

*Original Research Paper*

## Vitamin D intake and stroke incidence in adults

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### Abstract

Stroke is one of the non-communicable diseases which becomes a global health problem. One of the micronutrient intakes associated with a risk factor for stroke is vitamin D, in which a deficiency of this vitamin is associated with the incidence of ischemic stroke. Therefore, the objective of this study is to determine the relationship between vitamin D intake and the incidence of stroke in adulthood. The method administered is analytic observational with a case-control design and encompasses 40 respondents aged 20-60 years who are members of the Happy Embung community of Yayasan Stroke Indonesia (YASTROKI) DI Yogyakarta. The sampling technique was purposive sampling in the YASTROKI community in Yogyakarta, the measuring instrument employed was the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Data were examined by employing Chi square test with the results that more than one third of the respondents in the case group and the control group possessed less vitamin D intake (40% and 85%). There was a significant association between the intake of vitamin D and the incidence of stroke in adults ( $p = 0.016$ ). This study concludes that adequate nutritional intake, particularly vitamin D, is one way to reduce the risk of stroke and enhance the quality of life of stroke patients.

**Keywords:** vitamin D intake; mature age; strokes

### 1. Introduction

Non-communicable diseases (NCDs) are global health problems that account for 74% of total deaths worldwide, 17 million of whom die before they are 70 years old each year and 86% of these premature deaths occur in low- and middle-income countries (WHO, 2022). According to WHO (2022), there are four main categories of NCDs, which are diabetes, cancer, chronic respiratory diseases (chronic obstructive pulmonary disease and asthma), and cardiovascular disorders (heart attacks and strokes). Stroke is the third leading cause of death and disability and the second leading cause of death in the world in 2019 (Feigin et al., 2021). The number of stroke sufferers worldwide in 2019 was 12.2 million, with a prevalence of 101 million and the number of deaths from stroke 6.55 million (Feigin et al., 2021).

Based on the results of the Basic Health Research, the prevalence of stroke in Indonesia has increased significantly from 7 in 2013 to 10.9 in 2018 with Yogyakarta is the province with the most stroke cases exceeding the national average (14.6 %) (Kementerian Kesehatan RI, 2019). According to WHO (2020), in Indonesia, stroke accounts for 73% of deaths from infectious diseases, with 26% of them occurring before the age of 70. In addition to the cause of death, stroke is also associated with disability, decreased productivity and quality of life (Lekander et al., 2017; Ramos-Lima et al., 2018; Vyas et al., 2016).

Disability due to stroke in adulthood (productive) results in an economic burden and mental emotional burden for sufferers and other family members (Bucki et al., 2019; Fattore et al., 2012; Ganapathy et al., 2015; Gillard et al., 2015; Guo & Liu, 2015; Kotseva et al., 2019). The economic burden due to stroke also affects the country in the form of an increase in health financing. The total

cost of health care claims for stroke occupies the third position of catastrophic disease with the largest financing after heart disease and cancer in which the large budget used is 2.5 trillion rupiah or 13% of the total financing for catastrophic disease (BPJS Kesehatan, 2021).

Risk factors for stroke are grouped into two, which are risk factors that cannot be controlled (age; gender; genetics) and risk factors that can be controlled (hypertension, hypercholesterolemia, diabetes mellitus, heart disease, smoking and nutrition) (Boehme et al., 2017). One of the micronutrient intakes associated with risk factors for stroke is vitamin D intake. Vitamin D is a fat-soluble vitamin and contains a steroid molecule structure needed for metabolic processes in the body. The results of the study discovered that vitamin D deficiency was associated with the incidence of ischemic stroke (Hankey, 2017). Research linking vitamin D deficiency to cardiovascular disease presents that individuals with vitamin D deficiency experience a higher incidence of myocardial infarction. It is associated with the effect of vitamin D on renin production, slowing the proliferation of vascular smooth muscle cells, lowering low-density lipoprotein (LDL) cholesterol and increasing high-density lipoprotein (HDL) cholesterol (Pusparini, 2018). However, the relationship between vitamin D intake and stroke risk in adulthood remains to be explored further. Therefore, researchers are interested in conducting research with the aim of knowing the relationship between vitamin D intake and the incidence of stroke in adulthood.

