



Food Insecurity and Anthropometry in Adolescents: A Literature Review

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Abstract

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BACKGROUND: The increased risk of malnutrition is affected by food insecurity. Studies in adolescents still show mixed results.

AIM: This article aimed to evaluate the association between food insecurity and anthropometry measurements in studies involving adolescents.

MATERIALS AND METHODS: The databases used to obtain the literature were PubMed, ScienceDirect, MEDLINE, and PubMed Central. The keywords used were food security, food insecurity, hunger, malnutrition, obesity, adolescence, adolescents, teenagers, teens, and youth in studies published from 2010 to 2019. A total of 12 articles were used in this review.

RESULTS: The association between food insecurity and the incidence of malnutrition in adolescents in various regions is still diverse. Food insecurity had a negative correlation with BMI-for-age in three studies (33.3%), but one study (11.1%) showed the opposite result. Food insecurity was positively related to low height-for-age (stunting) in 50% of studies, while five other studies (55.6%) showed that food insecurity was not related to BMI-for-age or weight-for-age. Three studies (50%) showed that there was no association between food insecurity and height-for-age.

CONCLUSION: Longitudinal studies, such as Cohort studies, need to be conducted to ensure the actual relationship between food insecurity and nutritional status in various regions.

Introduction

Food security is a state when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs according to their preferences for an active and healthy life [1]. The pillars of food security are food availability, food access, and food utilization. These three pillars are closely related. If one aspect is not fulfilled, it may affect other aspects and thereby encouraging food insecurity [2]. Food unavailability and difficult access to food have the potential to increase the risk of malnutrition in various life cycles, including in children, adults, and adolescent groups [3].

Adolescence is a young age group at the age of 10–19 years [4], and the number of adolescents reaches 18% worldwide [5]. The nutritional requirements in adolescents increase rapidly due to the rapid increase in biological or psychological growth, either in boys or girls [6]. The second period of a growth spurt after infancy occurs in adolescence [7]. Besides that, the highest bone mass reserve is also found in adolescence [8]. Adolescent nutrition will affect the health of adolescents in the present and future, future

labor productivity, and improvement in the generation that will be born [9], [10], [11], [12].

Malnutrition is a major problem that contributes to decreased growth [13]. Manifestations of malnutrition can be observed in the nutritional status of adolescents. Nutritional status is the level of nutrients related to normal metabolism in the body [14]. The high and low intake of nutrients and their use in the body have an impact on nutritional status [15]. In adolescents, nutritional status can be determined by using anthropometric indicators, such as body mass index for age (BMI-for-age) and height-for-age [16]. BMI-for-age and height-for-age less than or equal to -2 standard deviations (SD) are categorized as thin and short, respectively. Meanwhile, BMI-for-age more than or equal to 1SD is categorized as overweight or obese, and height-for-age more than or equal to 2SD is categorized as high [16].

The potential for increased risk of malnutrition in adolescents is affected by the state of food insecurity [6]. The previous review in the children group showed that half of the studies showed a positive association between food insecurity and low nutritional status, especially stunting [3]. Family food insecurity is also associated with obesity in children and adult groups [3]. A review of similar studies in the adolescent

group could not be conducted deeper because the number of studies was still lacking.

This study aimed to evaluate the association between food insecurity and anthropometry in adolescents to provide an overview of the relationship between food security and nutritional status in adolescents globally.

Methods

Data Sources and Search Methods

The study was conducted from October to November 2019. The databases used in the literature search were PubMed, ScienceDirect, MEDLINE, and PubMed Central. Food security or food insecurity or hunger; malnutrition or obesity; adolescence or adolescents or teenagers; or teens or youth were used as keywords.

Study inclusion and exclusion criteria

The literature used in this review included articles published from 2010 to 2019 that aimed to assess the association between food security and nutritional status of adolescents, and the adolescents in the studies were defined as those aged 10–19 years [4]. Based on these criteria, 831 articles obtained from a search on PubMed, 32 articles from ScienceDirect, and 117 articles from MEDLINE were then reviewed (Figure 1). The same articles but the study objectives did not meet the established criteria, and the ones with different subject targets were excluded from the study. A total of 12 articles met the requirements, and they were used in this review.

