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ASSOCIATION BETWEEN HOMOCYSTEINE LEVELS AND RISK OF DEPRESSION IN OFFICE WORKERS WITH VEGAN DIET IN JAKARTA

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ABSTRACT

Depression is a significant global public health concern, and the rising prevalence of vegan diets is currently linked to an increased risk of depression in adults. One contributing factor may be vitamin B12 deficiency in vegans, which can elevate homocysteine levels. This study aims to examine the relationship between homocysteine levels and depression risk among vegan office workers in Jakarta. The research employs a quantitative, cross-sectional design. The population consists of all vegan office workers in Jakarta, with a sample of 58 respondents selected through purposive sampling. Data collection involved interviews, anthropometric measurements, and laboratory tests. The data were analyzed using univariate and bivariate analyses via SPSS version 20. The findings revealed that the average plasma homocysteine level in participants was 3.48 µg/L, considered low. The average PHQ-9 score was 4.75, indicating no depression or moderate depression. Bivariate analysis showed no significant association between homocysteine levels and depression risk, with a p-value of 0.412, suggesting no correlation between homocysteine levels and depression risk in vegan office workers in Jakarta.

KEYWORDS *homocysteine levels; depression; vegan diets*

INTRODUCTION

The World Health Organization (WHO) reports that over 280 million people, or approximately 28% of the global population, suffer from depression, making it a critical public health issue. Depression is now the leading cause of disability worldwide and is expected to become the primary contributor to the global disease burden by 2030. In Indonesia, Basic Health Research (Riskesdas) in 2018 found that more than 12 million individuals aged 15 and older experience depression. Socioeconomic factors and education significantly influence depression in Indonesia, as it negatively impacts job performance, attendance, and productivity. Globally, the rising incidence of depression in adults has been linked

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to the increasing adoption of vegan diets. In Indonesia, the number of vegans has surged to 160,000, marking a 2.7-fold rise since 2017. Veganism has gained popularity not only for its perceived health benefits but also for its role in mitigating environmental damage.

Vitamin B12 deficiency in vegans can lead to elevated homocysteine levels, as the body struggles to convert homocysteine into S-adenosylmethionine, which is essential for donating a methyl group to form neurotransmitters like dopamine, serotonin, and norepinephrine. Low levels of these neurotransmitters may contribute to depressive symptoms, while hyperhomocysteinemia is linked to conditions such as depression, schizophrenia, autism, Parkinson's disease, and bipolar disorder.

Research on the connection between vegan diets and the risk of depression has yielded mixed results. A meta-analysis conducted by Iguacel and colleagues, which reviewed 13 studies, revealed that vegans and vegetarians may be 2.14 times more likely to experience depression compared to those who follow non-vegan or non-vegetarian diets. Furthermore, a systematic review offered inconclusive findings, with some studies suggesting potential benefits of a vegan diet in managing depression risk and symptoms, while others reported no clear advantage. In Indonesia, various tools are used to screen for depression, with the Patient Health Questionnaire-9 (PHQ-9) being a common first step in the screening process. Since previous studies on the link between vegan diets, depression risk, and homocysteine levels in office workers have been inconclusive, further research is needed to explore this correlation.

RESEARCH METHOD

This study used a cross-section research design to determine the relationship between homocysteine levels and PHQ-9 scores in office workers with vegan diets in Jakarta. Furthermore, the process is carried out by interview, anthropometric measurements, intake checks and laboratory examinations. The interview was conducted to obtain the characteristics of the subject's data that had been listed on Form D, then the respondents would be asked about their food intake in the last month using the semi-quantitative FFQ method (Form E) on the form was written a list of foods containing vitamins B12, B6 and folic acid, respondents were asked about the frequency, type of processed food and portions, which used a food photo book as a guide. After that, the respondent data was input and analyzed using software in nutrisurvey 2007. Next, an interview was conducted to measure the level of depression using the PHQ-9 questionnaire (Form H). The PHQ-9 consists of nine short questions created based on the guidelines for the diagnosis criteria for depression in the DSM-IV so that it is in accordance with the PPDGJ-III used in Indonesia.

