabolism.[4] One study shows obesity is influenced by vitamin D deficiency. Low levels of vitamin D are associated with metabolic syndrome, autoimmune, cancer, and psychiatric disorders. This study is a continuation of the previous one. A preliminary study in the West Jakarta area aimed to see the picture of risk factors for causing vitamin D deficiency in young adults, it was found that 60.6% of 25(OH)D3 levels of subjects were classified as deficiency, and 33.3% were classified as insufficiency. As much as 93.9% of subjects in this mapping study's 25(OH)D3 levels experienced insufficiency to deficiency.[5] Another study conducted in Angke, West Jakarta found a prevalence of 54% of participants experiencing overweight).[6] Vitamin D is a lipid-soluble hormone so it can be used as a sign of metabolic disorders related to adipose tissue of the body.[7] According to sequestration theory, Vitamin D is a fat-soluble vitamin, so when there is an increase in fat in obese patients, there is an increase in the accumulation of Vitamin D in fat resulting in decreased serum vitamin D levels.[8,9]

Various VD genes can undergo polymorphisms in a singular nucleotide gene level, as found in previously stated cases. In these cases, it can lead to a deficiency of vitamin D, which is caused by dysfunctional VDR. A Singapore study showing a link between BMI and the levels of Vitamin D within the subject underlined the low proportion of Vitamin D adequacy in respondents with an increase in BMI of 35.8%.[10] Meanwhile, a study conducted in Taiwan on workers aged 26-65 years stated different results that there was no relationship between BMI and vitamin D levels, but age and season were important factors for hypovitaminosis D.[11]

Another finding was that variations in *the FokI, ApaI, and TaqI* genes were secondary risk factors for dyslipidemia, hyperglycemia, and hyperparathyroidism, but did not correlate with obesity.[12] There are still differences in research results regarding the relationship between genetic variations in Vitamin D receptors with predisposing factors to metabolic and cardiovascular diseases, especially obesity conditions. The prevalence rate of overweight and hypovitaminosis of vitamin D in the West Jakarta area is quite high, so the purpose of this study is to identify genetic variations of Vitamin D receptors and determine the relationship to obesity in terms of body mass index and body fat percentage in the group of workers in the West Jakarta.

METHODS

This study is an analytical observational study with a cross-sectional. This study involved a group of Dhamamsavana Foundation workers in the Angke Village area, West Jakarta. The included classes for this study were people aged between 20 to 64 years, workers indoors working 8 hours. These subjects had already consented to the study, and are willing to participate in the study. The people excluded from this study are those with a history of malignancy, kidney failure, autoimmune diseases, and limited mobility. This study used consecutive nonrandom sampling techniques.

The sample size used for this study used the infinite population formula: $n = Z\alpha\ 2xpxq / d2$, with $Z\alpha = 1.96$ $p = 0.54$ $q = 1\text{-}0.54 = 0.46$ $d = 0.05$ followed by the finite population formula $N = no / (1 + n0 / N)$, so a minimum of 60 samples are needed. Blood samples are taken to check fasting blood glucose levels, vitamin D, HDL, and triglycerides. Physical examination is also carried out in the form of height, weight, BMI, body fat percentage, and blood pressure checks of systole, diastole, and temperature.

Measurement procedure and how it works: The body height of the subjects is measured using a Seca height gauge with an accuracy of up to 0.1 cm. The subjects are measured in an upright position. BMI is calculated as the quotient of body mass. It is calculated as the body mass in kilograms divided by the height of the subjects as square meters (kg/m^2). Systolic (SBP) and diastolic (DBP) blood pressure is measured with a digital sphygmomanometer and calculated as

the average of two consecutive readings. For blood chemistry tests, fasting blood glucose will be sent to the clinical laboratory.

Genetic Analysis

Blood samples were gathered from veins using tubes containing EDTA. Genomic DNA was extracted from 200 µL of each sample using a DNA isolation kit (Zymo Research, Irvine, CA, USA). The extracted DNA samples were then stored in a freezer at -20°C for future analysis. The VDR polymorphism, including ApaI, BsmI, and FokI, was analyzed using RFLP (Restriction Fragment Length Polymorphism) methods by amplifying targeted DNA regions using PCR within a 50 µL reaction volume containing 25 µL of MyTaqTM HS Red Mix (2X) (Meridian Bioscience, Memphis, Tennessee, USA) and 20 µM of each primer.[13] The polymerase chain reaction involves an initial temperature of 95°C for 3 minutes, then, afterward, it is followed by 30 cycles of denaturation at the temperature of 95°C for 30 seconds, After the previously stated process, it is annealed for 30 seconds with a temperature 95°C, before being extended for 1 minute at 72°C, before finally undergoing final extension step for 5 minutes at 72°C.