Data collection and synthesis processes

Abstracts and articles were identified to see the compatibility with inclusion criteria. The title and contents of the article were examined so that we knew whether the article had similarities with other articles. The articles that met the inclusion criteria were coded and then summarized in Table 1 as follows: Author, design, sample, age of the subjects, nutritional status variable, confounding variables, food security measurement instruments, and results.

Results

A total of 12 studies were included in this review (Table 1). All of them used a cross-sectional design. Six studies mentioned that the sampling methods used were as follows: Two studies used the cluster sampling method [17], [18], two studies used

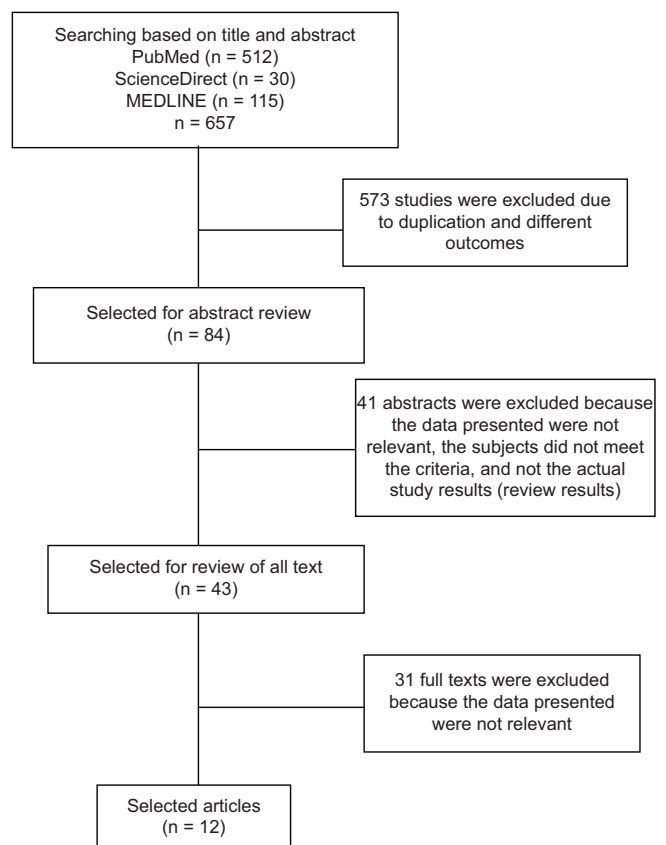


Figure 1. Literature Search and Determination Strategy

the multi-stage sampling method [19], [20], one study used a simple random sampling method [21], and one study used a combination of cluster sampling and simple random sampling (two-stage sampling) [22]. Three studies were multi-country studies conducted in developing countries or lower-middle-income countries (LMIC) [17], [18], [23] and five studies were conducted in Africa [19], [22], [24], [25], [26]. One study was conducted in Guatemala, Central America [21], one study in Canada [27], one study in the United States [28], and one study in Indonesia [20].

Nutritional status assessment in the study was conducted using the BMI, BMI-for-age, weight-for-age, height-for-age, and waist-to-height ratio (WHtR) using 2007 WHO references (16). One study assessed the nutritional status of adolescents based on BMI, one study assessed the nutritional status based on weight-for-age [27], and one study assessed the nutritional status based on WHtR [24]. Nine studies measured BMI-for-age [17], [18], [19], [20], [21], [22], [23], [24], [28] and six studies assessed the nutritional status based on the height-for-age indicator [19], [20], [21], [23], [24], [25], [26].

