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DETERMINANTS OF VITAMIN D STATUS ON PRESCHOOL CHILDREN AGED 48-59 MONTHS OLD IN KENDARI

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ABSTRACT

Vitamin D deficiency is a world health problem because it affects more than one billion children and adults. This study aims to identify factors associated with vitamin D status in preschool children aged 48-59 months old. The study used a cross-sectional design on 96 preschool children aged 48-59 months old in Kendari city. The withdrawal of research subjects used a consecutive sampling method. Data on the characteristics of the respondents and the characteristics of the parents of the respondents were obtained through interviews using a questionnaire. A digital scale and a stadiometer determine nutritional status by measuring body weight and height. The Chemiluminescent Microparticle Immunoassay (CMIA) method was used to determine serum levels of 25(OH)D. Meanwhile, the data analysis used the Chi-Square test, Kolmogorov Smirnov, and independent sample T-test. The prevalence of preschool children aged 48-59 months with vitamin D deficiency was 9.4%, 57.3% insufficiency, and 33.3% sufficiency. There was no relationship between gender, BMI/U, physical activity, vitamin D admissions, length of sun presentation, parental income, and mother's education with vitamin D status of preschool children aged 48-59 months old in Kendari city ($P > 0.05$). In this case, a strategy is needed to increase vitamin D intake through mandatory vitamin D fortification in the food industry and evaluating the time and amount of light exposure to sunlight is required to prevent vitamin D deficiency in preschoolers.

Keywords: 25-hydroxyvitamin, vitamin D status, sun exposure, preschool children, Kendari city

INTRODUCTION

The preschool period (age 3-6 years) is critical in the growth and development of children (Azijah & Adawiyah, 2021). This period is known as the golden age, when children need food intake in reasonable quantity and quality so that their growth and development can occur optimally (Davidson et al., 2018). Preschool-age children are a group that is prone to nutritional problems, one of which is stunting (Amirullah et al., 2020). Stunting is a condition in which a child's linear growth is stunted with a Z-core value of less than -2 standard deviations (Hikmahrachim et al., 2019). Based on Basic Health Research in 2018, the prevalence of stunting in preschool children with concise criteria was 7.7%, and short was 19.2% (Kementerian Kesehatan RI, 2018)(.

Linear growth is formed through the development of longitudinal bones, or long bones that occur in the growth plates through endochondral ossification; cartilage is first formed and then developed into bone tissue (Xian, 2014). Vitamin D is a micronutrient that plays a role in calcium homeostasis and bone health, so vitamin D plays an essential role in linear growth (Surve et al., 2018). The direct effect of vitamin D on linear growth is to express vitamin D receptors present in osteoblasts to increase differentiation and bone mineralization (van Driel & van Leeuwen, 2014).

Vitamin D2 (ergocalciferol), which comes from food, and vitamin D3 (cholecalciferol), which comes from the synthesis of vitamin D in the skin with the help of ultraviolet B (UVB) radiation, are the primary forms of vitamin D (Esposito & Lelii, 2015). Vitamin D2 and D3 are activated in the liver and kidneys by two hydroxylation reactions; D3 is converted to calcidiol (25-hydroxycholecalciferol), the biologically active form of vitamin D, while D2 is converted to 25-hydroxyergocalciferol. Vitamin D status is determined using 25(OH)D serum levels due to its relatively stable nature and longer half-life in blood (15 days) (Jufri et al., 2021). Serum levels of 25(OH)D <20 ng/ml are the cut-off for vitamin D deficiency, insufficiency <30 ng/ml, and sufficiency of 30-100 ng/ml (IDAI, 2018).