For ApaI polymorphism (g.59979G > T; rs7975232), a 745-bp PCR product was generated and digested with 1 U of FastDigest ApaI (Thermo Scientific, Hudson, NH, USA) at 37°C for 5 minutes. No cleavage site for the restriction enzyme was present for the A-allele, resulting in a 745 bp product. Conversely, individuals harboring the 'a-allele' exhibited cleavage products measuring 531- and 214-bp. In the case of BsmI polymorphism (A > G; rs1544410), an 870-bp fragment was amplified and treated with BsmI restriction enzyme (New England BioLabs), leading to variable fragment lengths indicative of different alleles. The allele 'B' was identified when an 870 bp product was present, indicating the absence of a cleavage site. Conversely, allele 'b' was identified using the fragments measured as 460, 234, and 176 bp, respectively. FokI polymorphism (C > T; rs10735810) involved amplification of a 273-bp product that was subjected to enzymatic cleavage using FastDigest FokI (Thermo Scientific, Hudson, NH, USA) at 37°C, producing characteristic fragment patterns. The assignment of alleles 'F' or 'f' was predicated upon the presence of a 273 bp fragment (F-allele), or the identified fragments of 198 and 65 bp fragments (f-allele), respectively. Heterozygous individuals (Ff) displayed products measuring 273, 198, and 65 bp concurrently. DNA fragments were cleaved and separated with 2% agarose gel electrophoresis to then be visualized using Blue light illumination following staining with Floro+green (1st Base, Singapore, Singapore). Enzyme and primer sequences were provided in Table 1.[14]

Table.1 Enzyme restriction sequences

Enzyme	Primers sequences	Genotype
ApaI	Forward: 5′- AGA GCA TGG ACA GGG AGCAAG-3′	AA, Aa, aa
	Reverse: 5′-AGAGCATGGACAGGGAGCAAG-3	
BsmI	Forward: 5′- AACCAGCGGGAAGAGGTCAAGGG-3′	BB, Bb,bb
	Reverse: 5′- CAACCAAGACTACAAGTACCGCGTCAGTGA-3′	
FokI	Forward: 5′- GATGCCAGCTGGCCCTGGCACTG-3′	FF,Ff,ff
	Reverse: 5′- ATGGAAACACCTTGCTTCTTCTCCCTG-3	

Statistical methods

The data (age, blood pressure, fasting glucose, HDL, triglyceride, and level of vitamin D) will be tested for normality, normal data will be presented as mean +/- SD, abnormal data will be presented as median (min, max), and categorical data (gender, ethnic, body mass index, percentage body fat, genotype VDR) will be presented as n (%). The bivariate test analyses the main hypothesis (VDR polymorphism vs BMI and fat percentage) using the Chi-square test if it meets the requirements or the Fisher test if it does not meet the requirements. Statistical analysis using software SPSS 25.0

Ethical statement

This research has passed the ethical review Number 002/KER/FK/2024 from the Research Ethics Commission of the Faculty of Medicine, Universitas Trisakti.

RESULTS

An overview of the characteristics of the subject of study can be seen in Table 2. Based on Table 2, the average age of subjects was 42.24, female as much as 58.1%. A total of 39 (69.1%) are Javanese. Blood pressure obtained average values of 121.82 ±17.51 mmHg for systolic and 78.24 ±11.01 for diastolic. Based on body mass index of 31 (50%) included in the category of obesity (BMI> 25) and 41 (66.1%) based on body fat percentage included in the category of obesity. The SNP of the VDR gene of most subjects had an Ff genotype of 34 (54.8%) for FokI, 42 (67.7%) of the Bb genotype for BsmI, 34 (54.8%) of the Aa genotype for ApaI and 60 (96.8%) of the TT genotype for TaqI.

Table 2. Subject Characteristics (n=62)

Variable	n(%)	mean± SD
Gender		
Man	26 (41.9)	
Woman	36 (58.1)	
Ethnic group		
Javanese	39 (62.90)	
Sundanese	13 (20,97)	
Betawi	2 (3.22)	
Batak	3 (4.84)	
Minang	5 (8.07)	
Age		42.24 ± 8.82
Blood pressure		
Systolic		121,82 ± 17,51
Diastole		78,24 ± 11,01
Fasting glucose		89.33± 13.39
HDL (high-density lipoprotein)		53,42 ± 13,36
Triglyceride		120,76 ± 78,46
Body mass index		
Obese	31 (50)	
Not obese	31 (50)	
% Body Fat		
Obese	41 (66.1)	
Not obese	21 (33.9)	
Level Vitamin D	16.50 ±6.54	
GDR		
FokI genotype		
FF (homozygote)	12 (19.4)	
Ff (heterozygote)	34 (54.8)	
ff	16 (25.8)	
BsmI genotype		
BB (homozygote)	10 (16.1)	
Bb (heterozygote)	42 (67.7)	
bb	19 (16.1)	

Table 2. Subject Characteristics (n=62) (continued)

Variable	n(%)	mean± SD
ApaI (rs7975232) **genotype**		
AA (homozygote polymorphic)	12 (19.4)	
Aa (heterozygote polymorphic)	34 (54.8)	
aa	16 (25.8)	
TaqI genotype		
TT (homozygote polymorphic)	60 (96.8)	
Tt (heterozygote polymorphic)	0 (0)	
tt	2 (3.2)	