Food insecurity was assessed by various indicators. Two studies used the question, “During the past 30 days, how often did you go hungry because there was not enough food in your home?” to determine the food-secure or food-insecure adolescents [18], [21], while two other studies used the Household Food Insecurity Access Scale (HFIAS) [19], [20]. One study used adolescents’ confession whether they slept on a

Table 1: Studies on the association between food insecurity and nutritional status

Number	Author and year	Study design	Sample	Age	Nutritional status variable	Confounding variables	Food security measurement instruments	Results
1	Candler <i>et al.</i> (2017) [17]	<ul style="list-style-type: none"> • Cross-sectional study • Data from 40 low-income and middle-income countries • Cluster sampling method 	61,603 female adolescents from 40 lower-middle-income countries	12–18 years	BMI-for-age	Gender equality, income, and health	<ul style="list-style-type: none"> • Reports from adolescents about sleep in a hungry state because there was no food as a proxy indicator for household food security • National food security was assessed using the Global Food Security Index (GFSAI) 	<ul style="list-style-type: none"> • Sleep in a hungry state sometimes was associated with the increased risk of thinness • A significant negative correlation between thinness and the Global Food Security Index (GFSI)
2	Caleyachetty <i>et al.</i> (2018) [23]	<ul style="list-style-type: none"> • Cross-sectional study • Data from 57 low-income and middle-income countries 	129,276 adolescents	12–15 years	BMI-for-age	Internal conflicts, democratic status, gross domestic product, urbanization, and annual survey	Combination of price level, price volatility, dietary requirements, and nourishment	Food insecurity had a positive correlation with the prevalence of stunting
3	Cordeiro <i>et al.</i> (2012) [22]	<ul style="list-style-type: none"> • Cross-sectional study • Kalosa region in Tanzania • Two-stage sampling plan • Cluster sampling and simple random sampling 	670 adolescents	10–19 years	BMI-for-age	Sex, age, first puberty, religion, parents' presence, school attendance, physical activity, health, and socioeconomic status	Household energy adequacy per adult equivalent (EnergyAdd)	<ul style="list-style-type: none"> • EnergyAdd had negative correlations with undernutrition (thinness) • CSI was not associated with undernutrition
4	Johnson <i>et al.</i> (2019) [21]	<ul style="list-style-type: none"> • Cross-sectional study • In the southwest Trifinio region of Guatemala 	620 students	12–18 years	BMI-for-age	Eating behavior, the frequency of feeling lonely, suicidal thoughts, being intimidated or attacked in a fight, age at first alcohol use and sexual initiation, and current alcohol use	A question "During the past 30 days, how often did you go hungry because there was not enough food in your home?"	No significant association
5	Kimani-Murage (2013) [24]	<ul style="list-style-type: none"> • Cross-sectional study • Agincourt subdistrict, Mpumalanga Province, in the northeastern countryside of South Africa 	1,848 adolescents	10–20 years	BMI-for-age and waist-to-height ratio (WHR)	Age, sex, puberty status, mother's age, family education, socioeconomic status, and residential area	Unstandardized questions of food security in households level	Food insecurity had a positive association with WHR
6	Manyanga <i>et al.</i> (2014) [18]	<ul style="list-style-type: none"> • Cross-sectional study • 43 developing countries • Cluster sampling 	23,496 adolescents	11–17 years	BMI-for-age	Age, sex, country, and intakes of vegetables and fruits	A question "During the past 30 days, how often did you go hungry because there was not enough food in your home?"	No significant association
7	Belachew <i>et al.</i> (2013) [25]	<ul style="list-style-type: none"> • Cross-sectional study • Selected randomly • Jimma Zone, Southwest Ethiopia 	2,084 adolescents	13–17 years	Height-for-age	Age, family income, and residence	Four index items that were adopted from the household food security questionnaire in developing countries	Food insecurity had a negative correlation with the linear growth of adolescents, especially female adolescents
8	Wolde <i>et al.</i> (2015) [19]	<ul style="list-style-type: none"> • Cross-sectional study • Multi-stage sampling technique • Dale Woreda, Southern Ethiopia 	450 students	7–14 year with a mean age of 10.7 years	BMI-for-age and height-for-age	Sex, age, the number of family members, mother's education, monthly income, helminthiasis, and food intakes	Household Food Insecurity Access Scale (HFIAS)	Food insecurity had a positive correlation with stunting and underweight in children
9	Kimani-Murage <i>et al.</i> (2011) [26]	<ul style="list-style-type: none"> • Cross-sectional study • Nairobi, Kenya 	2,404 orphans	6–14 years	Height-for-age and weight-for-age	Location of residence, age, ethnicity, relationship with the head of household, age of the head of household, sex of the head of household, the latest education of the head of household, the number of children in the family, and family socioeconomic status	Questions about perceived hunger, regular eating time, access to food, and lack of food	Food security was not associated with nutritional status
10	Maehara <i>et al.</i> (2019) [20]	<ul style="list-style-type: none"> • Cross-sectional study • Multi-stage sampling • Klalten Regency and West Lombok Regency, Indonesia 	2,160 adolescents	12–18 years	BMI-for-age and height-for-age	Characteristics of the regions, sociodemographic, morbidity, food intakes, physical activity, age, and sex of the adolescents	Household Food Insecurity Access Scale (HFIAS)	Food security was not associated with nutritional status
11	Bhawra (2017) [27]	<ul style="list-style-type: none"> • Cross-sectional study • First Nations and Métis groups in Canada 	6,900 adolescents	6–17 years	BMI	Demographics (the type of the First Nations and Métis groups, age, and sex), socioeconomic status (annual family income, mothers' education, and the number of family members), school location, and cultural variables	The responses used by Statistics Canada to categorize food-insecure households based on the statement that households could get nutritionally-balanced foods, whether the amount of food was reduced or the family members skipped meals because they did not have money to get food, the frequency of experiencing this condition, and how often the family felt hungry	Food insecurity was not associated with overweight and obesity after socioeconomic variables were included in the analysis
12	Florez <i>et al.</i> (2019) [28]	<ul style="list-style-type: none"> • Cross-sectional study • The National Health Interview Survey (NHIS) in the US population 	7,532 adolescents	12–17 years	BMI-for-age	Age, sex, ethnicity, indicators of mental health, year of the survey, level of welfare, nutritional supplement recipients, parental citizenship status, family structure, mother in the household, and mother's age	The food security questionnaire from the United States Department of Agriculture (USDA) with 10 items	Food security was associated with an increase in obesity in Latino adolescents

