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Association between Food Insecurity and Weight Disorders of Children and Adolescents in Iranian Population: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: The link between food insecurity and weight disorders of children or adolescents remains controversial. Therefore, this systematic review and meta-analysis aimed to clarify the association between food insecurity and weight disorders of children and adolescents in Iran. **Methods:** PubMed, ISI Web of Science, Scopus, Google Scholar, Magiran, and SID databases were searched up to August 2020. Study selection, data extraction, and bias assessment in the included studies were performed by two reviewers independently. Odds ratios (ORs) were calculated using a random effects model. **Results:** The pooled ORs of cross-sectional studies showed that food insecurity was not associated with the odds of underweight (OR 1.18, 95% CI 0.52, 2.70) with no evidence of publication bias but high heterogeneity between studies ($I^2 = 80\%$; $P < 0.05$). Similarly, the pooled ORs demonstrated that there was no association between food insecurity and obesity in children and adolescents of Iranian population (OR 1.29, 95% CI 0.91, 1.82) with no evidence of publication bias and heterogeneity between the studies ($I^2 = 0.0\%$; $P = 0.52$). **Conclusions:** There was no association between food insecurity and underweight or obesity in children and adolescents of Iranian population.

Keywords: Food insecurity; Child; Adolescent; Body weight; Pediatric obesity

Introduction

It has been estimated that 795 million people do not have access to enough food worldwide and 780 million of them are from developing countries (McGuire, 2015). Food security is defined as the physical and economic ability of all the people to access nutritious, safe, and sufficient foods to meet their needs for a healthy life at any time (Grainger, 2010). However, food insecurity means uncertain or limited access to nutritious, safe, and sufficient foods for healthy and active life at any time

(McGuire, 2015). Food insecurity in childhood is associated with poor health, learning problems, anthropometric disorders, including weight and height. It is also a predictor of chronic diseases, mental wellbeing, and the risk of suicide during late adolescence (Black, 2012, Ke and Ford-Jones, 2015, Simonovich *et al.*, 2020).

Geographic location is suggested as an important cause of vulnerability to food insecurity (Devereux *et al.*, 2004). The Middle East

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countries, such as Iran have unprecedented challenges that lead to food insecurity because of water scarcity, political turmoil, and social upheaval (Sun *et al.*, 2017).

Food insecurity has three levels, including, mild, moderate, and severe (Ayiraveetil *et al.*, 2020, Coates *et al.*, 2007). The association between food insecurity and weight disorders is poorly understood (Coates *et al.*, 2007). Previous studies have demonstrated an association between food insecurity and the risk of weight disorders (Lyons *et al.*, 2008, Reza zadeh *et al.*, 2016). Studies conducted on the association between food insecurity and weight disorders in children and adolescents have shown conflicting outcomes. For instance, a study on 7-11 years old children in Tabriz showed that food insecure participants had poor dietary intakes and nutritional status, and food insecurity prevalence was higher among boys than girls (Alipour *et al.*, 2016). Another study showed that food secure children had greater height and weight and the risk of stunting or underweight was lower than food insecure ones (Saha *et al.*, 2009).

The results of observational investigations on the association between food insecurity and overweight, obesity, or underweight are controversial. Thus, the present systematic review and meta-analysis aimed to assess the association between food insecurity and the weight abnormalities of children and adolescents in Iran.

Materials and Methods

Search strategy: ISI Web of Science, PubMed, Scopus, Google Scholar, Magiran, and SID were searched to find relevant papers. Medical Subjects and Headings (MeSH) were used, including the terms: 1) "food security" OR "food insecurity" OR "food insecure" OR "food supply"; 2) "Iran" OR "middle east"; 3) 1 & 2 to find relevant articles. Furthermore, a hand search was performed to find more relevant papers. All the articles published till August 2020 were included with no language restriction. Also, no restriction was applied for the type of studies.

Inclusion and exclusion criteria and study selection: This systematic review and meta-

analysis was done in accordance with PRISMA checklist 2009 (Wiley, 2011). The inclusion criteria consisted of studies 1) conducted on children and adolescents (under 18 years old), 2) measured household food security with one of the valid questionnaires, 3) calculated BMI-for-age-Z-score (BAZ) weight status, 4) calculated the relationship between food insecurity and indices of weight status, and 5) conducted in Iran. The exclusion criteria consisted of 1) editorial/letters to editor, review articles, 2) studies which were not published in peer-reviewed journals, such as abstracts from conference proceedings, dissertations, and master's thesis, and 3) papers with insufficient data. Two different authors (Derakhshandeh-Rishehri SM, Hassanzadeh-Rostami Z) assessed the title, abstract, and full text of the articles.

Quality assessment: The modified version of Newcastle–Ottawa Scale for non-randomized studies was used to assess the quality of the included studies (Wells *et al.*, 2000). This scale assessed the quality of studies in three major domains, including selection with a maximum of 5 stars, ascertainment of outcome with a maximum of 3 stars, and comparability to control confounders in the analysis or design with a maximum of 2 stars. The included studies with 0–3, 3–6, and 7–10 points were considered as low, moderate, and high quality, respectively.

Data extraction: Two authors (Derakhshandeh-Rishehri SM, Hassanzadeh-Rostami Z) were responsible for data extraction. The parameters, including name of the first author, publication date, country (or location), population (study participants), age, sample size, type of food insecurity, type of questionnaire, and prevalence of food insecurity, were extracted from each included study. Any uncertainty in the process of data extraction was resolved by discussing the case between the two authors (Derakhshandeh-Rishehri SM, Hassanzadeh-Rostami Z). For incomplete data, an email was sent to the corresponding author.