## 2. Research Method

This study is an analytic observational study with a case-control design. The research was conducted in the Happy Embung YASTROKI D.I. Yogyakarta with a time span of July to August 2021. Respondents in this study were 40 adults aged 20-60 years who were divided into case groups of 5 respondents and control group of 35 respondents. The sampling technique administered purposive sampling method. The inclusion criteria in this study were being willing to become a respondent by filling out informed consent, being able to communicate both directly and by telephone, age range from 20-60 years, and being able to perform moderate activities to be able to walk lightly or go jogging. Meanwhile, the exclusion criteria of this research is the existence of difficult conditions to communicate.

This study employs data on respondent characteristics such as age, gender, history of hypertension, smoking habits, occupation and recent education taken by administering the respondent's characteristics form. Data on vitamin D intake was obtained by administering the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) form with a span of the last three months from the time of data collection. The SQ-FFQ form of vitamin D intake was adopted from previous research and then validated on the nutrisurvey software application by presenting a list of foodstuffs containing vitamin D. After the SQ-FFQ form of vitamin D intake was filled in by the respondent, input was conducted on foodstuffs, food and beverages consumed at nutrisurvey software application to determine the respondent's vitamin D intake. Vitamin D intake is identified to be deficient if  $<15 \mu\text{g}/\text{day}$ .

Stroke incidence data was obtained by registering names and contacts of stroke survivors and their companions from the Happy Embung YASTROKI D.I. Yogyakarta. The research has received ethical approval or Ecthical Clearence obtained from the UNISA Research Ethics Commission with No: 1839/KEP-UNISA/VII/2021. Univariate data analysis was conducted to demonstrate the characteristics of the respondents studied incorporating age, gender, history of hypertension, smoking habits, occupation, recent education and vitamin D intake. Bivariate data analysis was performed to determine the relationship between vitamin D intake and the incidence of stroke by employing the Chi-square test. Meanwhile, the strength of the relationship between variables utilized the Odds-Ratio Test.

### 3. Result and Discussion

#### 3.1. Characteristics of Respondents

Characteristics of respondents in this study encompassed age, gender, history of hypertension, history of smoking, occupation and recent education as illustrated in table 1. Characteristics of respondents by gender in the case group were more male (60%), while in the controls were more female (68.57%). The results of this study are in accordance with previous studies which displayed that stroke patients were dominated by men (Keller et al., 2018; Mondal et al., 2022; Peters et al., 2020; Wang et al., 2019). Other studies also state that the prevalence of stroke is two times higher in men than women (Mondal et al., 2022).

The incidence of ischemic stroke is doubled in middle-aged women (<42 years) compared to men as a result of menopause and decreased sex hormones in women (Li et al., 2019). It also presents that in addition to gender, age also increases the risk of stroke (Béjot et al., 2019). The results of this study revealed that the age of stroke patients in the case group was entirely in the age range of 41-60 years (100%), while the control group was mostly 41-60 years old (77.14%). In accordance with research results (Rahayu, 2016) that in the age range 41-64 years, the risk of stroke is 23.58 times higher than people aged 15-40 years (95%CI= 2.81 – 519.08).

**Table 1.** Characteristics of research respondents

Characteristics	Case		Control	
	n	%	n	%
<b>Gender</b>				
Male	3	60	11	31.43
Female	2	40	25	68.57
<b>Age (year)</b>				
20-40	0	0	8	22.86
41-60	5	100	27	77.14
<b>History of Hypertension</b>				
Yes	5	100	2	5.71
No	0	0	33	94.29
<b>Smoking Habit</b>				
Yes	2	40	6	17.14
No	3	60	29	82.86
<b>Job</b>				
Civil Servant	1	20	4	11.43
Private/Entrepreneur	2	40	16	45.71
Unemployed	2	40	15	42.86
<b>Education</b>				
Junior High School	0	0	9	25.71
Senior High School	0	0	18	51.43
High School/University (D3/S1/S2/S3)	5	100	8	22.86
<b>Vitamin D intake (µg/day)</b>				
Sufficient	3	60	5	14.2
Not sufficient	2	40	30	85.7
<b>Total</b>	<b>5</b>	<b>100</b>	<b>35</b>	<b>100</b>