hungry stomach or not as an indicator of household food security levels [17]. In contrast, another study used perceived hunger, regular eating time, access to food, and lack of food as the indicators [26]. A study in Southwest Ethiopia used four index items adopted from the food security questionnaire used in developing countries [25]. A study in Tanzania used a combination of household energy adequacy per adult equivalent (EnergyAdq), Household Dietary Diversity Score (HDDS), and Coping Strategy Index (CSI) [22]. A study on off-reserve First Nations and Métis children and youth used the response of its research subjects to categorize food security in Canada [27]. A study on Latino youth used the food security questionnaire from the United States Department of Agriculture (USDA). A study of low-income and middle-income countries used a combination of the price level, price volatility, dietary requirements, and nourishment as a food security indicator [23]. Another study employed unstandardized questions of food security in households' level [24].

Several confounding factors were included in the analysis in each study to clarify that the association between food insecurity and anthropometry is not shaped by other factors. Nine studies assessed socioeconomic status [17], [19], [20], [22], [24], [25], [26], [27], [28], two studies measured physical activity [20], [22], four studies measured health (17, 19, 20, 22) and four studies assessed food intake [18], [19], [20], [21], [22]. Fruits and vegetables and unhealthy foods such as salty food and high-fat food and sugar-sweetened beverage were assessed using a food frequency questionnaire [18], [20], [21] or a 24-h dietary recall [19].

The review results indicated that food insecurity had a negative correlation with BMI-for-age in three studies out of nine studies that assessed food insecurity using the BMI-for-age indicator (33.3%). Adolescents from food-insecure households tended to be thinner than those in food-secure households [17], [19], [22]. A study using the WHtR parameter also showed that adolescents from food-insecure households were positively related to a high WHtR [24]. Three of the six studies (50%) that used the height-for-age indicator showed that food insecurity had a positive correlation with a low height-for-age (stunting) in adolescents [19], [23], [25]. Five other studies (55.6%) showed that food insecurity was not related to BMI-for-age [18], [20], [21], [23], [27] or weight-for-age [26]. Three studies (50%) also showed no association between food insecurity and height-for-age [20], [21], [26].