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Vitamin D deficiency is a world health problem because it affects more than one billion children and adults (Avagyan et al. 2016). Vitamin D status is directly affected by vitamin D intake (Ando et al. 2018), length of sun exposure (Middelkoop et al. 2022), and physical activity (Constable et al. 2021). Indirect factors such as host factors (age, sex, and nutritional status) (Avagyan et al. 2016) and sociodemographic factors (education and parental income) also influence vitamin D status (Moorani et al. 2019). In several studies, as much as 28% -62% of vitamin D deficiency occurs in low and middle-income countries (Walli et al., 2017). Children from lower socioeconomic strata are more at risk of experiencing vitamin D deficiency, which is associated with the ability to meet the need for vitamin D intake from food sources (Moorani et al., 2019).

Vitamin D is a unique vitamin because the body can produce it with the help of sunlight (Christakos et al. 2015). However, studies conducted in countries with abundant sunlight, such as South Asia, West Asia, Africa, and Southeast Asia, still appeared a high prevalence of vitamin D insufficiency. The majority of vitamin D lack was 60.7% in Palestine (Chaudhry et al. 2018), 74.6% in India (Surve et al. 2018), 18.8% in Iran (Nasiri-babadi et al. 2021), 45% in North Africa (Middelkoop et al. 2022) and 45.1% Indonesia (Ernawati and Budiman 2015).

Indonesia is tropical and has sunshine all year round (Dianisa et al., 2022). Despite the abundance of sunlight, the prevalence of vitamin D deficiency in children in Indonesia remains relatively high, with the category of insufficiency (serum 25(OH)D 25-49 nmol/L) of 45.1% and inadequate (serum 25(OH)D 50-74 nmol/L) of 49.3% (Ernawati and Budiman 2015). Preschool children's vitamin D status information still needs to be improved, particularly in Kendari, Southeast Sulawesi Province. As a result, this study aimed to determine the prevalence and factors associated with vitamin D status in preschool children aged 48-59 months old in Kendari City.

METHOD

The study used an observational analytic design with a cross-sectional design. The study was carried out between November and December of 2021. The research location was determined using the cluster sampling method based on the top three rankings of stunting prevalence in the Kendari city public health centers, namely the Abeli, Nambo, and Mata Public Health Centers (Kendari City Health Office 2019). The study has received ethical approval the Health Research Ethics Commission of the Institute for Research and Community Service, Halu Oleo University No: 1693a./UN29.20.1.2/PG/2021.

Furthermore, the population in this study consisted of preschool children aged 48-59 months, where the sample size was obtained using Cochran calculation of 96 samples. Withdrawal of research subjects used the Consecutive Sampling method with the criteria of preschool children aged 48-59 months in good health. In addition, the subject's parents were willing to sign informed consent for the subject's participation in the study.

In this study, the independent variables were preschool children's characteristics (gender and nutritional status), socioeconomic status (parental income), socio-demographic factors (mother's education), duration of sun exposure, physical activity, and vitamin D admissions. Vitamin D status is the dependent factor in preschool children aged 48-59 months old.

Data on the characteristics of preschool children, namely gender, mother's education, and parents' income, were obtained through direct interviews with the parents of the research subjects as respondents who were conducted by enumerators using a questionnaire. Mother's education is categorized as low if her last education did not complete high school and high if she graduated from high school and college (Wandani, Sulistyowati, and Indria 2021). Parents' income is categorized as low if their income is below UMR of Kendari city (≤ IDR 2,552,014.-) and high if their income is above UMR of Kendary city (> IDR 2,552,014.-) (Tri, Murbawani, and Fitranti 2018).