Another factor associated with stroke is a history of hypertension. The results demonstrated that the history of hypertension in the case group was higher (100%) compared to the control group (5.71%) as presented in [table 1](#). The results of this study were strengthened by several studies which revealed that there was a significant relationship between hypertension and stroke ([Lin et al., 2022](#); [Mekonen et al., 2020](#); [Sofyan et al., 2015](#)). The number of cases of hypertension in stroke patients ranges from 65-88% ([Lin et al., 2022](#); [Pathak et al., 2018](#); [Sofyan et al., 2015](#)). [Rahayu, \(2016\)](#) asserted that in the productive age group, a history of hypertension increases the risk of stroke by 45 times. The incidence of stroke can increase with increasing blood pressure and decrease if blood pressure can be maintained below 140/90 mmHg, both in ischemic stroke, intracranial hemorrhage, and subarachnoid hemorrhage ([Bundy et al., 2017](#); [Meschia et al., 2014](#); [Wajngarten & Silva, 2019](#); [Williamson et al., 2016](#)). [Peters et al., \(2013\)](#) argued that every 10 mm Hg increase in systolic blood pressure is associated with a 25% increased risk of stroke in both women and men.

Factors that also play a pivotal role in the incidence of stroke is a history of smoking. The characteristics of the study displayed that more than one third of the respondents (40%) in the case group owned a history of smoking. Smoking is a real cause of stroke, which is more general in early adulthood than in the elderly. According to [Pan et al., \(2019\)](#) active smokers possessed a higher risk of stroke than nonsmokers (OR: 1.46, 95% CI: 1.04-2.07, P.001). Smoking triggers the production of fibrinogen (blood clotting factor) more, hence, it stimulates atherosclerosis which causes blood vessels to narrow and blood flow to slow due to viscosity (thickness) ([Udani, 2013](#)). Smoking also increases fat oxidation which plays a significant role in the development of atherosclerosis and reduces the amount of HDL (good cholesterol) or reduces the ability of HDL to eradicate excess LDL cholesterol ([Rao Ch. & Subash Y., 2013](#)). The results of previous research conducted at the Santa Elisabeth Hospital Medan obtained as many as 70.6% of stroke patients caused by smoking habits ([Simbolon et al., 2018](#)). The risk of stroke in smokers does not only occur in active smokers, but also in passive smokers. Passive smokers increased the overall risk of stroke by 45% (OR: 1.45, 95% CI: 1.0-2.11, P.05) ([Pan et al., 2019](#)).

In addition to a history of hypertension and a history of smoking, a low level of education also affects the incidence of stroke, increasing the risk of death, recurrent stroke, and cardiovascular events after ischemic stroke ([Che et al., 2020](#)). In contrast to these findings, the results of this study indicate that 100% of the respondents in the case group possess the latest education graduating from college (D3/S1/S2/S3) as presented in [table 1](#). Stroke sufferers with higher education are associated with easy access to information and related stroke services incorporates participating in the stroke community. The stroke community can increase perceptions about health, quality of life, knowledge, self-efficacy, self-management, and caregiver support. Community helps provide families, communities, caregivers and stroke survivors with the support they need to recover from their injuries as quickly as possible ([Magwood et al., 2020](#)). [Morris & Morris, \(2012\)](#) explained that social support is critical to successful coping; increased self-efficacy and self-esteem in stroke survivors and their caregivers. This community provides a resource for sharing knowledge, experiences with psychological, social and emotional support ([Morris & Morris, 2012](#)). The existence of community and peer support stroke has an impact on establishing social connections, personal development, satisfaction, and a sense of belonging; feeling alive has a positive impact on the lives of others ([Kessler et al., 2014](#)).

[Vyas et al., \(2016\)](#) elaborated that compared to the general population, stroke survivors do not tend to work and earn lower hourly wages. The results of this study indicate that 40% of respondents in the case group are not working. The presence of respondents who do not work in the case group displays that disability due to stroke, particularly at productive age, does not only interfere with patient productivity ([Barral et al., 2021](#); [Cervantes et al., 2018](#)), but also causes a mental emotional burden on the family ([Bucki et al., 2019](#); [Guo & Liu, 2015](#)), hinder the productivity of family

members and result in an economic burden for the family (Fattore et al., 2012; Ganapathy et al., 2015; Gillard et al., 2015; Kotseva et al., 2019).

