Proceedings of the International Conference on Food, Nutrition, Health and Lifestyle, Vol. 1, Issue. 1, 2022, pp.1-9

ISSN 2682-7026 online
DOI: https://doi.org/10.17501/26827026.2022.1101

IODINE INTAKE DEFICIENCY AS A KEY PREDICTOR OF STUNTING AMONG ADOLESCENT GIRLS IN COASTAL AREA, MAJENE DISTRICT

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Abstract: Adolescence is a period in a lifespan with increased nutrition requirements for supporting optimal growth and reproductive maturation. There is a dearth of studies exploring the risk of stunting among adolescents in coastal areas. Majene Regency is a coastal area that is rich in animal protein sources. However, the stunting prevalence of adolescent girls in this area was relatively high. Therefore, this study aimed to identify the contributing predictors of stunting in adolescent girls. A cross-sectional involving 360 adolescent girls in secondary school was employed. Data were analyzed using the chi-square test and logistic regression with a significance of 5%. The overall prevalence of stunting in adolescent girls was 31.7%. Factors significantly associated with stunting were energy and iodine deficiency and wasting. Adolescent girls with low iodine intake (below RDA) were 1.9 times more likely to be stunted (p= 0.027). This study concluded that the prevalence of stunting among adolescent girls living in this coastal area was a high community nutritional problem. We recommended that nutrition promotion is needed, especially regarding the importance of consuming animal food sourced from the sea and the use of iodised salt fortification to prevent stunting in adolescent girls.

Keywords: iodine intake, nutrient deficiency, stunting, adolescent girls, coastal area

Introduction

Adolescent girls (aged 10-19 years) are a transition period from children to adults, characterised by rapid growth, sexual maturity, and complex psychosocial interactions, and the formation of lifelong adaptive or maladaptive behaviours. In addition, it is also a critical period for optimal nutrition fulfilment and as a phase of the window of opportunity to correct or pursue inadequate growth since childhood and reduce the impact of malnutrition in the first 1000 days of life (Patil et al., n.d.; Sparrow et al., 2021). Theoretically, up to 20% of total height and 45% of bone mass can be achieved during adolescence, with a peak growth rate that nearly matches that of infancy (Sparrow et al., 2021). Hence, youth is considered an additional critical window of opportunity, the last chance to pursue linear growth (Azupogo et al., 2021). About 15-25% of adults' height is achieved during the adolescence (Christian & Smith, 2018). Adequate growth during adolescent girls is needed to ensure

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optimal pregnancy outcomes, and avoiding teenage pregnancy is necessary to ensure optimal growth (Chaparro & Lutter, 2016).

In recent decades, nutritional problems among adolescent girls have been neglected in national and global research and policy. But the view has been shifted to prioritise young women as a driving force for global health and international development (Sparrow et al., 2021). Since many studies found that malnourished among young women was prevalent, intervention could benefit this age group. Data reported by UNICEF shows that young women aged 15-19 years in South Asia suffer from several types of malnutrition, including stunting (11%), wasting (39%), and anemia (55%) (Querol et al., 2021). The study of stunting in adolescent girls is underreported compared to other nutritional problem indicators aforementioned (Khara et al., 2015). However, in some countries, data show that half of the adolescent girls are stunted (Bush & Mates, 2017). Estimates of stunting in girls aged 15-19 range from 52% in Guatemala and 44% in Bangladesh to 8% in Kenya and 6% in Brazil (Black et al., 2013), while in Indonesia, according to the 2018 Riskesdas results, some adolescent girls are stunted at the age group of 13-15 years (24.9%) and 16-18 years (25%) (Ministry of Health, 2018).

Few studies investigated factors associated with stunting among adolescents, which are not much different from stunting determinants in children. Factors such as low socioeconomic status of the family (Abate et al., 2020; Maehara et al., 2019; Mostafa et al., 2021), poor access to clean water and sanitation (Abate et al., 2020; Gebregyorgis et al., 2016), low education level and age (Azupogo et al., 2021), geographical disadvantages including living rural, coastal (Alemu et al., 2021; Tariku et al., 2019; Van Tuijl et al., 2021), and mountainous areas (Blankenship et al., 2020) found to contribute to stunting among adolescents. Additionally, dietary intake greatly contributed to the occurrence of stunting in this group, including family food insecurity (Alemu et al., 2021; Hadush et al., 2021; Tariku et al., 2019) and low food diversity (Hadush et al., 2021; Kahssay et al., 2020).