Anthropometric measurement data for preschool children, including body weight and height, direct measurements were taken with a GEA brand digital weight scale with a precision of 0.1 kg and a SECA 213 brand stadiometer with a precision of 0.1 cm. Data on body weight

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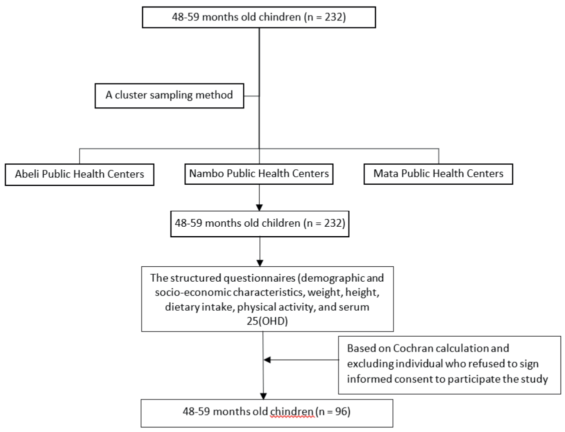

Figure 1. Flow chart of children through study

and height were further used to determine the classification of nutritional status based on the body mass index for age (BMI/U) Z-score. In this case, the anthropometric index Z-score was determined using the WHO-Anthro 2005 application (Ando et al. 2018). Vitamin D and calcium levels were obtained through the 24-hour food recall method using a 2x24-hour recall form on weekdays and holidays. Vitamin D intake is categorized as insufficient if the intake valve is below 2.24 µg/day and sufficient if it is in the range between 2.24 and 3.43 µg/day (Ando et al. 2018).

The duration of sun exposure is categorized as insufficient if the exposure to the sun is below 30 minutes/day and sufficient if the exposure to the sun is equal and more than 30 minutes (Hanwell et al. 2010). Physical activity data obtained through interviews using a 24-hour physical activity recall form were categorized as mild if the value of Physical Activity Level (PAL) was 1.4-1.69 and moderate if the PAL value was 1.70-1.99 (Fasikha, Masrikhiyah, and Rahmawati 2022).

Serum 25(OH)D levels were measured using the Chemiluminescent Microparticle Immunoassay (CMIA) method with Architect reagents at Prodia Kendari Clinical Laboratory to determine vitamin D status. Vitamin D status is classified as deficient if the serum 25(OH)D value is less than 20 ng/mL, insufficient if the serum 25(OH)D value is 21-29 ng/mL, and deficient if the serum 25(OH)D value is 30-100 ng/mL (IDAI 2018).

The data was analyzed with IBM SPSS version 24. The distribution and frequency of the respondents' characteristics were presented as numbers and percentages. The Chi-Square and Kolmogorov-Smirnov tests were used to investigate the relationship between the independent and dependent variables.

RESULTS AND DISCUSSION

Characteristics of Research Subjects

Table 1 showed that the respondents consisted of 48 men (50%) and 48 women (50%). The physical activity level of preschool children aged 48-59 months old was primarily mild by 72 people (75%). The findings of this study are consistent with previous research, which found that there were 33 children (55%) who had less-active physical activity by namely 27 people (45%) (Octaviani, Dody Izhar, and Amir 2018). The low level of children's physical activity is caused by the parenting style of the parents who support their children to be less active in moving; among behaviors that do not help children's physical activity is allowing children to have high screen time by watching television, playing gadgets for a long time and limiting outdoor activities for

Table 1. Sample Characteristics of Preschool Children Aged 48-59 Months (n = 96)

Characteristics	n	%
Gender		
Men	48	50
Women	48	50
BMI/U		
Malnutrition	13	13.5
Normal	83	86.5
Physical Activity		
Light	72	75
Currently	24	25
Vitamin D intake		
Not enough	60	62.5
Enough	36	37.5
Sun Exposure Duration		
Not enough	20	20.8
Enough	76	79.2
Vitamin D status		
deficiency	10	10.4
Insufficiency	54	56.3
Sufficiency	32	33.3

environmental safety and child health reasons (Rahmah, Ardiaria, and Dieny 2019).