Discussion

This review aimed to assess the association between food insecurity and the incidence of malnutrition in adolescents from various studies. This review also

showed that only 44.4–50% of studies indicated a significant association between food insecurity and nutritional status in adolescents using the BMI-for-age indicator or height-for-age indicator. The studies indicating no significant association between food insecurity and nutritional status in adolescents in this review were also nearly equal in number.

Food insecurity is associated with the low quantity and quality of food intake due to compensation for lack of food quantity and lack of food access [29], [30]. The quantity and quality of adolescents' intakes are related to their nutritional status [31], [32]. The low quantity of adolescents' food intake gives a manifestation in the form of poor nutritional status, and the low quality of diet (e.g., monotonous food intake) can give manifestations on the nutritional status in the form of low BMI-for-age and low height-for-age [33], [34]. The quality of diet is related to the adequacy of minerals in adolescents, which is associated with skeletal growth [35]. The quantity and quality of food intakes among adolescents in food-insecure households are lower than those in food-secure households [29].

In this review, it was known that two studies showed that food insecurity had a positive correlation with overweight and obesity [24], [28]. The results of a systematic review in groups of children and adults showed a similar positive correlation [3]. The low quality of diet also causes adolescents in food-insecure households to become fatter or more obese than those in food-secure households. Food-insecure households are easier to obtain high-calorie and low-nutrient foods due to the low prices [36], [37], [38]. Foods, such as vegetables and fruits, are categorized as low-energy groups but quite expensive to be affordable by food-insecure groups [37]. Food-insecure households also tend to buy food monotonously with little variation as a consequence of low financial conditions [39]. Foods with high-calorie counts cause weight gain more easily if consumed regularly [40].

The association between food insecurity and nutritional status can also be explained through morbidity levels that affect nutritional status. Adolescents in food-insecure households also have a higher risk of having health problems than those in food-secure households [29], [41]. If this condition persists for a long time, it will mainly inhibit the growth of adolescents that will be manifested in height-for-age [3]. However, two studies assessing adolescent's health as a confounding variable in this review showed that food security was still related to nutritional status, independent of adolescent's health status [17], [22].

Food security has a negative correlation with household socioeconomic levels [42], [43]. Food-insecure households tend to have low income, large families, poor residence sanitation, and low maternal education [43], [44], [45]. These various socioeconomic factors have positive correlations with undernutrition [46], [47] or overnutrition [48] in

adolescents. Nine studies in this review involved socioeconomic factors as confounding variables in their analyses [17], [19], [20], [22], [24], [25], [26], [27], [28]. However, the above variables were not analyzed simultaneously in all studies. Two studies showed that the association between food insecurity and obesity became insignificant after incorporating socioeconomic variables into the analysis [20], [27]. One study also showed that the association between food security and stunting disappeared after adjusting for wealth status [20]. Therefore, household socioeconomic conditions can affect the association between food security and nutritional status in adolescents.

In this review, other articles showed that there was no significant association between food security and nutritional status in adolescents [18], [21], [26], [27]. These studies did not include various confounding variables in the analyses that could disrupt the association between food security and adolescent nutrition, such as socioeconomic conditions [18], [21] health conditions [18], and physical activity [21], [26], [27]. An instrument of food security assessment may not capture the differentiation among cultural settings in a study, so that actual food security situation may not be shown [26].

This review indicated that the association between food insecurity and nutritional status of adolescents in various countries still showed mixed results. The limitation of this review was that it could not control various confounding variables that were not assessed and not included in the analyses in several studies. Further research to observe the association between food security and adolescents' nutritional status also needs to be conducted by analyzing food intake, health, policies, socioeconomic conditions, and various food security programs that have been performed.

Conclusion

The association between food insecurity and anthropometry measurement in adolescents in various regions is still diverse. However, the relationship between food security and malnutrition both over and undernutrition existed in some studies reveals the need to take concern in food security intervention to support nutrition and health in adolescents. Various studies with large sample sizes and longitudinal study design (e.g., Cohort study) need to be conducted to ensure the actual relationship between food insecurity and nutritional status in various regions. Various confounding factors also need to be included in further research related to the conceptual framework that affects food insecurity and nutritional status in adolescents.

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