The next form asked to respondents is a questionnaire to measure physical activity using GPAQ (Form I), the questionnaire contains 16 questions to see physical activity asked in three domains, namely physical activity at work, travel activities from one place to another, and recreational activities and sedentary

behaviors, then the results are recorded on Form I in a form that has been converted in metabolic equivalent (MET).

a. Anthropometric Measurements
   Height (cm), weight (kg) and abdominal circumference (cm) have been measured, measurements are taken 2 times then the results will be averaged and then recorded in Form G.
b. Laboratory examination
   Laboratory tests are performed to measure the levels of homocysteine in the serum. Respondents were asked to fast for 8-12 hours before the examination was carried out, then a blood sample would be taken through the mediana pinch vein. Homocysteine examination was carried out using the ELISA method at the Laboratory of the Faculty of Medicine, University of Indonesia with the highest homocysteine level of 14 mcg/day.

RESULT AND DISCUSSION

Characteristics of the research subject

After receiving approval from the Ethics Committee of the Faculty of Medicine, University of Indonesia (ethical review certificate number KET-840/UN2.F1/ETIK/PPM.00.02/2023, Appendix 1), the study employed a cross-sectional design to examine the relationship between homocysteine levels and depression risk in office workers. Data collection was conducted from July to August 2023, with sampling carried out at a vegan community in Jakarta. The study included 58 participants, all of whom were informed about the research purpose and objectives. After consenting, they signed an informed consent form, and data collection proceeded, including interviews and blood sample collection. The blood samples were sent to the Biochemistry Laboratory at the Faculty of Medicine, University of Indonesia. Two samples were excluded due to lysis, resulting in extreme values, leaving 56 homocysteine samples for analysis.

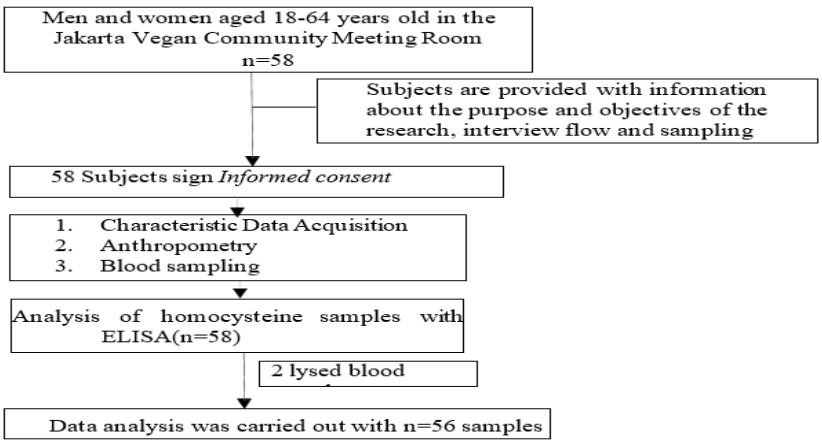

Figure 1 Flow of Subject Selection Research on the Relationship Between Homocysteine and the Risk of Depression in Office Workers with Vegan Diets in Jakarta

Table 1 Distribution of Subjects Based on Sociodemography, Homocysteine Levels, Vitamin B12 Intake, and PHQ-9 Score

Variable	n(%)		Mean±SD	Median (min-maks)
Age			33.07±10.31	
Gender				
Man	24	42,9		
Woman	32	57,1		
Income				
≥UMR	48	85,7		
< UMR	8	14,3		
Education				
> 12 years of compulsory study	44	78,6		
≤12 years old Compulsory Study	12	21,4		
Marital Status				
Unmarried	27	48,2		
Marry	29	51,8		
Smoking Habits				
No	55	98,2		
Already	1	1,8		
Alcohol Consumption				
No	14	25,0		
Already	42	75,0		
IMT			23.29±3.57	
Depression Score			4.75±3.87	
Homocysteine			3.48±0.76	
Levels B12 Intake			4.17±0.79	
Physical Activity				575 (144-1006)

UMR: Regional minimum wage; BMI: Body mass index

The characteristics of the subjects based on socioeconomic status show that only a small portion, 14.3%, have an income below the minimum wage (UMR). In terms of education, 78.6% hold a bachelor's, master's, or doctoral degree. Regarding marital status, 51.8% of the participants were married. As for lifestyle habits, 75% of the subjects (42 individuals) reported consuming alcohol, while only 1.8% (1 person) smoked. Table 4.1 also highlights the nutritional status of the subjects, showing an average BMI of 23.29±3.57, which is classified as overweight. Additionally, all subjects met the recommended intake of vitamin B12 according to the AKG. Physical activity levels indicated that 17 subjects had light activity with a GPAQ score of less than 600, while 39 subjects had a GPAQ score of 600 or higher.

