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The Effect of Vitamin D Deficiency with Stunting and Overweight: A Meta-analysis Study

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Abstract

BACKGROUND: Childhood malnutrition, such as stunting and obesity, is an international public health issue leading to an increase in mortality and morbidity risk. Vitamin D deficiency has also been identified as a worldwide public health matter associated with the rise of related-chronic disease prevalence.

AIM: This study aimed to investigate the effect of Vitamin D deficiency with stunting and overweight in children.

METHODS: It was a systematic review and meta-analysis study that used articles from an online database of PubMed, which was published from 2011 to 2021. It employed stunting and overweight as the dependent variables and Vitamin D deficiency as the independent one. The data were analyzed using RevMan.

RESULTS: Subjects with below-standard Vitamin D levels in the body incured 1.86 higher risk of stunting (OR = 1.86; 95% CI 0.90–3.84; p = 0.09) and 2.76 higher risk of being overweight (OR = 2.76; 95% CI 0.96–7.99; p = 0.09) compared with those with normal Vitamin D levels. This result was not statistically significant.

CONCLUSION: Vitamin D deficiency is closely related to stunting and overweight among children under 18 years.

Introduction

Overweight and obesity in childhood and adolescence are international public health issues leading to an increased risk of obesity in adulthood, which finally brings about an increase in mortality and morbidity risk due to diseases associated with overweight and obesity [1].

In addition to overweight and obesity, the incidence of malnutrition associated with complications in children's growth problems is stunting. Stunting is also a public health problem with a particular worldwide concern [2]. It refers to the condition with a relatively low height according to the common age standard [3]. Stunting settings are native to increased susceptibility to infection, impaired brain development, and low IQ in children, and an increase in the risk of obesity and metabolic syndrome in adulthood [4], [5], [6].

Vitamin D deficiency cases among adults and children have been increasingly reported in several regions of the world [7], [8], [9], [10], [11], [12]. An issue of Vitamin D deficiency in children is a special concern because it inhibits children's needs to grow and develop [13], [14]. Children require higher calcium than adults do; they need calcium balance to ensure an adequate supply of calcium for the mineralization of growing bones [15], [16]. Limited data and information regarding the relationship of Vitamin D deficiency with nutritional status problems, especially stunting and overweight, underlie the current study.

Methods

Study design

The design of this study is a systematic review and meta-analysis.

Inclusion criteria

This study involved articles published from 2010 to 2021 in the PubMed online database. To

search the related articles, the researchers input the keywords "Vitamin D deficiency," "stunting," "overweight," and "children." The inclusion criteria of this study were: (1) Articles describing the relation of Vitamin D deficiency with stunting or overweight; (2) original research papers; (3) subjecting children aged 0–18 years; and (4) adopting multivariate logistic regression analysis method. The exclusion criteria for this study were: (1) Articles not in English or Indonesian; (2) review papers; and (3) incomplete or unavailable research data.

Study variables

The dependent variables are stunting and overweight and the independent one is Vitamin D deficiency.

Operational definition

Vitamin D deficiency refers to the condition where a serum 25-OH D3 level in the body is below <50 nmol/l (<20 ng/ml).

Stunting is defined as a state of chronic malnutrition caused by a relatively-long time lack of nutritional intake resulting in growth disorders in children. The WHO categorizes stunting as a condition that is height per age <1 standard deviation (SD) from the WHO Child Growth Standards median (WHO, 2013).

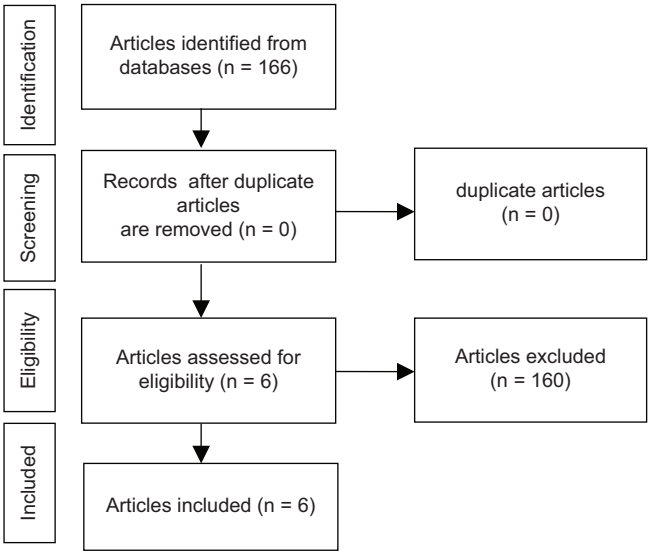

Figure 1: The PRISMA flow chart

Being overweight is defined as a condition of excessive accumulation of body fat. In children and adolescents, overweight is identified by a body mass index (BMI) or waist circumference that exceeds the normal standard.

