Comparison of food security and nutritional status among adolescent girls aged 15-19 in highland and coastal areas of Garut Regency, West Java

Dadang Herdiansyah[1, 2], *Budi* Setiawan[1*], and *Ikeu* Tanziha[1]

[1]Department of Community Nutrition, Faculty of Human Ecology, IPB University, 16680 Bogor, Indonesia
[2]Public Health Study Program, Faculty of Public Health, Muhammadiyah University of Jakarta, 15419 Tangerang Selatan, Indonesia

Abstract. Nutritional status and food security are interrelated factors that directly influence health outcomes. Adolescent girls, a vulnerable population, frequently face malnutrition, including anemia and chronic energy deficiency (CED), which can have lasting health implications. This study examined and compared the food security and nutritional status of adolescent girls residing in highland and coastal regions of Garut, West Java. This study employed an analytic observational method with a cross-sectional design, involving 318 adolescent girls aged 15-19 years from two regions: Cigedug (highland) and Caringin (coastal). Data collection included direct interviews using the HFIAS questionnaire, anthropometric measurements, and hemoglobin testing. The results indicated that food security levels were higher in the coastal area (27.7%) compared to the highland (14.7%). However, the prevalence of anemia among adolescent girls was greater in the coastal area (45.8%) than in the highland (31.3%). Although no significant difference in nutritional status related to CED was observed between the two regions, the prevalence of CED remained higher in the coastal area (57.4%). In conclusion, significant differences were observed in food security status and hemoglobin levels between adolescent girls in the two locations.

1 Introduction

Nutritional status and food security are two interrelated factors that directly impact adolescent health [1]. These aspects are particularly critical during adolescence, a developmental stage marked by rapid physical, emotional and transformations in cognitive processes. Adolescent girls are especially vulnerable to malnutrition, including anemia and chronic energy deficiency (CED) [2]. Such nutritional deficiencies can have significant and lasting effects, not only on the health of the girls themselves but also on their future offspring, perpetuating a cycle of poor health and malnutrition across generations [3].

* Corresponding author: bsetiawan@apps.ipb.ac.id

The prevalence of undernutrition varies across different geographical regions, such as highlands and coastal areas. These regions often possess distinct characteristics that influence the stability of food availability and the health condition of adolescents. Elements such as availability of varied food options and regional eating habits play a crucial role in shaping dietary intake and nutritional outcomes in these areas [4].

In highland areas, access to food sources is often restricted due to challenging geographical conditions and limited transportation infrastructure. Residents in these regions primarily depend on locally produced agricultural goods, which may not sufficiently meet diverse nutritional requirements. Studies indicate that highland populations generally consume more plant-based protein, such as beans and vegetables, compared to animal protein sources. In contrast, coastal areas benefit from better access to seafood, including fish and other marine products, which are rich in protein and omega-3 fatty acids. This availability supports a more varied and nutrient-dense diet. Studies indicate that diets in coastal regions are generally of higher quality, with adequate intake of energy, protein, and fat [5].

Eating habits in the highland regions are often shaped by local traditions and the availability of food resources. Carbohydrate- rich foods, such as rice or corn, serve as dietary staples, but the variety of food options is frequently limited. Studies have indicated that while protein intake from plant-based sources is generally adequate, the lack of dietary diversity may contribute to specific nutritional deficiencies. In coastal areas, dietary habits are more diverse, facilitated by access to various seafood and fresh vegetables. This diversity supports a more balanced nutritional intake. Foods from coastal regions are often richer in vitamins and minerals, owing to the wide range of available food sources [6].

Several studies have investigated the nutritional status and food security of adolescents in highland and coastal regions. Findings consistently indicate that adolescents in highland areas often exhibit poorer nutritional status compared to their coastal counterparts. This study highlighted that restricted access to diverse food sources and challenging environmental conditions significantly contribute to nutritional issues among adolescents in highland regions. Conversely, while coastal areas benefit from better access to marine resources, they still encounter challenges such as limited dietary diversity and the effects of climate change on fishing activities.

Moreover, food insecurity has been demonstrated to negatively impact the physical development and overall health of adolescents. Numerous studies underscore a strong correlation between poor nutritional status and food insecurity, which affects a significant proportion of adolescents globally. For instance, a study in Bangladesh reported that 67.5% of adolescents experienced food insecurity, emphasizing the urgent need for targeted interventions to enhance their dietary intake. Seasonal fluctuations in food availability further exacerbate this issue, complicating the diets of economically disadvantaged adolescents [2].