Homocysteine Levels in Office Workers with Vegan Diets in Jakarta

The homocysteine levels of all subjects were categorized as low, with values ranging from a minimum of 1.24 μmol/L to a maximum of 5.388 μmol/L, well below the normal cutoff of <14 μmol/L, as shown in Table 1.

Risk of Depression in Office Workers with a Vegan Diet in Jakarta

The study subjects were screened for depression using the PHQ-9 tool, with results ranging from no depressive symptoms to mild depression. Specifically, 29 subjects showed no signs of depression (score 0-4), 18 subjects were classified as having mild depressive symptoms (score 4-9), and 9 subjects were identified as experiencing mild depression (score 10-15), as detailed in Table 1.

Relationship Between Age, Gender, Marital Status, Income, Education, BMI, Smoking Habits, Physical Activity And Vitamin B12 Intake With PHQ-9 Score

The correlation analysis for the age variable (r=-0.318) indicated a relationship with depression risk, which is considered moderately correlated. In contrast, homocysteine levels (r=0.112) showed a weak correlation with depression risk. BMI and PHQ-9 scores also exhibited a weak correlation (r=0.158). Similarly, weak correlations were found for vitamin B12 intake (r=-0.123) and physical activity (r=-0.041), as shown in Table 2 of sub-chapter 4.

Table 2 Bivariate analysis of numerical variables with PHQ-9 Score

Variable	Depression Score (n = 56)		
	r	95% CI	*p-value*
Usia	-0,318	-0,536 – -0,060	0,017*
Up to Homocysteine	0,112	-0,156 – 0,364	0,412
IMTa	0,158	-0,110 – 0,404	0,246
B12a intake	-0,123	-0,374 – 0,144	0,365
Physical Activities	-0,041	-0,301 – 0,224	0,899

aPearson correlation bSpearman correlation; *p<0.05

The correlation analysis for the age variable (r=-0.318) showed a relationship with depression risk, which is considered moderately correlated based on the correlation coefficient interpretation. In contrast, homocysteine levels (r=0.112) exhibited a weak correlation with depression risk. Similarly, weak correlations were found between BMI and PHQ-9 scores (r=0.158), vitamin B12 intake (r=-0.123), and physical activity (r=-0.041), as shown in Table 4.2 of sub-chapter 4.4.

Subjects with an average income above the minimum wage (UMR) (p-value <0.001) and more than 12 years of education (p-value <0.001) showed a significant relationship with depression risk. Marital status also had a significant relationship (p <0.05). However, the variables of gender, smoking habits, and depression risk did not show significant relationships (p >0.05), as detailed in Table 4.3. Based on the bivariate analysis, age, income, education, marital status, and smoking habits had p-values <0.20, so these variables were included in the multivariate analysis.

Relationship Between Homocysteine Levels And PHQ-9 Score

To see the relationship between homocysteine levels and PHQ-9 scores, a Pearson correlation test was carried out (table 2, sub chapter 4.4) with the result that there was an insignificant relationship (p=0.412). Based on the purpose of this study, which is to know the relationship between homocysteine and the PHQ-9 score, homocysteine is still included in the multivariate analysis by including characteristic variables that have the potential to have a relationship with the PHQ-9 score (p<0.2), the results can be seen in table 4 The multivariate analysis model of the relationship between homocysteine and the PHQ-9 score includes variables that have a value of p <0.2 from the results of the analysis of the unadjusted coefficient.