Study instruments

The process of searching and filtering the articles used the PRISMA diagram (Figure 1). The articles should have met the inclusion criteria and have been reviewed using a critical appraisal by the research design of the article.

Results

Subject characteristics

There were a total of 166 articles found from the PubMed online database using the keywords "Vitamin D deficiency," "stunting," "overweight," and "children" published between 2011 and 2021. Based on the inclusion criteria and process in qualitative and quantitative synthesis, a total of six articles – four of which were about overweight and the remaining two were about stunting – were collected. The characteristics of each article included in the qualitative synthesis are described in Table 1. Extracted data for each article are shown in Table 2. The number of references and journal sources is available in Table 3. There are two independent variables analyzed using the review manager application 5.3.

The relationship between Vitamin D deficiency and stunting

There were 2 studies included in this analysis [17], [18]. Based on the forest plot (Figure 2), subjects with serum 25-OH D3 levels below the normal standard in the body pose a stunting risk of 1.86 compared to the subjects with normal serum 25-OH D3 levels in the body. This result proves statistically insignificant (p = 0.09). The heterogeneity of the article (I2) shows the figure of 81%, so the authors use random effect data for the analysis result.

The publication bias shown in the funnel plot chart (Figure 3) cannot be interpreted because it only subjects two articles.

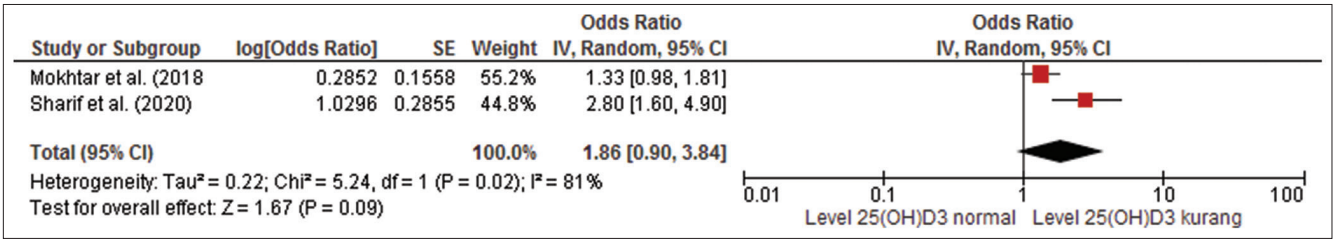

Figure 2: Forest plot of stunting variable

Table 1: Characteristic study included

No	Author (year)	Title	Country	Study Design	Subject	Outcome
1	Sharif *et al*. (2020)	Association of vitamin D, retinol and zinc deficiencies with stunting in toddlers: findings from a national study in Iran	Iran	Cross-sectional	Kids (10-36 month)	Although serum 25(OH) D3 levels were not significantly associated with stunting in the overall study population, we found a positive association among toddlers who used nutritional supplements.
2	Mokhtar *et al*. (2018)	Vitamin D status is associated with underweight and stunting in children aged 6-36 months residing in the Ecuadorian Andes	Ecuadorian Andes	Cross-sectional	Kids (10-36 month)	After adjusting for age and sex, children with 25(OH) D concentration<42·5 nmol/l were more likely to be stunted than children with higher serum concentration.
3	Sharif *et al*. (2019)	Serum Levels of Vitamin D, Retinol and Zinc in Relation to overweight among Toddlers: Findings from a National Study in Iran	Iran	Cross-sectional	Kids (15-23 month)	a marginally significant inverse association was found between serum levels of 25(OH) D3 and overweight
4	Flores *et al*. (2017)	Vitamin D deficiency is common and is associated with overweight in Mexican children aged 1–11 years	Mexico	Cross-sectional	Kids (1-11 years)	Overweight/obese school-age children had a higher risk of vitamin D deficiency compared with normal-weight children
5	Wakayo *et al*. (2016)	Vitamin D Deficiency is Associated with Overweight and/or Obesity among Schoolchildren in Central Ethiopia: A Cross-Sectional Study	Central Ethiopia	Cross-sectional	Kids (11-18 month)	We concluded that vitamin D deficiency is an independent predictor significantly associated with overweight and/or obesity among schoolchildren from rural and urban settings in Ethiopia.
6	Greene-Finestone *et al*. (2017)	Overweight and obesity are associated with lower vitamin D status in Canadian children and adolescents	Canada	Cross-sectional	Kids (6-17 month)	This study confirms the independent association of overweight/obesity to 25-hydroxyvitamin D level and vitamin D status after adjustment for other factor