Although numerous studies have examined food security and nutritional status, many have overlooked the specific factors influencing food security among adolescents in distinct geographical contexts. Furthermore, these studies often focus on the general population, neglecting vulnerable groups such as adolescent girls. Consequently, further research is to establish more impactful and sustainable intervention strategies aimed at improving the nutritional status of adolescents. This study seeks to compare the food security and nutritional status of adolescent girls aged 15-19 years in highlands and coastal areas.

2 Materials and methods

2.1 Design, location, and time

This study employs a cross-sectional comparative research design to examine two distinct locations: highland and coastal areas. The research was conducted in Garut Regency, focusing on Cigedug Sub-district, representing the highland area, and Caringin Sub-district, representing the coastal area.

The study was carried out over three months, from February to April 2024. This timeframe allowed the researchers to gather comprehensive and relevant data on the differences in nutritional status and food security among adolescent girls in two distinct geographical settings, as well as to identify the factors influencing these disparities.

2.2 Population and sampling

The participants in the study included adolescent girls aged 15-19 years. The selection of highland and coastal locations was carried out using a purposive sampling method, based on elevation above sea level (masl) criteria. After reviewing secondary data, Cigedug sub-district was selected as the highland location, while Caringin sub-district was chosen to represent the coastal area. This study involved 318 adolescent girls, comprising 163 from highland areas and 155 from coastal areas. The inclusion criteria included households with adolescent girls aged 15-19 years who were unmarried, resided in the research locations, and provided informed consent by agreeing and signing the consent form.

2.3 Data collection

Data collection was carried out through interviews, questionnaires, anthropometric measurements, and hemoglobin tests to provide a comprehensive understanding of the challenges faced by adolescent girls in relation to food security and nutritional status.

2.3.1 Food security

Food security data collection was carried out using respondent interviews using the Household Food Insecurity Access Scale (HFIAS) questionnaire. The questionnaire categorized food security levels as “Food secure” (score 0-1), “Slightly food insecure” (score 2-7), “Moderately food insecure” (score 8-14), and “Severely food insecure” (score 15-27) [7]. This tool is specifically designed to assess household access to sufficient and quality food.

2.3.2 Anthropometric

Anthropometric evaluations were performed following standard practices, including the assessment of weight, height, and upper arm circumference. These methods provide accurate evaluations of an individual's nutritional and health status.

Weight was measured using calibrated Omron brand scales to ensure accuracy, providing critical information about body mass and nutritional status, such as underweight, overweight, or obesity. Height was measured with a Metrisis brand stadiometer, in contrast, the upper arm circumference was determined by a OneMed brand tape measure. These measurements are essential for identifying individuals at risk of malnutrition.

2.3.3 Hemoglobin Levels

Hemoglobin levels were measured using a standardized Hemoque 201 brand hemoglobin test kit, with blood samples carefully collected to ensure accuracy and precision. This method provides a quick and efficient assessment of hemoglobin levels, which is crucial for diagnosing anemia. The cutoff for anemia in women is an Hb level of <12 mg/dL [8].

2.4 Data analysis

The information gathered from this study was evaluated using SPSS software. The normality of the data was assessed through the Kolmogorov-Smirnov test. For data with a normal distribution, the independent t-test was employed, while the Mann-Whitney test was utilized for data that did not follow a normal distribution. A p-value of $p<0.05$ was considered statistically significant.

3 Results and discussion

Household food security levels in both highland and coastal areas were predominantly categorized as mild food insecurity. However, a greater proportion of food-secure households was observed in coastal areas (27.7%) compared to highland areas (14.7%). The prevalence of underweight individuals was higher among those residing in coastal areas (27.7%) compared to highland areas (23.3%), whereas the prevalence of overweight individuals was higher in highland areas (11.7%) compared to coastal areas (7.8%). Nutritional issues such as anemia and chronic energy deficiency (CED) were more prevalent among adolescent girls residing in coastal areas compared to those in highland areas (Table 1).