Table 3 Multivariate analysis of variables with PHQ-9 score (n=56)

Variabel	*Unadjusted* koefisien	*p-value*	*Adjusted* koefisien	95% CI	*p-value*
Usia	-0,119	0,017*	-0,095	-0,146-.0, 075	0,521
Pendapatan					
≥ UMR			Reff		
< UMR	4,958	0,001*	0,123	-1,841-4,537	0,4
Pendidikan					
> 12 tahun wajib belajar			Reff		
≤ 12 tahun wajib belajar	5,515	0,001*	0,489	1,793-7,337	0,002*
Status Pernikahan					
Belum Menikah			Reff		
Menikah	-2,199	0,032*	0,141	-3,340-1,169	0,338
Kebiasaan Merokok					
Tidak			Reff		
Ya	5,345	0,173*	0,2	-0,50 – 12,0	0,070
Homosistein	0,569	0,412	0,028	-1,321-1,031	0,806

Uji regresi linear *p<0,2

After linear regression on each variable to the PHQ-9 score, only homocysteine levels were obtained which had a p-value of <0.2, but because it was an independent variable in this study, it was still included in the linear regression by including all variables (adjusted coefficient). The relationship between homocysteine levels and PHQ-9 scores is that every 1 mcg increase in homocysteine will increase the PHQ-9 score by 0.028 points.

In the multivariate analysis, only the educational variable had a significant result (p<0.05) which had the interpretation that education ≤ 12 years of compulsory learning could increase the PHQ-9 score by 0.489 points compared to subjects who received education > 12 years of compulsory learning. The adjusted R-square assessment shows that these variables only represent 38.1% of the variables at risk of depression.

Discussion

Characteristics of the Research Subject

In this study, 57.1% of the subjects were women and 42.9% were men, with all participants being of productive age, averaging 33 years old. According to the Cabinet of the State Secretariat of the Republic of Indonesia, the country's population is currently around 250 million, with 60% being of productive age. This

number is expected to grow, and by 2040, the productive-age population in Indonesia is projected to reach 195 million. Productive-age individuals have a threefold risk of depression compared to those aged 60 and older, due to early exposure to stressful life events linked to chronic diseases and mental health challenges. Office workers were selected as study subjects because they are productive and accessible for research. In this context, an office worker is someone who spends between two-thirds and three-quarters of their working hours engaged in sedentary office tasks, both inside and outside the workplace. All subjects followed a vegan diet for various reasons, with religious spirituality being the primary motivation. The study also measured marital status through interviews, revealing that 51.8% of the subjects were married, while the rest were unmarried due to work commitments.

In terms of educational characteristics, 78.6% of the subjects were university graduates (S1/S2/S3) and exhibited a low risk of depression. This aligns with research by Bhina Patria in 2022, which indicates that higher education contributes to better public health outcomes and shows a significant and consistent relationship between educational attainment and both physical and mental health. Individuals with higher education tend to be healthier and live longer, largely because better education enhances health literacy. Among the 56 subjects, there were 5 individuals with master's degrees (S2), all of whom reported no depression, scoring between 0-4 on the PHQ-9. In the group with bachelor's degrees (S1), 3 subjects (9.4%) showed mild depression, 10 (31.2%) exhibited depressive symptoms, and 19 (59.4%) had no signs of depression. None of the subjects with a high school education were free from depression risk, as all had scores ranging from 5 to 12. Income below the regional minimum wage (UMR) is identified as a risk factor for depression. According to Sareen et al., individuals with lower household incomes are at a higher risk of depression compared to those with higher incomes. Interviews conducted by the researchers revealed that office workers earning below the Jakarta UMR held various job types, including those with a commission-based salary, pay-per-task arrangements, and freelance work. Regarding smoking habits, only one subject was a smoker. This low percentage of smokers may be attributed to the generally higher education levels of the participants, as Tamioka et al. noted that increased knowledge often correlates with heightened health awareness.

Regarding alcohol consumption habits, subjects continued to drink alcohol, which can be derived from the fermentation of plant-based sources such as rice, sugarcane, potatoes, cassava, and corn. Some participants were even required to consume alcohol daily, averaging 1-2 sloki (25ml). This practice aligns with the Mediterranean diet, which suggests that the phenolic acids present in fermented alcohol can serve as antioxidants for the body, potentially preventing cancer and neurodegenerative diseases.84 Phenolic acids or polyphenols are the main source of antioxidants derived from food, and are easily absorbed in the intestines, the source of polyphenols comes from fruits, grains and nuts, chocolate and beverages such as coffee and fermented beverages.85