Anthropometric examination is a method for determining the size, proportion, and composition of the human body based on body weight and length/height parameters. It consists of four indices: Weight-for-age Z-score (WAZ), Body Length/Z-height-age (HAZ) score, weight-to-height (WHZ) Z-score, and BMI. Preschool children's nutritional status can be determined using an anthropometric examination (RI Ministry of Health 2020). Table 1 showed that the number of respondents with normal nutritional status based on BMI/U was 83 people (86.5%). This is in line with the results of the nutritional status measurement of preschool children in Jember, where it was found that the number of children who had good nutritional status based on the BMI/U index was 50%, while 33% was thin, and 16% was fat (Permatasari and Nurmawati 2018).

Body weight and body length/height are anthropometric measurements that can be done at any time and in all age groups. The size of weight and height needs to be measured regularly to monitor the growth of children. Body weight is the best indicator to determine nutritional status because it is sensitive to the slightest change and does not require a lot of time and money to implement. In this case, changes in body weight can describe the metabolic activity of all body tissues, including bone tissue, muscle, fat, and body fluids. Height is also an essential anthropometric measure in monitoring children's growth to determine their nutritional status (Hartian et al., 2022).

Nutritional problems are influenced by internal factors, including food intake and infectious diseases, while external factors are parents' education, type of work, parents' income, and mothers' knowledge regarding food availability, and food consumption patterns. Mother's education is closely linked to a mother's wisdom in providing adequate nutrition for her children; this is because mothers with a high level of education have a better ability to understand information and knowledge related to nutrition so that the risk of children experiencing malnutrition is lower than mothers with low education (Puspitasari et al. 2021). Table 2 showed that there were 48 (50%) mothers with low education levels (below Senior High School_SMA) and 48 (50%) mothers with higher education. The role of the mother is significant in determining the type of food consumed by the family, especially the selection of nutritionally balanced foods for preschoolers.

The family's socio-economic condition, especially the parents' income, plays a vital role in the nutritional status of preschoolers because it can determine the quality and quantity of food consumed in the family. Table 2 shows that most of the respondent's parents have a low income by 72 people (75%), while those who had high income was only 24 people (25%). Previous studies have shown that nutritional problems are heavily influenced by low parental income and education, where parental income affects the provision of healthy and balanced nutrition for children's growth and development (Halim, Warouw, and Manoppo 2018). This is in line with research conducted in Bangkalan, where it is known that the proportion of stunted children under five is more common in families with low income by, 38.2%. In comparison, in families with high income, 17.9% of children under five experienced stunting (Illahi 2017). Parents from the middle to upper economic class tend to pay more attention to their children's nutritional intake compared to parents from the lower economic class. So that children from middle to upper class families could grow up with good nutritional status. On the other hand, children from low-income families tend to experience problems, such as malnutrition, undernutrition, or stunting (Halim, Warouw, and Manoppo 2018).

All age groups experience the problem of vitamin D deficiency, and it was estimated that around 30% -50% of people in various parts of the world experience it (Erisma et al., 2016).

Table 2. Family Characteristics (n = 96)

Characteristics	n	%
Mother's Education		
Low (< SMA)	48	50
High (≥ SMA)	48	50
Parents Income		
Low (≤ IDR 2,552,014,-)	72	75
High (>IDR 2,552,014,-)	24	25

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Several studies have found that vitamin D status is significantly related to food intake, UV exposure, latitude, season, genetic variation, ethnicity, socioeconomic status, and physical activity (Fink et al., 2019).

The most common causes of vitamin D deficiency are insufficient exposure to UVB rays to help synthesize vitamin D in the skin and insufficient intake of vitamin D-containing foods (Holick 2007). Table 1 shows that 76 (79.2%) children had sufficient long sunlight exposure, more than 30 minutes per day. The Indonesian region receives high sun exposure, but vitamin D insufficiency is still relatively high. Table 1 shows that 9 children (9.4%) had vitamin D deficiency, 55 had insufficiency (57.3%), and 32 (33.3%) had sufficiency. A lack of vitamin D intake from food and supplementation is another factor affecting vitamin D status (Pludowski et al. 2018). Table 1 also reveals that 60 children (62.5%) had inadequate vitamin D admissions. Vitamin D-containing foods significantly impact nutrient sufficiency for average growth (Mokhtar et al., 2018).