Table 3. Bivariate Analysis of Association of VDR Gene SNPs with Body Mass Index (n=62)

SNP VDR	Body mass index			OR	95% CI	p
	Not obese n (%)	Obese N (%)	Total n (%)			
FoxI						
FF (Reference)	6 (19.4)	6 (19.4)	12 (19.4)			0.047*
Ff	15 (48.4)	19 (61.3)	34 (54.8)	5.06	0.91-28.15	
ff	10 (32.3)	6 (19.4)	16 (25.8)	0.67	0.07-6.11	
BsmI						
BB (Reference)	4 (12.9)	6 (19.4)	10 (16.1)			0.781
Bb	22 (71.0)	20 (64.5)	42 (67.7)	0.67	0.16-2.71	
bb	5 (16.1)	5 (16.1)	10 (16.1)	0.67	0.11-3.92	
ApaI						
AA (Reference)	6 (19.4)	6 (19.4)	12 (19.4)			0.832
Aa	16 (51.6)	18 (58.1)	34 (54.8)	0.71	0.19-2.76	
aa	9 (29.0)	7 (22.6)	16 (25.8)	0.17	0.17-3.02	
TaqI						
TT	29 (93.5)	31 (100)	60 (96.8)			0.151**
Tt	0	0	0			
tt	2 (6.5)	0	2 (3.2)	0.88	0.10-15.33	

CI: confidence interval; OR: odds ratio; *p<0.05; ** fisher

The results of bivariate analysis showed that SNP of the FoxI VDR gene obtained a significant relationship with body mass index, with a p-value of 0.047 (Table 3), while the BsmI VDR gene obtained a statistically meaningful relationship with body fat percentage, with a p-value of 0.043 (Table 4). Figure 1 presents representative gel electrophoresis results of PCR products digested with *FokI*, *BsmI*, and *ApaI* enzymes, clearly showing the banding patterns corresponding to different genotypes.

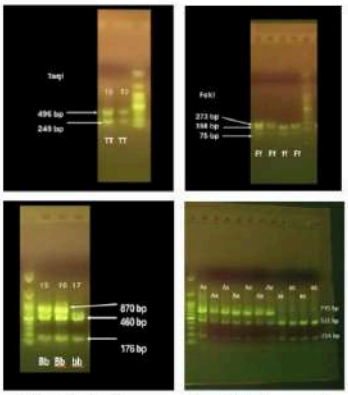


Figure 1. Restriction Fragment Length Polymorphism VDR

Table 4. Bivariate Analysis of SNP Relationship of VDR Gene with Body Fat Percentage (n=62)

SNP gen VDR	Body Fat Percentage			OR	95% CI	p
	Not Obese n (%)	Obese n (%)	Total n (%)			
FokI						
FF (reference)	4 (19)	8 (19.5)	12 (19.4)			0.937
Ff	11 (52.4)	23 (56.1)	34 (54.8)	3.78	0.78-18.13	
ff	6 (28.6)	10 (24.4)	16 (25.8)	1.2	0.19-7.44	
BsmI						
BB (reference)	1 (4.8)	9 (22)	10 (16.1)			0.043*
Bb	18 (85.7)	24 (58.5)	42 (67.7)	1.37	0.30-6.32	
bb	2 (9.5)	8 (19.5)	10 (16.1)	0.43	0.07-2.68	
ApaI						
AA (reference)	4 (19)	8 (19.5)	12 (19.4)			0.96
Aa	12 (57.1)	22 (53.7)	34 (54.8)	0.3	0.56-1.62	
aa	5 (23.8)	11 (26.8)	16 (25.8)	0.8	0.12-5.20	
TaqI						
TT	20 (95.2)	40 (97.6)	60 (96.8)			0.624
Tt	0 (0)	0 (0)	0 (0)			
tt	1 (4.8)	1 (2.4)	2 (3.2)	0.5	0.03-8.42	

OR: odds ratio; CI: confidence interval; *p<0.05

DISCUSSION

The levels within the subjects of this study have an average of 16.50 ng/ml, and can be categorized as vitamin D deficient, this may be because the average employee works indoors so that less outdoor activities and inadequate exposure to natural sunlight. Low exposure to sunlight is the main cause of reduced vitamin D intake, which leads to deficiency of vitamin D. Vitamin D has various physiological roles in the body such as hemostatic calcium and phosphate, regulating the process of proliferation and differentiation of the human cells, immune system and also affecting the effectivity of the cardiovascular system. Vitamin D deficiency conditions are found

to affect a variety of acute and chronic diseases. Vitamin D deficiency is associated with various metabolic disorders. These include cases of type 2 diabetes, common obesity, and other kinds of metabolic syndromes as well.[15]