The subjects' intake of vitamin B12 met the recommended dietary allowance (AKG), despite not consuming animal products. Based on the SQ-FFQ assessment, tempeh served as the primary protein source for these individuals. Tempeh is made

from fermented soybeans inoculated with the mold Rhizopus oligosporus, which undergoes a process of boiling, soaking, wrapping, and incubation at temperatures between 30-37°C for 24 to 36 hours. This incubation allows the mold to grow on the tempeh's surface, penetrating the soybean grains and binding them together. Tempeh contains an average of about 5µg of vitamin B12 per 100g, with the vitamin produced by the non-pathogenic bacteria Klebsiella pneumoniae and Citrobacter freundii during soaking and fermentation. The subjects reported frequently attending seminars and workshops on making tempeh independently, and some have even begun to prepare it at home, adding yeast fortified with vitamin B12. All subjects consistently choose foods enriched with vitamin B12, recognizing the risk of deficiency associated with their dietary choices.

On average, the subjects were categorized as overweight, attributing their condition to prolonged sitting and a lack of physical activity. They noted that their weight gain began in the last two years following the pandemic, which coincided with an increase in vegan fast food options in Indonesia. During the pandemic, subjects reported a heightened fear of contracting the Coronavirus, leading them to eat more regularly and engage in home workouts, which helped them maintain an ideal weight at that time. Physical activity was assessed using the GPAQ, a tool developed by WHO to measure activity levels. The study revealed poor results, with activity levels below 600 MET, indicating insufficient moderate-to-vigorous physical activity per week. Despite subjects expressing a preference for public transportation and walking, the intensity of their exercise had decreased compared to the previous two years.

Distribution of Homocysteine Levels in Research Subjects

Homocysteine plasma levels were measured from blood samples at the Biochemistry & Molecular Biology Laboratory, Faculty of Medicine, University of Indonesia. A total of 58 subjects were sampled via venipuncture into vacutainer tubes, followed by a centrifugation process to isolate the blood plasma. However, two subjects were excluded due to extreme values caused by blood lysis, resulting in the analysis of 56 samples. The analysis revealed a median homocysteine level of 3.48 µmol/L, with the lowest value recorded at 1.24 µmol/L and the highest at 5.38 µmol/L. All vegan subjects had homocysteine levels within the normal to low range (<14 µmol/L), which contradicts the existing theory that vegans typically experience vitamin B12 deficiency, leading to elevated homocysteine levels. Vegans are now aware of the risk of vitamin B12 deficiency associated with their diets and, thanks to improved health literacy, they consume fortified foods. An experimental study by Susianto in 2020 demonstrated that participants who consumed 100 grams of vitamin B12-fortified oatmeal powder daily for three months, from March 20 to June 19, 2010, experienced a decrease in median homocysteine levels from 20.1 µmol/L before the intervention to 15.1 µmol/L at its conclusion.

All subjects in this study exhibited normal to low homocysteine levels, consistent with findings by M. Krajcovicova, which reported average homocysteine levels of 13.18 µmol in vegetarians compared to 10.19 µmol in omnivores. While vegetarian homocysteine levels appear higher, they still fall within the normal range

of <14 μmol. Since 2016, Gianluca Rizzo has suggested that individuals with very low or no animal food consumption should meet their vitamin B12 needs through supplements or fortified foods. This recommendation is also supported by the Academy of Nutrition and Dietetics. Currently, vitamin B12 deficiency is not a significant concern for vegans due to the availability of fortified food options.

Vitamin B12 intake is directly associated with homocysteine levels in the body. Since vegans typically have very low consumption of animal products, their vitamin B12 intake is at risk of decreasing, potentially leading to elevated homocysteine levels. However, the subjects in this study were well-informed and recognized that reliable sources of B12 for vegans include fortified foods (such as certain plant-based milks, soy products, and breakfast cereals) and B12 supplements. The normal vitamin B12 levels observed in this study can be attributed to sufficient reserves in the body from a diet that includes B12 fortification. Research indicates that the body can store between 1-5 mg of vitamin B12 in the liver, which can last for 1-5 years. The daily requirement is approximately 1-2 μg, so regular consumption of tempeh and B12-fortified foods can adequately meet daily needs and ensure long-term storage in the body.