Host Factors, Social Demographics, Vitamin D Intake, Duration of Sun Exposure, and Physical Activity with Vitamin D Status

Gender and nutritional status of preschool children aged 48-59 months were the host factors in our study. The mean serum 25(OH)D level did not differ significantly between boys and girls. This is consistent with the findings of a study (Chen et al., 2021), which discovered no significant difference in mean serum 25(OH)D levels between boys and girls. Nonetheless, in this study, it was discovered that more girls than boys had vitamin D deficiency. The reason is because boys play outside the house more, so they are exposed to more sun, stimulating vitamin D production in the skin. A survey in Bahrain also revealed that boys' serum

Table 3. Association Host Factor, Physical Activity, Duration of Sun Exposure, Vitamin D Intake and Social Demographics with Vitamin D Status

Variable	Vitamin D status						*p*-value
	Deficiency		Insufficiency		Sufficiency		
	n	%	n	%	n	%	
Gender							
Men	4	8.3	27	56.3	17	35.4	0.942*
Women	6	12.4	27	56.3	15	31.3	
BMI Z-score							
Malnutrition	1	7.7	8	61.5	4	30.8	1.000[b]
Normal	9	10.8	46	55.4	28	33.7	
Physical Activity							
Light	9	12.5	42	58.3	21	29.2	0.232[a]
Currently	1	4.2	12	50	11	45.8	
Vitamin D intake							
Not enough	7	11.7	35	58.3	18	30	0.639[a]
Enough	3	8.3	19	52.8	14	38.9	
Sun Exposure Duration							
Not enough	3	15	10	50	7	35	0.703[a]
Enough	7	9.2	44	57.9	25	32.9	
Mother's Education							
Low (< SMA)	7	14.6	25	52.1	16	33.3	0.387[a]
High (≥ SMA)	3	6.3	29	60.4	16	33.3	
Parents Income							
Low (≤ Rp. 2,552,014,-)	9	12.5	39	54.2	24	33.3	0.491[a]
High (>Rp. 2,552,014,-)	1	4.2	15	62.5	8	33.3	

[a]Chi Square Test [b]Kolmogorov-Smirnov Test*Independent-Samples T Test

25(OH)D levels were significantly higher than girls (Isa et al., 2020).

Vitamin D3 (cholecalciferol) is a skin-produced vitamin via a non-enzymatic process in which 7-dehydrocholesterol (7-DHC) is damaged to the B ring by solar radiation in the 280-320 nm UVB spectrum to form pre-D3, which is then thermosensitively isomerized to D3 via a non-catalytic process (Bikle 2016). Activation of 7-dehydrocholesterol into vitamin D3 is influenced by UVB intensity which varies based on the latitude and season of an area as well as the level of skin pigmentation. Melanin in the skin can prevent UVB from reaching 7-DHC, so D3 production is limited (Clemens et al. 1982).

The analysis of the relationship test between Z-score BMI/Age and vitamin D status in preschool children aged 48-59 months old in Kendari city yielded a P value of 1,000 > 0.05, indicating that there was no significant relationship between Z-score BMI/Age and vitamin D status. Furthermore, this study found that many children with normal nutritional status had vitamin D insufficiency. Previous research has found an inverse relationship between BMI/U Z-score and 25(OH)D levels in both the univariate and multivariate models, with 102 (26.1%) children with normal nutritional status having vitamin D deficiency. This finding suggests that increasing one's BMI is a risk factor for vitamin D deficiency (Esmaeili Dooki et al., 2019). Similar findings have been reported in other studies, which show no significant relationship between BMI and the prevalence of vitamin D deficiency (Gordon et al., 2008). This is linked to decreased vitamin D bioavailability because of vitamin D deposition in adipose tissue (Kamycheva et al., 2003).