The findings of this study suggest a potential association between VDR gene polymorphisms, particularly FokI VDR gene SNPs, and BMI. This suggests that the presence of VDR genetic variation may potentially hold influence over the regulation of body fat distribution, and the body weight. It seems reasonable to suggest that vitamin D plays an important role in calcium and phosphate metabolism, as well as in several other biological functions, including the modulation of immune and inflammatory responses. These functions may affect body weight regulation. [16,17] Furthermore, vitamin D plays an important role in body weight regulation and energy metabolism, as it is understood that VDR is expressed in various tissues, including the liver, muscle, and adipose tissue, all of which are involved in energy metabolism. This study offers further insight into the potential influence of VDR gene polymorphisms on the body's response to vitamin D, which may in turn affect BMI. The observed association between VDR FokI SNPs and BMI suggests that these genetic variations could be considered potential genetic markers for predicting the risk of obesity or weight loss.[16,18,19]

This study lends further support to the findings of previous studies, which have indicated that VDR may play a role in regulating body weight and body composition. It seems that individuals with VDR gene polymorphisms may tend either a lower or a higher BMI, depending on the specific gene variation in question. It seems that the interaction between genes and environmental factors, such as exposure, may depend on the type of variation involved. Additionally, some studies have suggested that the interaction between the VDR gene and environmental factors, such as dietary vitamin D intake and sun exposure, may potentially influence BMI.[19,20]

One study in China suggests that there may be a potential association between FokI polymorphism and increased susceptibility to metabolic syndrome in the pediatric age group. [21] There is some evidence to suggest that the VDR polymorphism may be associated with increased BMI. This could be due to the location of genes that are more related to vitamin D receptor function, which may affect gene transcription activity, mRNA stability, or interactions with co-factors that are important in metabolic processes. Furthermore, it is possible that changes in receptor structure due to these polymorphisms could alter the affinity or binding effectiveness of vitamin D, which could then affect various metabolic pathways, including those involved in body weight regulation and body fat distribution.[22,23] It seems likely that the interaction between VDR polymorphisms and several environmental factors such as vitamin D intake, sun exposure, and lifestyle may contribute to BMI variability and be associated with the onset of several diseases.[24,25]

The Chinese study found that VDR SNP variations did not correlate with BMI and WC, but these VDR variations were related to triceps skin fold thickness and body fat percentage. In the GT ApaI genotype is associated with higher cholesterol and LDL levels. The VDR variant has an important influence on adipose and adipose network activity in Han China.[2] VDR is expressed in the adipose tissues, examples include 3-TC-LI adipocyte, the SAT and VAT presence in humans, the human preadipocytes, and the other differentiated adipocytes as well. This adipose tissue has various functions for lipid synthesis, fatty acid transport, and adipokine secretion [21]. The study by Fang found that there is no relationship between VDR SNP and BMI or WC, the difference can be influenced by different ethnic backgrounds. The increase in body fat percentage is linked with the presence of the T allele of FokI and the T allele of ApaI, meanwhile, the cases of triceps skin fold thickness are linked with the G allele of rs2239179 and the T allele of ApaI.[2]

It seems that there might be a link between the BsmI SNP polymorphism in the VDR gene and body fat percentage. This could be due to some factors, including the location of the BsmI SNP in an area that affects the vitamin D receptor in functionality and expressionality. It is thought that the VDR gene intronic region is where the BsmI SNP is located, which could potentially affect the mRNA splicing process and VDR protein expression. It is thought that variations in the splicing process may result in the production of different vitamin D receptor isoforms, which could potentially lead to variations in biological activity. It is thought that variations in BsmI SNPs may

affect the binding affinity of vitamin D to the receptor, which could potentially influence the transcriptional activity of genes regulated by VDR. This could have implications for the regulation of genes involved in body fat distribution and fat metabolism. It is also possible that BsmI polymorphism may affect the stability of mRNA, which could in turn affect the amount of VDR protein present in adipose cells.[26,27]

Polymorphism ApaI and BsmI genotypes showed significant differences in WC, WHR, body fat percentage, TG, and HDL-C levels, implying that these specific VDR genotypes are linked particularly to the lipid profile and distribution. Dyslipidemia, encompassing hypertriglyceridemia and low HDL-C, constitutes a facet of metabolic syndrome. Vitamin D's potential impact on lipid metabolism has been a subject of interest. Numerous epidemiological investigations have explored the nexus between vitamin D levels and dyslipidemia. Vitamin D status has a positive correlation between vitamin D with serum HDL-C levels, along with a negative correlation with TG within the context of lipid regulation, adipose tissue takes on a pivotal role. It is noteworthy that this tissue expresses the VDR along with enzymes involved in vitamin D metabolism and associated signaling pathways, thus emerging as the principal reservoir for vitamin D storage.[28-30]

It seems that genetic variation in the form of BsmI polymorphism may influence leptin levels in the body. The adipocyte cells produce the Leptin hormone, which affects energy metabolism and is thought to regulate appetite. It seems possible that the VDR gene polymorphism may affect how vitamin D interacts with adipose tissue, affecting leptin production. It is reasonable to suggest that leptin plays an important role in energy regulation and body weight management. It is also reasonable to suggest leptin levels affect body mass index (BMI) and body fat percentage. It is thought the hypothalamus in the brain affects leptin's function to inhibit appetite and increase energy expenditure. In individuals with a normal body weight, there is a fluctuation in leptin levels by the body's fat reserves. However, in individuals who are obese, leptin levels are typically elevated, yet they may experience leptin resistance, which is when the body does not respond effectively to leptin signals. This can result in disturbances in the regulation of appetite and energy expenditure. Furthermore, leptin resistance in obese individuals can contribute to the difficulty in losing weight despite high leptin levels.[31-34]