Distribution of PHQ-9 in subjects

The risk of depression was evaluated using the PHQ-9 questionnaire, which has been validated for use as a depression risk screening tool in healthcare facilities across Indonesia. In this study, the PHQ-9 scores revealed an average of 4.75, with scores ranging from a low of 0 to a high of 13. Notably, two subjects recorded the highest depression score of 13. Additionally, researchers conducted interviews with 58 subjects regarding their work habits, most of whom reported working over 40 hours per week. This finding aligns with a study by Yeogyeong Yoon and colleagues in South Korea, which found that the risk of depressive symptoms was significantly elevated among individuals working more than 68 hours per week (PR: 1.14, CI: 1.07–1.21). 94

Relationship Between Age, Gender, Marital Status, Income, Education, BMI, Smoking Habits, Alcohol Consumption, Physical Activity And Vitamin B12 Intake With A PHQ-9 Score

A linear regression test was carried out with each variable (unadjusted coefficient) in table 4.4 sub chapter 4.5 obtained the variables of age, gender, marital status, income, BMI, smoking habits and physical activity were eligible to be continued on the linear regression test (adjusted coefficient). In table 4.4 sub chapter 4.5, it is found that in the age variable, every 1-year reduction can increase the PHQ-9 score point by 0.119 (p=0.521). This is in line with research by Sikström, 2023 which states that young adults (16-29 years old) are more likely to be affected by depression and severe anxiety than those over the age, this study also said that in 2022, as many as 16% of young adults in Sweden experience severe anxiety, the etiology of the condition is events experienced during childhood such as persecution, bad parental ties, stressful life events, and genetic factors.95 In Indonesia, the prevalence of mental and emotional disorders with depressive symptoms at the age of 15 years and above reaches about 6.1% of the total

population of Indonesia. (Riskesdas)2. Based on this, it is important to screen for depression from an early age as a prevention of depression.

In the income variable where if they have income below the UMR, the PHQ-9 score will increase by 0.123 points compared to subjects with income above the UMR (p=0.4). A study by Matthew, 2020 stated that a person with the lowest income in a community will be 1.5 to 3 times more likely to suffer from depression, anxiety, and other general mental illnesses than those with the highest income.96 This is clarified by Chao Li, 2022 who explains Maslow's hierarchy of needs theory, which is a hierarchical pyramid with physiological order, security, love/belonging, self-esteem, and self-actualization. High income is directly proportional to self-actualization which is at the highest level of Maslow's pyramid. Depression decreases as income increases, however, Chao Li also explains that further income increases also have a major mental health impact.97

In the variable of marital status, it was found that getting married could increase the PHQ-9 score by 0.141 compared to subjects who were not or were not married. In some studies this still shows an inconsistent relationship, in Zhao's 2022 study showed that married respondents tended not to have high happiness, but they had higher subjective well-being and lower depression than respondents who were divorced, separated, widowed, and never married98. In contrast to the findings of this study, research conducted by Osman in 2022, which utilized the PHQ-9 as a screening tool for depression in a cross-sectional study, revealed that 30.2% of the married women surveyed experienced depressive symptoms. Key factors contributing to these symptoms included having an older husband, residing with extended family, experiencing verbal abuse from a partner, weight gain, and low levels of marital satisfaction.99

Only one subject in this study was a smoker, based on the results of the analysis, it was found that smokers could increase the PHQ-9 score by 0.2 points compared to non-smokers. Kim GE, et al conducted a study using the Cohort method after 7.7 years of follow-up period, 2,833 cases of depression were identified. He divided the subjects into non-smokers, long-time quit smokers and heavy smokers, the result was that non-smokers and long-time quit smokers had a lower risk of depression compared to persistent heavy smokers (HR 0.817; CI 95%, 0.689-0.967 and HR: 0.691; CI 95%: 0.559-0.853). Subjects who quit and reduce cigarettes in the short term had a lower risk of depression, but this was not significant (p>0.05).100 El-Sherbiny, 2022 also explained that smoking and depression have a reciprocal relationship, smoking is associated with psychological symptoms and shows moderate to high levels of nicotine dependence. Nicotine dependence is the main motive for reducing stress levels.101

Among all the variables examined, only the education variable showed a significant value ($p < 0.05$). This finding aligns with Bhina Patria's research, which indicates that higher education can enhance public health conditions by establishing a significant and consistent link between formal education attainment and both physical and mental health outcomes, as well as facilitating access to healthcare services. In contrast, the gender variable, along with vitamin B12 intake, BMI, and alcohol consumption, did not demonstrate a significant relationship in this study.