The relationship between Vitamin D deficiency and overweight

There were 4 studies included in this analysis [19], [20], [21], [22]. Based on the forest plot (Figure 4), subjects with 25-OH D3 serum levels below the normal standard in the body incure a risk of being overweight by 2.76 compared to those with normal 25-OH D3 serum levels. This result is not statistically significant (p = 0.06). The heterogeneity of the article (I2) shows the figure of 91%, so the authors employ random effect data for the analysis result.

The funnel plot chart (Figure 5) shows a publication bias in the analysis results due to the asymmetrical location of the circle.

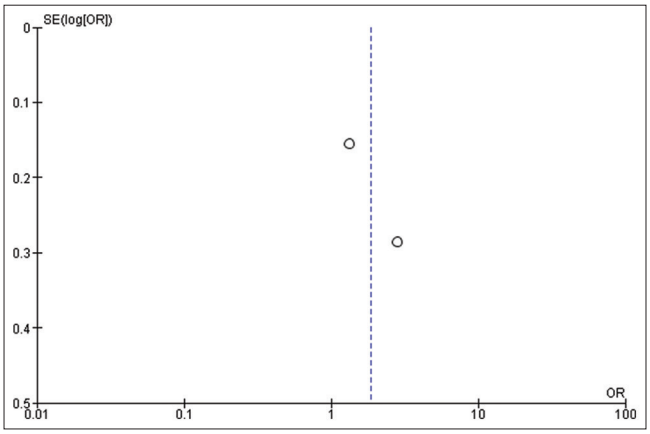

Figure 3: Funnel plot of stunting variable

Discussion

The meta-analysis result in this study indicates a close relationship between the amount of Vitamin D (measured by levels of 25-OH D3) in the body and the incidence of stunting and overweight.

Vitamin D deficiency with stunting

This study suggest that vitamin D levels affect the incidence of stunting. Subjects with a level of 25-Hydroxyvitamin D3 (25-OH D3) <50 nmol/l are more susceptible to stunting compared to those with a level of 25-OH D3 >50 nmol/l.