Furthermore, dietary intake, especially zinc and iodine play a significant role in supporting the growth and neurobehavioral development of children. Many studies have shown that deficiency of these nutrients was associated with stunting, although in children population (Abbag et al., 2021; Abdollahi et al., 2019; Amarra et al., 2007; Gibson et al., 2007). Unfortunately, adolescent girls living in rural areas are likely to have lower iodine intakes, increasing the risk of being iodine deficiency for this group. A study in rural Tanzania demonstrated that adolescent girls in this area experienced lower urinary iodine concentration (UIC) (Bakar et al., 2017). It is important to further investigate whether it has associated with low diversity and food insecurity, which are typical of poor socioeconomic households.

Prevention of stunting in adolescents should have started to be considered because this group determines the future of the next generation (Christian & Smith, 2018). Teenage pregnancy is quite common worldwide and stunted among adolescent girls can have adverse implications for their health and their babies, increasing the risk of stunting. This situation will perpetuate the cycle of misfortune between generations (Chaparro & Lutter, 2016; Mason & Dorman, 2017).

West Sulawesi Province is one of the provinces in Indonesia with the second-highest prevalence of stunting in Indonesia, and Majene Regency is the district with the highest number of stunting within the province (Ministry of Health, 2018). The district is a large coastal area with many animal protein

food sources that the people can consume. Our previous school-based study in Mamuju Regency found that 34.1% of female adolescent girls were stunted (Patimah et al., 2019). This finding was slightly different from our research at another location (Maros Regency, South Sulawesi Province), which found that stunted among adolescent girls was only 23.6% (Patimah et al., 2016). However, we have no data to confirm whether low iodine intakes or other factors cause stunting among adolescent girls in this area. Additionally, there is a dearth of research exploring stunting and locally stunting-driven factors among adolescent girls in this coastal area. Therefore, we aimed to investigate those predictors and focus on the contribution of iodine intake to stunting occurrence in adolescent girls.

Materials and Methods

Study Design and Setting

This study used a cross-sectional design in four secondary schools in Majene Regency, West Sulawesi Province. The four schools consist of two junior high schools (Sekolah Menengah Pertama - SMP) and two senior high schools (Sekolah Menengah Atas - SMA). Each school strata is represented by schools under the auspices of the ministry of education & culture (SMPN 1 and SMAN 1) and the ministry of religion (MTS and MAN). This research is part of multi-year research that will last for three years, specifically for the variables that are the focus of the study in this study collected since 2021 and have received research ethics permission from the health research ethics committee of Medical Faculty, Hasanuddin University (194/UlJ4. 6.4.5.31/ PP36/2020).

Sample Size, Data Collection and Analysis Procedure

A total of 360 students from classes VII and X in each school were selected to participate in this study. Prior to data collection, the research assistants were trained in anthropometric measurements and interviews to measure height and collect dietary intake information using a 2x24-hour recall form. The participants' height was measured using a stadiometer (d= 0.1 cm). We calculated the height-for-age z-score (HAZ) using WHO Anthro Plus software. Stunting is defined if the HAZ score is <-2 SD (Ministry of Health, 2020). Dietary intake from 24-hour recall data was analysed using Nutrisurvey software for Windows. The results of the analysis of nutrient intake are categorised as adequate if consumption is >80% of the recommended dietary allowance (RDA) for macronutrients and >77% for micronutrient intake (Gibson, 2005).

All anthropometric and dietary intake data were inputted into SPSS for windows for further analysis. We performed chi-square and logistical regression tests with a significance level of $p<0.05$ to determine the predictor factors for stunting in adolescent girls. The condition for the variables to be included in the logistic regression test model is if the results of the bivariate test have a p-value <0.25.

Results and Discussion

Table 1 shows that from 360 samples, there were 114 (31.7%) adolescent girls suffering from stunting, which was more widely distributed in the middle-aged group (13-15 years), aligned with a study conducted in Northwestern Ethiopia (Birru et al., 2018). The high stunted rate in adolescent girls indicates a major public health problem. Stunted adolescent girls generally experience growth deficits since childhood (Lassi et al., 2017). Additionally, stunted adolescent girls are more likely to

occur in low socioeconomic status families characterised by low levels of parental education (Junior high school and below) and work in the non-formal sector. Parents' employment and father's education were significantly different ($p<0.05$) between stunted adolescents and their adolescent counterparts.