Table 1. Characteristics of adolescent girls in highlands and coastal areas in Garut Regency, West Java

Variable	Highlands (n=163)		Coastal (n=155)		Total (n=318)	
	n	%	n	%	n	%
Food Security Status						
Food secure	24	14.7	43	27.7	67	21.0
Mildly food insecure	71	43.6	71	45.8	143	45.0
Moderately food insecure	68	41.7	41	26.5	108	34.0
Nutritional Status						
Underweight	38	23.3	43	27.7	81	25.5
Normal	104	63.8	95	61.3	199	62.6
Overweight	19	11.7	12	7.8	31	9.7
Obese	2	1.2	5	3.2	7	2.2
Hemoglobin Levels						
Anemia (<12 g/dL)	51	31.3	71	45.8	122	38.4
Normal (≥12 g/dL)	112	68.7	84	54.2	196	61.6
Chronic Energy Deficiency						
CED	87	53.4	89	57.4	176	55.3
Normal	76	46.6	66	42.6	142	44.7

Table 2. Comparison of food security and nutritional status of adolescent girls in highlands and coastal areas in Garut Regency, West Java

Variable	Highlands	Coastal	*p*
	Median (IQR)	Median (IQR)	
Food Security Status	6.00 (8.00)	3.00 (8.00)	0.001*
Nutritional Status	20.14 (4.14)	20.05 (4.56)	0.488
Hemoglobin Levels	12.60 (2.00)	12.10 (2.10)	0.001*
Chronic Energy Deficiency	23.20 (3.40)	22.60 (3.90)	0.277

[1]Food Security Status (Score)
[2]Nutritional Status (Kg/m²)
[3]Hemoglobin Levels (g/dL)
[4]Chronic Energy Deficiency (Cm)
Note: *Different Significant at $p<0.05$ analysis was conducted using Mann-Whitney because the data were not normal.

A significant difference was observed in food security scores and hemoglobin levels between adolescent girls residing in upland and coastal areas ($p<0.05$). Coastal areas exhibited higher food security (27.7%) compared to upland areas (14.7%), while the prevalence of anemia was greater among adolescent girls in coastal areas (45.8%) than in upland areas (31.3%). Low hemoglobin levels are influenced by several factors, including increased iron demand, insufficient dietary iron intake, reduced iron absorption due to malabsorption, excessive blood loss, and impaired plasma iron transport [9]. Additionally, hemoglobin levels are closely associated with energy and protein adequacy.

Coastal areas benefit from abundant marine resources that significantly enhance the local diet. The availability of seafood is crucial for ensuring food security in these regions, as it contributes to higher nutrient intake and greater dietary diversity. In contrast, upland areas are more dependent on agriculture, which often provides less dietary variety and is more susceptible to crop failures and weather-related fluctuations. Reliance on limited agricultural products in upland areas can result in nutritional deficiencies, particularly during adverse weather conditions. Enhancing food security in both coastal and upland regions requires the promotion of sustainable fishing practices in coastal areas and the diversification of agricultural strategies in upland areas. By adopting a balanced approach to food production, communities can improve resilience to environmental challenges, ensure a stable and nutritious food supply, and work towards achieving greater food security and sustainability [10].

Despite access to diverse food sources, coastal communities may still face nutritional deficiencies, particularly in iron intake, leading to anemia. The high prevalence of anemia among adolescent girls is primarily attributed to increased iron requirements during menstruation and insufficient consumption of iron-rich foods. Additionally, certain food dietary habits can hinder iron absorption. For instance, consuming tea or coffee with meals can significantly inhibit iron uptake, exacerbating anemia symptoms even when iron-rich foods are part of the diet [11].

In coastal areas with hot weather, adolescents frequently choose sweetened tea drinks as their preferred beverage. However, this habit may contribute to health concerns, particularly regarding iron absorption. Sweet tea contains tannins, which are well-documented inhibitors of iron absorption in the digestive tract. When consumed alongside iron-rich foods, the tannins in the tea can bind to dietary iron, forming insoluble complexes dietary that reduce the body's ability to absorb iron effectively. Additionally, adolescents in coastal areas often consume sweetened condensed milk as an energy source. However, the high calcium content in sweetened condensed milk can inhibit iron absorption. Calcium and iron compete for absorption in the digestive tract, and consuming sweetened condensed milk alongside iron-rich foods can further exacerbate issues with iron absorption.