Vitamin D deficiency can cause an increased risk of diabetes mellitus.[35] VDR gene variations that have been known to have a relationship with obesity are *FokI (rs 2228570), BsmI (rs1544410), ApaI (rs7975232),* and *TaqI* (rs 731236). Expression of mRNA and proteins from VDRs such as BsmI is associated with an increased incidence of obesity.[26] Several studies provide pro and con results on the relationship of VDR gene polymorphism with obesity. The results of the study of Tobias et al. showed that vitamin D 25 OH levels were lower in subjects with more weight and obesity compared to subjects with normal and less weight.[36] This is associated with a very slow vitamin D release rate, caused by body fat, which will lead to low serum 25(OH)D levels.

Studies in Iranian populations are known to show a relationship between variations in *ApaI* and obesity, and become one of the risk factors for obesity. However, the *TaqI* gene was found to have no meaningful association with obesity. [25] Rayinda et.al found the *BsmI* gene has a connection to insulin resistance and the lack of vitamin D within the body. However, this had no association with the occurrence of obesity cases in tropical populations. The study also suggested that *the FokI gene* has been associated with an increased incidence of diabetes mellitus in Asian populations.[27] The *FokI* gene was found to be associated with increased blood glucose levels and BMI of more weight and/or obese in Turkey.

The findings that this study had shown have the potential bring contribution toward developing an effective strategy for the control of obesity and body weight. VDR polymorphisms have been shown to influence vitamin D metabolism, highlighting the significance of consuming nutritional and vitamin D supplementation approaches and other environmental factors. However, there are still limitations of this study, including the absence of certain crucial environmental factors, such as sun exposure, dietary habits, and vitamin D supplementation.

CONCLUSION

Based on this study, the polymorphisms of Vitamin D receptors are associated with body mass index (BMI) and the percentage of body fat. FoxI and BsmI were associated with obesity and body weight. Other strategies are needed to prevent obesity such as physical activity, dietary restriction, and vitamin D supplementation. Further studies are needed to explore other VDR gene polymorphisms as the larger sample.

CONFLICT OF INTEREST

The authors should make a conflict-of-interest disclosure statement or a declaration that they do not have any conflicts of interest. They should disclose at the time of revision any financial arrangement they may have with a company whose product is pertinent to the submitted manuscript or with a company making a competing product. Such information will be held in confidence - while the paper is under review - and will not influence the editorial process.

ACKNOWLEDGMENTS

The authors declare that there is no conflict of interest in this study.

DATA AVALABILITY

Data sharing does not apply to this article.

SUPPLEMENTAL DATA

None.

AUTHOR CONTRIBUTIONS

Conceptualization: Y, M. Data curation: Y, M, MD, EM. Format analysis: M, EM, RZ. Methodology: Y, M, MDH writing of the original draft: Y. Writing of review and editing: M, MD, RZ.

DECLARATION OF USING AI IN THE WRITING PROCESS

We are using the Grammarly application for English grammar and Mendeley for arranging references.

LIST OF ABBREVIATIONS

VDR= Vitamin D Receptor; SNP= Single Nucleotide Polymorphism; WC= Waist Circumference; BMI= Body Mass Index

REFERENCES

1. Ayuningtyas D, Kusuma D, Amir V, Tjandrarini DH, Andarwati P. Disparities in obesity rates among adults: Analysis of 514 districts in Indonesia. Nutrients. 2022;14(16):1-18. DOI:10.3390/nu14163332
2. Shen F, Wang Y, Sun H, et al. Vitamin D receptor gene polymorphisms are associated with triceps skin fold thickness and body fat percentage but not with body mass index or waist circumference in Han Chinese. Lipids in health and disease. 2019;18(1):97. DOI:10.1186/s12944-019-1027-2
3. Lim JU, Lee JH, Kim JS, et al. Comparison of World Health Organization and Asia-Pacific body mass index classifications in COPD patients. International Journal of COPD. 2017;12:2465-2475. DOI:10.2147/COPD.S141295
4. Shah D, Gupta P. Vitamin D deficiency: Is the pandemic for real? Indian Journal of Community Medicine. 2015;40(4):215-217. DOI:10.4103/0970-0218.164378
5. Santoso AH, Yanti D, Silaban L, Charissa O. Pemetaan awal kadar 25 (OH) D dan faktor risiko defisiensi vitamin D pada dewasa muda di Jakarta Barat. Tarumanegara Medical Journal. 2023;5(1):16-25. DOI: 10.24912/tmj.v5i1.23706
6. Yohana Y, Meiyanti M, Margo E, Kartadinata E. Evaluasi pengukuran glukosa darah puasa dan

asam urat pada lanjut usia di Kelurahan Angke, Jakarta Barat. Jurnal Dharma Bhakti Ekuitas. 2023;7(2):123-130. DOI:10.52250/p3m.v7i2.644