Meanwhile, maternal education was not significantly different between stunted and non-stunted adolescent girls. This result was in line with a study in Nepal that found that maternal education was not associated with stunting (Van Tuijl et al., 2021). As a chronic nutritional problem, stunting is not only related to inadequate intake but also socioeconomic conditions, including parents' education and occupation (GAIN, 2018).

Table 1. Characteristic of Sample and Their Family

Variable	Stunting (n=114)	Normal (n=246)	P Value
Age (years)			
10-12	17 (14.9)	26.0)	0.000
13-15	54 (47.4)	136 (55.3)	
16-18	43 (37.7)	46 (18.7)	
Father's Occupation (Non formal)	94 (82.5)	180 (73.2)	0.035
Mother's Occupation (Non formal)	101 (88.6)	197 (80.1)	0.030
Father's Education (Low)	60 (52.6)	101 (41.1)	0.026
Mother's Education (Low)	56 (49.1)	99 (40.2)	0.071

Based on the intake of nutrients that contribute to bone growth, it was found that almost all types of nutrients consumed were lower in the stunting group of adolescent girls except for protein, vitamin A and iron. The only significant differences between stunted and non-stunted participants were vitamin D and iodine intakes (Table 2). The frequency of foods with high bioavailability, such as marine fish consumed 2-3 times per day, was lower in the stunting group than in the non-stunted group (24.6% vs. 28.5%), which could also result in inadequate iodine consumption. Inadequate iodine intake for a long period will cause low iodine accumulation in the body, which can affect growth and development. This finding is supported by a study in Saudi Arabia which reported that the proportion of stunted students with low UIC was significantly higher than those with a high UIC (Abbag et al., 2021). Similarly, milk consumption (powdered milk and sweetened condensed milk) was rarely consumed by stunted girls as a source of vitamin D. Around 38.6% never consume sweetened condensed milk, and 41.2% never consume powdered milk. Although the study location has diverse animal-source foods, low consumption of iodine and vitamin D among adolescent girls may be associated with the knowledge and understanding of the importance of consuming these foods. Therefore, it is essential to provide nutrition education for this population.

The deficiency of nutrients (macro and micronutrients) is a direct factor most often involved in post-natal growth retardation. Adequate intake of energy, protein, or various micronutrients is needed to maintain normal nutritional status; however, it is also important to consider bioavailability of those nutrients as this factor influence the absorption in the body. For example, consuming nutrients derived from plants, which have low bioavailability, may affect their utilisation (Branca & Ferrari, 2002; Mikhail et al., 2013).

The achievement of the nutritional adequacy rate from the intake of each nutrient by adolescent girls, it appears that almost all of them who have an intake below the nutritional adequacy rate is more common in adolescent girls who are classified as stunting except that low calcium intake is more commonly found in adolescent girls who were not stunted. Based on chi-square test results, energy intake, iodine, and wasting are the three factors significantly related to the incidence of stunting in adolescent girls, such as (Table 3). The deficiency of energy and iodine might cause growth retardation (Branca & Ferrari, 2002). The energy deficit will increase protein requirements to use as energy. The protein that was previously higher in the female adolescent group will decrease to meet the energy needs of those experiencing a deficit. Moreover, the participants also consumed more plant-based protein with low bioavailability, which can decrease the concentration of the IGF-1 hormone. Thus, strengthening its relationship with the incidence of stunted (Tessema et al., 2018). This finding was in line with a study on children in Ethiopia, which found that those who were stunted had a lower daily energy intake than those who were not stunted ($p< 0.05$). Additionally, inadequate energy intake was positively related to children's linear growth failure ($b= 0.0003$, $p= 0.04$) (Tessema et al., 2018). Inadequate intake of iodine will have an impact on the occurrence of hypothyroidism because insufficient serum thyroid hormone secretion can interfere with somatic growth (skeleton and peripheral tissue), which is closely related to the action of the growth hormone IGF (Farebrother et al., 2018).