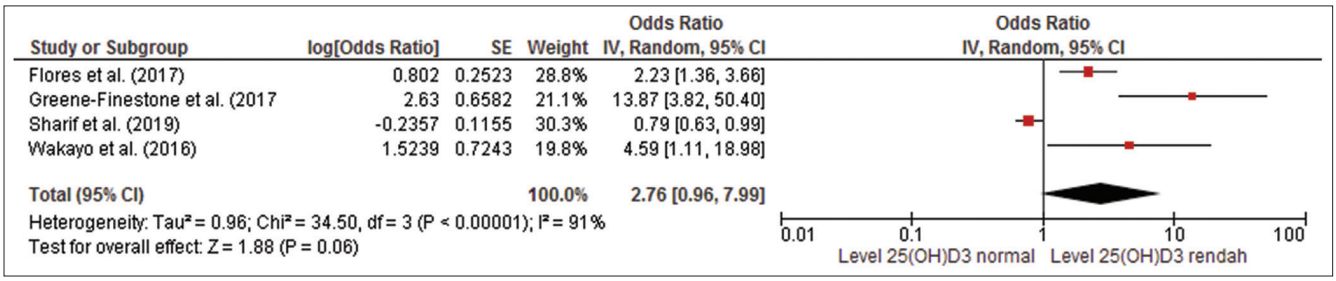

Figure 4: Forest plot of overweight variable

Table 2: Data extraction from study included

No	Dependent Variable	Study	AOR	95% CI	Sample size	Vitamin D (level serum 25(OH) D3)	Adjusted Factor With
1	Stunting	Sharif *et al*. (2020)	1.33	0.98-1.82	4261	<10 ng/mL	sex and residential area, age, family size, first-rank birth, birth interval with previous child, birth-weight, history of diseases (diarrhoea, respiratory infection, fever, epitaxy and fauvism), supplement use (vitamin A, vitamin D, iron and zinc supplements), as well as serum levels of retinol, 25(OH) D3 and zinc
		Mokhtar *et al*. (2018)	2.8	1.6-4.7	516	≥42.5 nmol/l	age (dichotomous) and sex
2	Overweight	Sharif *et al*. (2019)	0.79	0.63–0.99	4261	<10 ng/mL	age, family size, first-rank birth, age difference with pre-child, birth weight, history of diseases (diarrhea, respiratory infection, fever, epistaxia and fauvism)
		Flores *et al*. (2017)	2.23	1.36-3.66	2695	<50 nmol/l (<20 ng/ml)	BMI Z-score, age, gender, area, region, ethnicity, socio-economic status, energy and vitamin D intake
		Wakayo *et al*. (2016)	4.59	1.11-18.91	174	<50 nmol/L	age groups, vitamin D status and socioeconomic status
		Greene-Finestone *et al*. (2017)	2.63	1.34-5.18	1755	<40 nmol/L	-

Table 3: Journal from study included

No	Journal source	Quantity
1	Public Health Nutrition	2
2	Paediatrics and Child Health (Canada)	1
3	Public Health	1
4	Archives of Iranian Medicine	1
5	Nutrients	1

It goes in line with the research suggesting a relationship between Vitamin D status and nutritional status (height per age) [23]. Other studies also explain that children with stunting make a significantly low consumption of Vitamin D [24].

There found differences in the research results that Vitamin D status is not associated with child's growth delay [25]. The difference may be due to variations in place, method, and research analysis. Vitamin D is produced from cholesterol in the skin from sunlight. It can also be obtained from food and supplements. It functions for bone growth and health, as well as calcium homeostatic processes [26]. This is what may underlie the mechanism of the influence of Vitamin D deficiency on stunting.

Vitamin D deficiency with overweight

This study suggest that there is an effect of Vitamin D levels on the incidence of overweight. Subjects with levels of 25-OH D3 <50 nmol/l are more prone to overweight compared to those with levels of 25-OH D3 >50 nmol/l.

The problem of Vitamin D deficiency is greater in children in the overweight BMI category compared to the normal ones [27]. Correspondingly, another study suggests that children with overweight/obese BMI are more susceptible to Vitamin D deficiency as indicated by low levels of 25-OH D3 in the body [28].

Vitamin D deficiency might bring about overweight due to the close relationship between low Vitamin D levels and metabolic syndrome (elevated blood pressure, weak buildup in the body, elevated blood sugar, cholesterol, and triglyceride levels) [29]. Based on *in vitro* experiments and animal examination, a research explains that the use of Vitamin D affects other tissues in the body, including the pancreas [30]. This affects the homeostatic process of glucose and fat,

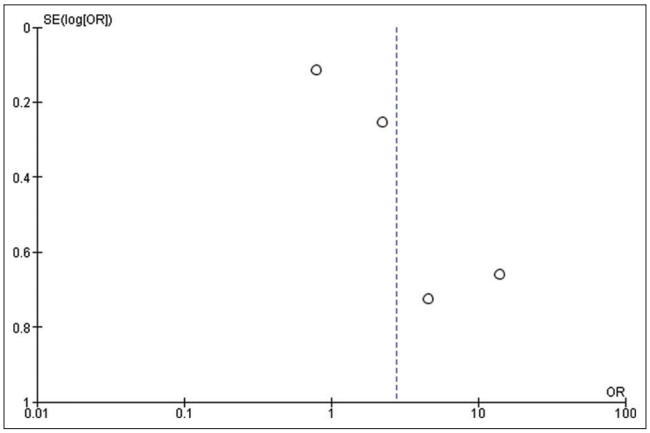

Figure 5: Funnel plot of overweight variable

resulting in a mechanism that explains how vitamin D contributes to overweight or obesity [30], [31], [32].

Conclusion

The study concludes that there is a relationship between the problem of Vitamin D deficiency in the body with stunting and being overweight. Although the result is insignificant, there indicated a potential for publication bias in the overweight variable. The evaluation of the eligibility of the identified studies was based on predefined criteria and done independently by the six researchers, who examined in detail the quality of those studies. This study highlighted the factors that we need to consider while developing health promotion activities. Further, health literacy, counseling and education program need to be develop in both clinical and community settings.

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