7. Vranić L, Mikolašević I, Milić S. Vitamin D deficiency: Consequence or cause of obesity? Medicina (Lithuania). 2019;55(9). DOI:10.3390/medicina55090541
8. Khan SM, El HajjChehadeh S, Abdulrahman M, Osman W, Al Safar H. Establishing a genetic link between FTO and VDR gene polymorphisms and obesity in the Emirati population. BMC Medical Genetics. 2018;19(1):1-9. DOI i:10.1186/s12881-018-0522-z
9. Fronczek M, Osadnik T, Banach M. Impact of vitamin D receptor polymorphisms in selected metabolic disorders. Current Opinion in Clinical Nutrition and Metabolic Care. 2023;26(4):316-322. DOI:10.1097/MCO.0000000000000945
10. Man REK, Li LJ, Cheng CY, Wong TY, Lamoureux E, Sabanayagam C. Prevalence and determinants of suboptimal vitamin D levels in a multiethnic asian population. Nutrients. 2017;9(3):1-12. DOI:10.3390/nu9030313
11. Wang LK, Hung KC, Lin YT, et al. Age, gender and season are good predictors of vitamin D status independent of body mass index in office workers in a subtropical region. Nutrients. 2020;12(9):1-13. DOI:10.3390/nu12092719
12. Gokhan Bagci, Can Huzmeli FC. Vitamin D receptor polymorphisms in overweight/obese chronic kidney disease patients undergoing hemodialysis. Turk J Nephrol. 2023: [Epub Ahead of Print]. DOI: 10.5152/turkjnephrol.2023.23369
13. Djurovic J, Stojkovic O, Ozdemir O, et al. Association between FokI, ApaI and TaqI RFLP polymorphisms in VDR gene and Hashimoto's thyroiditis: Preliminary data from female patients in Serbia. International Journal of Immunogenetics. 2015;42(3):190-194. DOI:10.1111/iji.12199
14. Rasoul MA, Haider MZ, Al-Mahdi M, Al-Kandari H, Dhaunsi GS. Relationship of four vitamin D receptor gene polymorphisms with type 1 diabetes mellitus susceptibility in Kuwaiti children. BMC Pediatrics. 2019;19(1):1-13. DOI:10.1186/s12887-019-1448-0
15. Karonova T, Grineva E, Belyaeva O, et al. Relationship between vitamin D status and vitamin D receptor gene polymorphisms with markers of metabolic syndrome among adults. Frontiers in Endocrinology. 2018;9(AUG):1-7. DOI:10.3389/fendo.2018.00448
16. Park JE, Pichiah PBT, Cha YS. Vitamin D and metabolic diseases: Growing roles of Vitamin D. Journal of Obesity and Metabolic Syndrome. 2018;27(4):223-232. DOI:10.7570/JOMES.2018.27.4.223
17. Banjabi AA, Al-Ghafari AB, Kumosani TA, Kannan K, Fallatah SM. Genetic influence of vitamin D receptor gene polymorphisms on osteoporosis risk. International Journal of Health Sciences. 2020;14(4):22-28.
18. Agliardi C, Guerini FR, Bolognesi E, Zanzottera M, Clerici M. Autoimmunity: A narrative review. Biology. 2023;12(916):1-16. DOI: 10.3390/biology12070916
19. Argano C, Mirarchi L, Amodeo S, Orlando V, Torres A, Corrao S. The role of vitamin D and its molecular bases in insulin resistance, diabetes, metabolic syndrome, and cardiovascular disease: State of the art. International Journal of Molecular Sciences. 2023;24(20):1-26. DOI:10.3390/ijms242015485
20. Mahmoud R, Kimonis V, Butler MG. Genetics of obesity in humans: A clinical review. International Journal of Molecular Sciences. 2022;23(19):1-15. DOI: 10.3390/ijms231911005
21. Wang D, Su K, Ding Z, Zhang Z, Wang C. Association of vitamin D receptor gene polymorphisms with metabolic syndrome in Chinese children. International Journal of General Medicine. 2021;14:57-66. DOI:10.2147/IJGM.S287205
22. Araújo EP dos S, Lima SCV da C, Galdino OA, Arrais RF, de Souza KSC, de Rezende AA. Association of CYP2R1 and VDR polymorphisms with metabolic syndrome components in non-diabetic Brazilian adolescents. Nutrients. 2022;14(21). DOI:10.3390/nu14214612
23. Liu Y, Guo X, Huang SY, et al. Evaluation of association studies and a systematic review and

meta-analysis of VDR polymorphisms in type 2 diabetes mellitus risk. Medicine (United States). 2021;100(28):E25934. DOI:10.1097/MD.0000000000025934