### 3.2. Relationship of Vitamin D Intake with Stroke Incidence

The relationship between vitamin D intake and the incidence of stroke is demonstrated in table 2. The results illustrated that insufficient vitamin D intake (40% of respondents) was associated with the incidence of stroke ( $p$  0.016). It is reinforced by previous research which states that vitamin D deficiency has a relationship with the incidence of ischemic stroke (Chaudhuri et al., 2014; Fahmy et al., 2019; Talebi et al., 2020). Higher infarct volume is independently associated with lower serum 25(OH)D (blood vitamin D levels) levels in stroke patients (Huang et al., 2016; Nie et al., 2017; Turetsky et al., 2015; Wang et al., 2014). Other studies have also uncovered that vitamin D deficiency owns an impact on the incidence of myocardial infarction in cardiovascular disease (Milazzo et al., 2017; Pusparini, 2018). Vitamin D deficiency is also directly associated with the increased blood pressure, proliferation of vascular smooth muscle cells, increased levels of Low Density Lipoprotein cholesterol (LDL cholesterol), and reduced levels of High Density Lipoprotein cholesterol (HDL cholesterol) (Pusparini, 2018). Vitamin D functions as an endogenous suppressor of the renin-angiotensin system (RAS) by blocking the activity of the cyclic AMP response element in the vitamin D promoter renin gene to directly inhibit renin expression. Uninhibited renin expression and the presence of vitamin D deficiency conditions will maintain hypertension, thereby increasing the risk and severity of stroke (Dong et al., 2014).

**Table 2.** Vitamin D intake with stroke incidence

Vitamin D Intake	Respondent Group				OR (95% CI)	<i>p</i>
	Case		Control			
	n	%	n	%		
Sufficient	3	60	5	14.29	9 (0.756 – 123,322)	0.016
Not Sufficient	2	40	30	85.71		

The results of this study unveiled that lack of vitamin D intake increased the risk of stroke up to 9 times but this result was not statistically significant (OR: 9, 95% CI: 0.756-123,322). It is due to the higher intake of vitamin D in the case group compared to the control group. Respondents with insufficient vitamin D were revealed to have a 2.88 times higher risk of stroke than those with appropriate levels, and this risk increased to 13.78 times higher in respondents who were deficient in vitamin D compared to those in the moderate category (Fahmy et al., 2019). The findings of this study indicate that the incidence of vitamin D deficiency and the incidence of stroke influence each other. Vitamin D deficiency is a significant risk factor for ischemic stroke and can worsen stroke severity (Wajda et al., 2019; Yarlagaadda et al., 2020), and conversely when compared with healthy people, stroke patients illustrated a significant decrease in serum vitamin D levels (Fahmy et al., 2019; Selim et al., 2019). Vitamin D supplementation in adults has proven to be one of the recommended therapies to treat or prevent vitamin D deficiency (Sizar et al., 2022).

The results of the meta-analysis revealed that vitamin D3 can be the supplement of choice because it is more effective in increasing the serum 25(OH)D concentration than vitamin D2 (Tripkovic et al., 2012). The results of a previous study discovered that individuals who received vitamin D supplements had a significant improvement in their stroke prognosis after three months (Narasimhan & Balasubramanian, 2017; Park et al., 2015). The most consumed supplements by

respondents in this study were vitamin D supplements containing 1000 IU or 25 g per tablet. Apart from supplements, the respondents' vitamin D intake in this study was obtained from food intake. The most frequently consumed foods are bread, chicken eggs, fish, tempeh, oyster mushrooms, oranges and cheese martabak. Adequacy of vitamin D in a day can be obtained through sunlight and a balanced diet obtained from various food sources (Jungert et al., 2014; NHS, 2017; Wacker & Holick, 2013). Fish and fish products are the primary dietary sources of vitamin D, followed by eggs, fats and oils, breads and bakery products, and milk and dairy products (Jungert et al., 2014). The application of a healthy lifestyle and adequate nutrition is one way to reduce the risk of stroke. The results displayed that the application of a healthy lifestyle, particularly associated with to nutrition, could reduce the risk of stroke by up to 80%. The risk of stroke can be lowered by 40% or more in high-risk patients by adopting a diet rich in olive oil, whole grains, fruits, vegetables, and nuts and low in cholesterol and saturated fat (Spence, 2019).

#### 4. Conclusion

The results demonstrated that there was a significant relationship between vitamin D intake and the incidence of stroke in adulthood. Lack of vitamin D intake can increase the risk of stroke up to 9 times. Implementing a healthy lifestyle encompassing paying attention to the adequacy of nutritional intake, particularly vitamin D is one way to reduce the risk of stroke and enhance the quality of life of stroke sufferers. This research can be administered as the basis for the implications of further research associated with the consumption of vitamin D in the prevention of stroke at various ages.

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