Severe and repeated wasting can be associated with stunting, despite the fact that these nutritional problems can occur concurrently. In addition, there is growing evidence of a reciprocal relationship between wasting and stunting, in which episodes of wasting determine the risk of stunting. To a lesser extent, stunting can also promote wasting (Thurstans et al., 2022). The study results in Nigeria showed a temporal relationship between wasting and stunting in children under the age of 2 years (Kohlmann et al., 2021).

Table 2. The Differences in Nutritional Intake among Adolescent Girls

Nutrients Intake	Stunting (n = 114)	Normal (n = 246)	P value
Energy (Kcal)	1178.4±531.19	1293.8±560.0	0.065
Protein (g)	55.2±58.22	51.6±25.6	0.536
Calcium (mg)	324.7±359.26	376.9±439.6	0.268
Vitamin D (mg)	5.0±5.2	6.2±5.1	0.048
Vitamin A (mg)	528.8±2543.8	345.9±336.8	0.446
Iodine (mg)	93.4±149.1	139.1±190.2	0.014
Iron (mg)	6.2±5.4	6.1±5.2	0.870
Zinc (mg)	4.3±2.8	4.9±2.9	0.100

Table 3. Intake of Nutrients Related to Stunting in Adolescent Girls

Variable	Stunting (n=114)	Normal (n=246)	P Valuea
Energy Intake*	97 (85.1)	182 (74.0)	0.012
Protein Intake*	67 (58.8)	127 (51.6)	0.125
Vitamin A Intake#	94 (82.5)	185 (75.2)	0.080
Zinc Intake#	97 (85.1)	202 (82.1)	0.295

Iodine Intake#	82 (79.6)	142 (67.9)	0.020
Calcium Intake#	102 (89.5)	221 (89.8)	0.525
Iron Intake#	96 (85.0)	202 (82.1)	0.307
Vitamin D Intake#	100 (87.7)	203 (82.5)	0.135
Wasting	10 (8.8)	9 (3.7)	0.042

*(<80% RDA); #(<77% RDA); a= Chi Square test

The main predictor of stunting in adolescent girls is low iodine intake. According to the results of logistic regression tests, low iodine intake (below the RDA) is 1.9 times more likely to be stunted (OR 1,895; 95% CI: 1,076 to 3,337; p-value 0.027) compared to adequate iodine intake (Table 4). About 80% of young women who have insufficient intake of iodine (below the RDA) are stunted, while among young women who are not stunted there are 67.9% have inadequate intake (Table 3). The study results by Simbolon and Hapsari (2018) also found that about 73.1% of children under five who did not have insufficient iodine intake were stunted (Simbolon & Hapsari, 2018). It is known that adolescents are more independent in their food choices and are more likely to be influenced by their peers who consume contemporary foods such as junk and fast food with low nutritional quality. At the same time, the intake of fruits and vegetables, which is micronutrient-rich sources, was very low. The results of this study are in line with the results of a review of various studies from low-middle income countries showing that there is a greater likelihood of iodine deficiency in girls and older age due to dietary pattern transition, which is higher in energy-dense foods, processed and micronutrient-poor foods, both in children and adolescents (Wrottesley et al., 2022).

Table 4. Predictor Factors of Stunted based on Logistic Regression Test

	B	S.E.	Wald	Sig.	Exp(B)	95% C.I.for EXP(B)	
						Lower	Upper
Wasting	-0.943	0.509	3.434	0.064	0.389	0.144	1.056
Iodine Intake	0.639	0.289	4.905	0.027	1.895	1.076	3.337
Constant	-0.295	0.526	0.314	0.575	0.745		

Conclusion

This study concluded that the stunting among adolescent girls was a community nutritional problem in this coastal area, where inadequate iodine intake is the main predictor of stunting. This study has limitations because it does not examine the level of iodine in the urine to strengthen the results of this study. Nutrition promotion is needed, especially regarding the importance of consuming animal-sourced foods from the sea. We also recommend promoting iodised salt fortification to prevent stunting in adolescent girls. In addition, further investigations of iodine salt fortification with larger samples are warranted to evaluate the effectiveness of this intervention to prevent stunting among adolescent girls in this community.

Acknowledgement

Thank you to the Ministry of Education, Culture and Higher Education for providing financial support for the study. We also thank all the research participants, including the teachers and school staff, who assisted in the data collection process.

Declaration of Interest Statement

All authors have no conflict of interest in this manuscript.

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