24. Rebelos E, Tentolouris N, Jude E. The role of vitamin D in health and disease: A narrative review on the mechanisms linking vitamin D with disease and the effects of supplementation. Drugs. 2023;83(8):665-685. DOI:10.1007/s40265-023-01875-8
25. Ostadsharif M, Rashidi F. Association of ApaI polymorphism of VDR gene with obesity in Iranian population. Biomedica. 2021;41(4):2-34. DOI:10.7705/biomedica.5898
26. Khattab Y, Reda R, El-Gaafary M, Zeitoun Y, Abo-Shady R, Abdelhady W. BsmI gene polymorphism of vitamin D receptor in obese Egyptian male medical students and its relationship with vitamin D deficiency. Egyptian Journal of Medical Human Genetics. 2022;23(1). DOI:10.1186/s43042-022-00275-z
27. Rahmadhani R, Zaharan NL, Mohamed Z, Moy FM, Jalaludin MY. The associations between VDR BsmI polymorphisms and risk of vitamin D deficiency, obesity and insulin resistance in adolescents residing in a tropical country. PLoS ONE. 2017;12(6):1-14. DOI: 10.1371/journal.pone.0178695
28. Jorde R, Grimnes G. Vitamin D and metabolic health with special reference to the effect of vitamin D on serum lipids. Progress in Lipid Research. 2011;50(4):303-312. DOI: 10.1016/j.plipres.2011.05.001
29. Landrier JF, Karkeni E, Marcotorchino J, Bonnet L, Tourniaire F. Vitamin D modulates adipose tissue biology: possible consequences for obesity? The Proceedings of the Nutrition Society. 2016;75(1):38-46. DOI:10.1017/S0029665115004164
30. Bennour I, Haroun N, Sicard F, Mounien L, Landrier JF. Vitamin D and obesity/adiposity—A brief overview of recent studies. Nutrients. 2022;14(10):1-16. DOI: 10.3390/nu14102049
31. Xu Y, Lou Y, Kong J. VDR regulates energy metabolism by modulating remodeling in adipose tissue. European journal of pharmacology. 2019;865:172761. DOI:10.1016/j.ejphar.2019.172761
32. Picó C, Palou M, Pomar CA, Rodríguez AM, Palou A. Leptin as a key regulator of the adipose organ. Reviews in Endocrine and Metabolic Disorders. 2022;23(1):13-30. DOI: 10.1007/s11154-021-09687-5
33. Obradovic M, Sudar-Milovanovic E, Soskic S, et al. Leptin and obesity: Role and clinical implication. Frontiers in Endocrinology. 2021;12(May):1-14. DOI: 10.3389/fendo.2021.585887
34. Sundari LPR, Purnawati S, Tunas IK, Weta IW. Low 25 hydroxyvitamin D and high leptin level as risk factors of metabolic syndrome in obese women. Current Research in Nutrition and Food Science. 2022;10(3):1161-1168. DOI: 10.12944/CRNFSJ.10.3.29
35. Gariballa S, Al-Bluwi GSM, Yasin J. Frequency of vitamin D receptor gene polymorphisms in a population with a very high prevalence of vitamin D deficiency, obesity, diabetes and hypertension. Biomedicines. 2023;11(4). DOI:10.3390/biomedicines11041202
36. Tobias DK, Luttmann-Gibson H, Mora S, et al. Association of body weight with response to vitamin D supplementation and metabolism. JAMA Network Open. 2023;6(1):e2250681. DOI: 10.1001/jamanetworkopen.2022.50681

Vitamin D receptor polymorphism associated with obesity in productive age population: A cross-sectional study

ORIGINALITY REPORT

16%	13%	10%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	jurnal.uii.ac.id Internet Source	2%
2	Tatiana Karonova, Elena Grineva, Olga Belyaeva, Anna Bystrova, Edward B. Jude, Alena Andreeva, Anna Kostareva, Pawel Pludowski. "Relationship Between Vitamin D Status and Vitamin D Receptor Gene Polymorphisms With Markers of Metabolic Syndrome Among Adults", Frontiers in Endocrinology, 2018 Publication	1%
3	journal.uii.ac.id Internet Source	1%
4	Submitted to Trisakti University Student Paper	1%
5	Geissler, Catherine, Powers, Hilary. "Human Nutrition", Human Nutrition, 2023 Publication	1%
6	www.researchgate.net Internet Source	1%
7	www.science.gov Internet Source	1%
8	www.mdpi.com Internet Source	1%
9	www.researchsquare.com Internet Source	1%

10	open.library.ubc.ca Internet Source	<1 %
11	e-sciencecentral.org Internet Source	<1 %
12	journals.sagepub.com Internet Source	<1 %
13	eprints.undip.ac.id Internet Source	<1 %
14	www.sciencegate.app Internet Source	<1 %
15	jurnal.untirta.ac.id Internet Source	<1 %
16	www.besjournal.com Internet Source	<1 %
17	Laura Flore, Renato Robledo, Laura Dettori, Marco Scorcu et al. "Association of VDR Polymorphisms with Muscle Mass Development in Elite Young Soccer Players: A Pilot Study", Sports, 2024 Publication	<1 %
18	garuda.kemdikbud.go.id Internet Source	<1 %
19	www2.mdpi.com Internet Source	<1 %
20	Gurleen Kaur Chauhan, Srujana Medithi. "Polymorphisms of the Vitamin D Receptor (VDR) Gene: a possible trigger for the onset of Obesity, Type 2 Diabetes Mellitus and other Metabolic Syndromes", Gene Reports, 2021 Publication	<1 %
21	oamjms.eu Internet Source	<1 %