Relationship Between Homocysteine and PHQ-9 in Subjects

In this study, a linear regression analysis was performed to explore the relationship between homocysteine levels and depression risk in vegans. The bivariate test, however, showed no significant association, with a p-value of 0.412. Previous research, such as Saraswatthy's 2019 study, found a possible link between hyperhomocysteinemia and depression, reporting an odds ratio of 4.09 (95% CI 0.93-17.99). However, that study was conducted on the economically disadvantaged Bhil population in India, suggesting that socioeconomic factors may have influenced the depression outcomes, posing a limitation to the findings.

Megan Frances Lee's 2021 research further highlights the complexity of the relationship between homocysteine levels, depression risk, and vegan diets. In a cross-sectional study of 219 adults aged 18 to 44 (M=31.22, SD=7.40), the study examined the connection between plant-based diet quality and depression in vegans (n=165) and vegetarians (n=54). Results indicated that higher quality plant-based diets were associated with an increased risk of depressive symptoms in both groups, with an odds ratio (OR) of 1.215 ($p<0.001$). On the other hand, those who did not experience depression benefited from better quality diets rich in antioxidants, which offered protection against depressive symptoms, with an OR of 1.125 ($p=0.012$).

Research suggests that several mechanisms can help reduce the risk of depression, including the Hypothalamic-Pituitary Axis (HPA), oxidative stress, inflammation, gut microbiota, and epigenetics. These pathways highlight how a healthy diet can play a role in reducing depression risk. A 2020 study by Wolfgang Marx confirmed that following a Mediterranean diet, which consists of 75% plant-based foods, boosts antioxidant levels and may help protect against depression. Similarly, a 2021 study in the World Journal of Psychiatry emphasized dietary recommendations for preventing depression, advocating for the Mediterranean diet. This approach encourages the consumption of fruits, vegetables, nuts, cereals, whole grains, and seeds, along with foods high in omega-3 polyunsaturated fatty acids, while reducing processed, fast, and sugary foods.

In addition to the role of antioxidants, Gianluca Rizzo and colleagues highlighted three key pathways for the conversion of homocysteine into methionine: the transulfuration pathway, the folic acid-dependent pathway, and the folic acid-independent pathway. In the folic acid-independent process, choline serves as a precursor to betaine, which helps convert homocysteine into methionine, reducing the risk of hyperhomocysteinemia. Since whole plant foods generally contain higher levels of choline than many animal products, vegans who consume a balanced amount of plant-based foods can potentially lower their risk of depression associated with elevated homocysteine levels.

Advantages and Limitations of Research

This study has certain limitations, including the lack of assessment on whether the subjects consumed vitamin B12-fortified foods or added nutritional yeast to their diets, which could introduce bias into the findings. These dietary practices are important for preventing health issues related to elevated homocysteine levels. The omission of this information may affect the results, and ensuring such efforts are documented could help avoid any negative perceptions

related to religious dietary practices. Another limitation is that it does not assess the factors that cause depression risk in the subject's work and does not assess the intake of vitamins B6 and B9 which also have a relationship with homocysteine levels. The advantage of this study is that it is the first study in Indonesia to link homocysteine levels and depression scores in vegan populations. In addition, the vegan diet in this study can be carried out by vegans in other populations because eating foods fortified with vitamin B12 can help increase vitamin B12 levels and lower homocysteine levels in the body.

CONCLUSION

Based on the information provided, the following conclusions can be drawn: First, the subjects of this study were men and women from the Jakarta area, aged 18 to 64 years, with an average age of 33, and generally had an overweight nutritional status. All subjects had adequate vitamin B12 intake according to the Recommended Dietary Allowance (AKG), earned above the minimum wage, and had over 12 years of education. Their average physical activity levels were low, and the majority of subjects did not smoke. Second, the average plasma homocysteine level among the participants was 3.48 μg/L, indicating a low level. Third, the average score on the PHQ-9 for the subjects was 4.75, suggesting they experienced no depression to mild depression. Fourth, those with less than 12 years of education had a PHQ-9 score that was 0.489 points higher than those with more than 12 years of education, indicating that lower education levels may increase the risk of depression. Fifth, there was no significant relationship found between homocysteine levels and the risk of depression among office workers following a vegan diet in Jakarta.

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