Furthermore, air pressure in coastal areas can influence hemoglobin levels in the blood through physiological mechanisms related to oxygen availability. Coastal regions generally have higher air pressure and oxygen levels compared to highland areas. This results in differences in the body's adaptation to environmental conditions. In high-altitude areas, the lower air pressure reduces the partial pressure of oxygen (PO_2), prompting the body to produce more hemoglobin to optimize oxygen transport [12]. This acclimatization process results in individuals living at high altitudes having higher hemoglobin levels compared to those in coastal areas, where air pressure and oxygen levels are higher, thus reducing the need for increased hemoglobin production. Research indicates that individuals in lowland or coastal areas tend to have lower hemoglobin levels due to the absence of hypoxia (oxygen deficiency), a condition typically experienced by those in highland regions.

Eating habits among adolescents play a crucial role in their nutritional health. For instance, if traditional diets fail to prioritize the inclusion of iron-rich foods during this critical developmental period, malnutrition may persist, even when general food security is adequate [11]. The absence of focus on essential nutrients can hinder adolescent growth and development, potentially leading to long-term health issues. Addressing these dietary gaps through education and community initiatives can enhance dietary diversity and meal frequency, which are essential for the health of adolescent girls [13].

Iron is crucial for the formation of hemoglobin, which transports oxygen in the blood. Adolescents, particularly girls, have increased iron requirements due to menstrual blood loss. The recommended daily intake (RDA) for adolescent girls is 15 mg. Iron-rich foods are categorized into two types: heme iron and non-heme iron. Heme iron, present in animal-based foods, is absorbed more efficiently by the body. The primary sources of heme iron include beef, chicken, fish, seafood such as shrimp and shellfish. Non-heme iron, found in plant-based foods, includes beans, vegetables such as spinach, broccoli, and sweet potatoes. To improve the uptake of non-heme iron, it is advantageous to consume iron-rich foods together with foods abundant in vitamin C, like citrus. fruits.

Table 2 shows that there was no significant difference in the nutritional status and chronic energy deficiency (CED) between adolescent girls residing in upland and coastal regions ($p>0.05$). The prevalence of SEZ among adolescent girls in coastal areas was higher (57.4%) compared to those in the highlands (53.4%). Furthermore, the intake of nutritious food and eating behaviors are direct factors contributing to nutritional problems [4].

Coastal areas often offer availability of diverse food options, including fish and other seafood, which contribute to dietary diversity. However, the overall nutritional quality of these diets may remain insufficient to meet the specific micronutrient needs of adolescent girls, particularly for iron, zinc and vitamin A. Research indicates that increased food availability, when accompanied by deficiencies in essential nutrients, may result in suboptimal nutritional status and a higher prevalence of chronic energy deficiency (CED). For instance, insufficient awareness of the importance of iron-rich foods can lead to inadequate consumption among adolescents, contributing to anemia despite access to diverse food sources [14].

The level of health education on nutrition plays a critical role in addressing chronic energy deficiency (CED) among adolescents. In many regions, including coastal areas, health education programs tailored specifically to the nutritional needs of adolescent girls during growth and menstruation are insufficient. Without adequate knowledge of the importance of consuming iron-rich foods or understanding how to balance their diet effectively, these girls remain at risk of CED, even in food-secure environments.

Socio-economic conditions significantly influence food security and nutritional outcomes. In coastal areas, industries such as fishing and tourism may provide income opportunities; however, disparities in wealth distribution can result in pockets of poverty where residents struggle to afford nutritious food. Conversely, upland areas face distinct

socio-economic challenges that limit access to diverse food sources, yet these challenges do not necessarily correspond to higher rates of chronic energy deficiency (CED) among adolescents. Parental education and family income are critical factors influencing nutritional outcomes. Parents with limited education often lack sufficient knowledge of nutrition and healthy practices, which can adversely affect their children's dietary habits. Bridging educational gaps and enhancing access to diverse food options are essential strategies for improving the nutritional status of families in both coastal and upland areas [15].

4 Conclusion

Significant differences were observed in food security status and hemoglobin levels among adolescent girls in upland and coastal areas. While adolescent girls in coastal areas demonstrated better food security, they also exhibited a higher prevalence of anemia. Efforts to improve food security should be complemented by comprehensive nutrition education and the promotion of sustainable agriculture and fishing practices. Ensuring that adolescent girls receive adequate nutrition to support their growth and health is equally crucial. These findings highlight the importance of further research to identify factors contributing to food insecurity and anemia in both regions.

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