22	ppjp.ulm.ac.id Internet Source	<1%
23	www.scielo.br Internet Source	<1%
24	eurchembull.com Internet Source	<1%
25	www.jstage.jst.go.jp Internet Source	<1%
26	www.revistafarmaciahospitalaria.es Internet Source	<1%
27	Erika Zilahi, Ji-Qing Chen, Gábor Papp, Antónia Szántó, Margit Zeher. "Lack of association of vitamin D receptor gene polymorphisms/haplotypes in Sjögren's syndrome", Clinical Rheumatology, 2014 Publication	<1%
28	f1000research.com Internet Source	<1%
29	link.springer.com Internet Source	<1%
30	www.coursehero.com Internet Source	<1%
31	www.medscimonit.com Internet Source	<1%
32	Irene Karampela, Alexandra Sakelliou, Natalia Vallianou, Gerasimos-Socrates Christodoulatos, Faidon Magkos, Maria Dalamaga. "Vitamin D and Obesity: Current Evidence and Controversies", Current Obesity Reports, 2021 Publication	<1%

33	Theodora Adamantidi, George Maris, Petroula Altantsidou, Alexandros Tsoupras. "Anti-Inflammatory Benefits of Vitamin D and Its Analogues against Glomerulosclerosis and Kidney Diseases", Sclerosis, 2024 Publication	<1%
34	dergipark.org.tr Internet Source	<1%
35	journals.plos.org Internet Source	<1%
36	mail.fortunejournals.com Internet Source	<1%
37	pubmed.ncbi.nlm.nih.gov Internet Source	<1%
38	www.frontiersin.org Internet Source	<1%
39	www.medrxiv.org Internet Source	<1%

Exclude quotes	On	Exclude matches	< 10 words
Exclude bibliography	On		

Journals

Sort by

Impact

Search journals

Search...

Filter

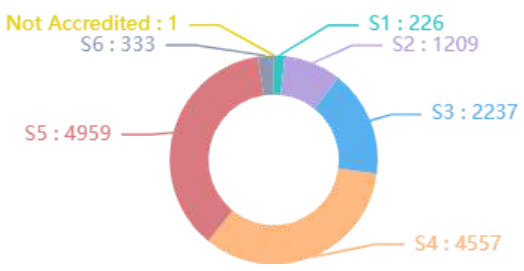
13.522

Total Journals

1.782

Total Publishers

Acceditations Level



Results for *"jkki"*

× clear search

Previous 1 Next

Page 1 of 1 | Total Records 2

JKKI : JURNAL KEDOKTERAN DAN KESEHATAN INDONESIA

Google Scholar Website Editor URL

Universitas Islam Indonesia

P-ISSN : 20854145 | E-ISSN : 25272950 Subject Area : Health, Science

S2 Accredited Garuda Indexed

0,72
Impact

18
H5-index

1.650
Citations 5yr

2.025
Citations

Journals

Sort by

Search journals

JURNAL KEBIJAKAN KESEHATAN INDONESIA : JKKI

Google Scholar | Website | Editor URL

Pusat Kebijakan dan Manajemen Kesehatan FKKMK UGM

P-ISSN : 20892624 | E-ISSN : 26204703 | Subject Area : Health

S3 Accredited | Garuda Indexed

0,00 Impact		9 H5-index	
622 Citations 5yr		647 Citations	

Previous 1 Next

Page 1 of 1 | Total Records 2

Get More with SINTA Insight

Go to Insight

SERTIFIKAT

Direktorat Jendral Pendidikan Tinggi, Riset dan Teknologi
Kementerian Pendidikan, Kebudayaan, Riset dan Teknologi Republik Indonesia

TERAKREDITASI

Kutipan dari Keputusan Direktorat Jendral Pendidikan Tinggi, Riset, dan Teknologi
Kementerian Pendidikan, Kebudayaan, Riset dan Teknologi Republik Indonesia

Nomor: 164/E/KPT/2021

Peringkat Akreditasi Jurnal Ilmiah Periode II Tahun 2021

Nama Jurnal Ilmiah:

Jurnal Kedokteran dan Kesehatan Indonesia

E-ISSN: 25272950

Fakultas Kedokteran, Universitas Islam Indonesia

Ditetapkan Sebagai Jurnal Ilmiah:

TERAKREDITASI PERINGKAT 2

Akreditasi Berlaku selama 5 (lima) Tahun, yaitu:
Volume 12 Nomor 1 Tahun 2021 Sampai Volume 16 Nomor 2 Tahun 2025

Jakarta, 27 December 2021

Plt. Direktur Jendral Pendidikan Tinggi, Riset, dan Teknologi

Prof. Ir. Nizam, M.Sc., DIC, Ph.D., IPU, ASEAN Eng
NIP. 196107061987101001