Vitamin D, which comes from food or is synthesized in the skin, is mainly stored in adipose tissue as a reserve for metabolism and is used when 25(OH)D production is reduced. The adipose tissue level is inversely correlated with vitamin D status; the greater a person's adipose tissue, the higher the possibility of experiencing vitamin D deficiency (Abbas 2017).

The movement of skeletal muscles that results in energy expenditure is physical activity (Rice & Howell, 2000). Physical activity in preschool children is identical to a pattern of long intermittent combinations with low and concise strenuous activity. In preschoolers, physical activity ranging from moderate to vigorous lasts only about 16 minutes daily (Raustorp et al., 2012). Physical activity at an early age (2-6 years) is associated with a positive effect on health. A tracking study on children aged one month to 4.9 years discovered a link between increased physical activity and adipose size, bone density, and cardiometabolic factors (Timmons et al., 2012).

Physical activity helps increase bone mass, reduce calcium excretion, and increase its absorption efficiency to increase serum calcium and conserve the use of serum vitamin D in various calcium metabolism (Al-Othman et al., 2012). Elsayyad et al. (2020) discovered that increased physical activity increased serum vitamin D levels significantly. Physical activity and vitamin D status in preschool children in Kendari city were found to have no significant relationship in this study. This study supports previous research (Giudici et al., 2017) that found no link between physical activity and serum vitamin D levels. The different methods of assessing physical activity cause differences in the results of these studies (Wanner et al., 2015). The technique used to evaluate physical activity in this study was one-day activity recall using a 24-hour physical activity recall questionnaire with physical activity level assessment indicators using the Physical Activity Level (PAL) value.

The analysis of the relationship test between vitamin D intake and vitamin D status of preschool children in Kendari city was found to be insignificant. However, most preschool children had insufficient vitamin D intake (62.5%). The average vitamin D intake for preschoolers in Kendari is only 2.24 mcg/day, far from the recommended vitamin D intake for preschoolers according to the Nutrition Adequacy Rate (RDA), which is 15 mcg per day. In line with several previous studies, vitamin intake was still relatively low in all age groups. According to the INCA2 survey, vitamin D intake in children aged 3-17 years in France was only 2 mcg/day (Drali et al. 2021).

Furthermore, a previous study (Ando et al., 2018) on the factors influencing serum 25(OH) D levels in three-year-old Japanese children

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found no significant relationship between vitamin D intake and vitamin D deficiency risk factors, nor a significant correlation between vitamin D intake and average serum 25(OH)D levels. This finding contradicts the findings of another study (n Chaoimh et al., 2018), which discovered that there was a clear association between vitamin D intake and serum 25(OHD) levels after adjusting for the season and that the effect of vitamin D intake on serum 25(OHD) levels is more potent in winter than in summer.

In Japan, fish accounts for 85% of vitamin D intake, while milk (vitamin D content 0.3 mcg or 12 IU/100 g) accounts for 10% of total vitamin D intake. In this case, recommendations for vitamin D supplementation for children are rare and not specific (Ando et al., 2018). In Ireland, fortified milk or supplements account for most of vitamin D intake, with naturally vitamin D-rich foods (e.g. eggs and fish) accounting for only 9-12% of total vitamin D intake (ní Chaoimh et al. 2018). The consumption pattern of the Japanese society is almost the same as that of the people of Kendari city, specifically, vitamin D is obtained from natural food sources such as eggs and fish; very few preschoolers consume vitamin D-enriched foods such as milk because milk consumption in the community is still deficient, not even one. Children taking supplements containing vitamin D. A Japanese study found that eating foods fortified with vitamin D or taking vitamin D supplements was more helpful in raising serum 25(OH)D levels than eating more vitamin D-rich natural foods to avoid 25(OH)D deficiency.

Nearly 90% of Vitamin D requirements are met by adequate sun exposure to the skin via UVB radiation action (between 10 a.m. and 3 p.m.), and another 10% is completed through the intake of foods containing vitamin D (Surve et al., 2018). Several studies have examined skin factors that influence vitamin D status, including skin pigmentation and elements of sun exposure, such as time, length of exposure, the proportion of exposed skin area, and sunscreen use behavior. (Quah et al., 2018) . In this study, the observed skin factor was sun exposure; based on the analysis of the relationship test, discovered no strong relation between sun exposure time and vitamin D status (P value = 0.575 > 0.05). However, the study found that many children had an adequate period of exposure, namely more than 30 minutes per day, but experienced vitamin D insufficiency. This is because the average preschool child in Kendari city has playing activities outside the home in the morning, starting at 7 o'clock morning to 10 a.m. when the sun begins to get hot and will return to playing outdoors at 4 p.m. when the sun's rays begin to fall, even though the solar radiation spectrum is stable from 10 a.m. to 3 p.m. with a peak spectrum of 297 nm (Tsiaras & Weinstock, 2011).

This study's results align with previous studies (Öhlund et al., 2013; Ando et al., 2018), which found that sun exposure did not affect serum 25(OH)D levels. This is due to the method of measuring sun exposure which only measures outdoor playing time but does not consider exposed skin areas, usage of sunscreen, as well as the duration of exposure. Another study discovered a positive association between the length of sun exposure and 25(OH)D serum, with an adjusted OR of 6.1 (3.6-10.2; P = 0.0001) (Drali et al., 2021).

Several studies have found that socio-demographic factors such as socioeconomic status and parental education influence vitamin D levels. According to the results of the relationship test analysis (Table 3), there were no meaningful association between parental education and vitamin D status (P = 1,000 > 0.05). In this study, an inverse association was found between mothers with a high level of education but having children with vitamin D insufficiency status by 29 people (60.4%) compared to a group of mothers with low education, which only amounted to 26 people (54.2%). This proves that the level of education is only sometimes directly proportional to the practice of parenting. The findings of this study are aligned with those reported by Voortman et al. (2015) and Ando et al. (2018), which showed that a mother's education was not significantly related to 25(OH)D levels.

Parents' income variable also did not have a significant relationship to the vitamin D status of Kendari city's preschool children (P = 0.583 > 0.05). This result is in line with previous research, which found no significant relationship between parental income and children's vitamin D status (Avagyan et al., 2016). Different results were also obtained from another research project (Voortman et al., 2015) which showed a relationship between parents' income level and vitamin D status.

In contrast to the mother's education level, parental income is directly proportional to the vitamin D status of Kendari city preschool children. The research results revealed that children with low parental income levels experienced more insufficiency than children whose parents had high incomes. On average, parents of preschool children in the study area work as fishermen and casual laborers with an income of only around IDR 500,000.00 to IDR 1,000,000.00 per month. Parents' income is associated with the ability to buy food sources of vitamin D, both from natural sources (fish, eggs, liver) and those fortified with vitamin D (milk, cereals) (French et al., 2019).

CONCLUSIONS AND RECOMMENDATIONS

The prevalence of vitamin D deficiency in preschool children aged 48-59 months old in Kendari city was very high, with 10.4% having low vitamin D status and 56.3% lacking. There was no relationship between gender, BMI/U, vitamin D intake, physical activity, length of sun exposure, mother's education, and parental income with preschool children's vitamin D status in Kendari. Furthermore, research with a larger sample size is needed to prove the relationship between host factors (age, sex, and nutritional status), duration of sun exposure, sociodemographic factors (parental education and parental income), physical activity, and vitamin D intake with vitamin D status. One approach to overcoming vitamin D deficiency is to regulate vitamin D fortification in the food industry because daily consumption of natural sources (fish, eggs, liver) is insufficient to meet daily vitamin D needs. Furthermore, evaluating the time and amount of light exposure to sunlight is required to prevent vitamin D deficiency in preschoolers.

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