In the current study, BAZ was used to assess weight status. Accordingly, $BAZ < -2$ was considered underweight, $-2 \leq BAZ \leq +1$ normal, $+1 < BAZ \leq +2$ overweight/at risk of overweight, and $BAZ > +2$ was considered obese (Esfandiari et al. 2018).

Data analysis: The association between food insecurity and weight disorders in children and adolescents was calculated by computing pooled OR and 95% confidence interval. A random effects model was used to estimate the within and between the studies variances (DerSimonian and Laird, 1986).

I-squared was used for assessing the heterogeneity. According to I-squared test, values $< 25\%$, 25% to 50% , and $\geq 50\%$ were considered low, moderate, and high heterogeneity, respectively (Higgins and Thompson, 2002). For assessing small study effects, Begg's test, Egger's test, and funnel plot were used. Sensitivity analysis was done to assess the effect of each study on overall effect. All statistical analyses were done by Stata version 11.0 software (Stata Corporation).

Results

Study selection: Among the 1556 articles, 23 full texts were assessed for inclusion and exclusion criteria. Seventeen articles were excluded after full-text screening; ten articles did not measure the association of food insecurity (FI) and weight status indices, three articles did not measure BAZ, and four articles did not have sufficient data. Finally, six studies were qualified to be included in the meta-analysis, among which one study had case control design. For increasing the generalizability of the results, only five studies from Iran with cross-sectional design were included in the final analysis (**Figure 1**).

Characteristics of the included studies: The mean age of the participants ranged from 9 to 17 years. All the studies were performed on both genders. Sample sizes of the eligible studies ranged from 240 to 610 participants. Four, three, and three studies reported underweight, overweight, and

obesity in children and adolescents, respectively. Three studies assessed food security via 18-items U.S. Department of Agriculture (USDA) food security module, and two studies used 16 items Cornell questionnaire. All the included studies had cross-sectional design (**Table 1**).

Quality assessment: The overall quality assessment results of the included studies are summarized in supplementary **Table 1**. Five studies had moderate quality (Ahmadihoseini et al., 2019, Basirat et al., 2012, Farzaneh et al., 2017, Shahraki et al., 2016), and one study had high quality (Jafari et al., 2017). Thus, all the eligible studies had acceptable quality to be enrolled in the final analysis.

Publication bias: The visual inspection of the funnel plot showed no evidence of publication bias in the meta-analysis of the association between food insecurity and weight disorders of children and adolescents in Iranian Population (Figure S1). The Begg's and Egger's tests did not show any publication bias for the association between food insecurity and underweight ($P = 0.2$, $P = 0.1$), or obesity ($P = 0.6$, $P = 0.7$).

Sensitivity analysis: To evaluate the association between food insecurity and weight disorders according to BAZ among the children and adolescents in Iranian population, a sensitivity analysis was performed according to the random-effects model. The results of sensitivity analysis showed that one study had no effect on the pooled estimated association between food insecurity and underweight, also between food insecurity and obesity in Iranian children and adolescents.

Meta-analysis results: The pooled analysis showed that food insecurity was not significantly associated with the odds of underweight (OR 1.18; 95% CI 0.52, 2.69; $I^2 = 80.0\%$) (**Figure 2**). Pooled analysis of cross-sectional studies showed that food insecurity was non-significantly associated with the odds of obesity (OR 1.29; 95% CI 0.91, 1.82; $I^2 = 0.0\%$) (**Figure 3**).

Table 1. Systematic table of the included studies.

Author and Year (Reference)	Population and Age (months)	Type FI	Location	Sample size	Design	Questionnaire	N (%) BAZ<-2 (FI)	N (%) +1<BAZ≤+2 (FI)	N (%) BAZ>+2 (FI)
Ahmadihoseini, et al. 2019 (Ahmadihoseini et al., 2019)	<6-years old Children (9-80)	FI (1/2/3)	Golshahr, Mashhad, Iran	240	Cross- Sectional	USDA-18	60 (40.8)	15 (10.2)	Not- reported
Basirat, et al. 2012 (Basirat et al., 2012)	6-12 years old students (94-128)	FI	Farokhsha, Shahrekor, Iran	310	Cross- Sectional	Radimr/ Cornell-16	45 (91.8)	6 (12.2)	2 (4.1)
Farzaneh, et al. 2017 (Farzaneh et al., 2017)	14-17 years old students (168-204)	FI (1/2/3)	Bostan Abad, East Azerbaijan, Iran	480	Cross- Sectional	USDA-18	1 (0.2)	52 (10.8)	13 (2.7)
Jafari et al. 2017 (Jafari et al., 2017)	7-12 years old children (84-144)	FI	Isfahan, Iran	587	Cross- Sectional	Radimer/ Cornell-16	Not- reported	Not-reported	69 (16.5)
Shahraki, et al. 2016 (Shahraki et al., 2016)	14-17 years old children (92-127)	FI (1/2/3)	Zabol, Sistan and Baluchestan, Iran	610	Cross- Sectional	USDA-18	49 (19)	Not-reported	Not- reported

FI: Food Insecurity; **FI (1/2/3):** Food Insecurity (mild, moderate, and severe); **FI (Hun 1/2/3):** Food Insecurity (without hunger, with moderate hunger, and with severe hunger)
N (%): Number (Percent) / **BAZ:** BMI-for-age-Z-score/ **USDA:** U.S. Department of Agriculture Food Security Module

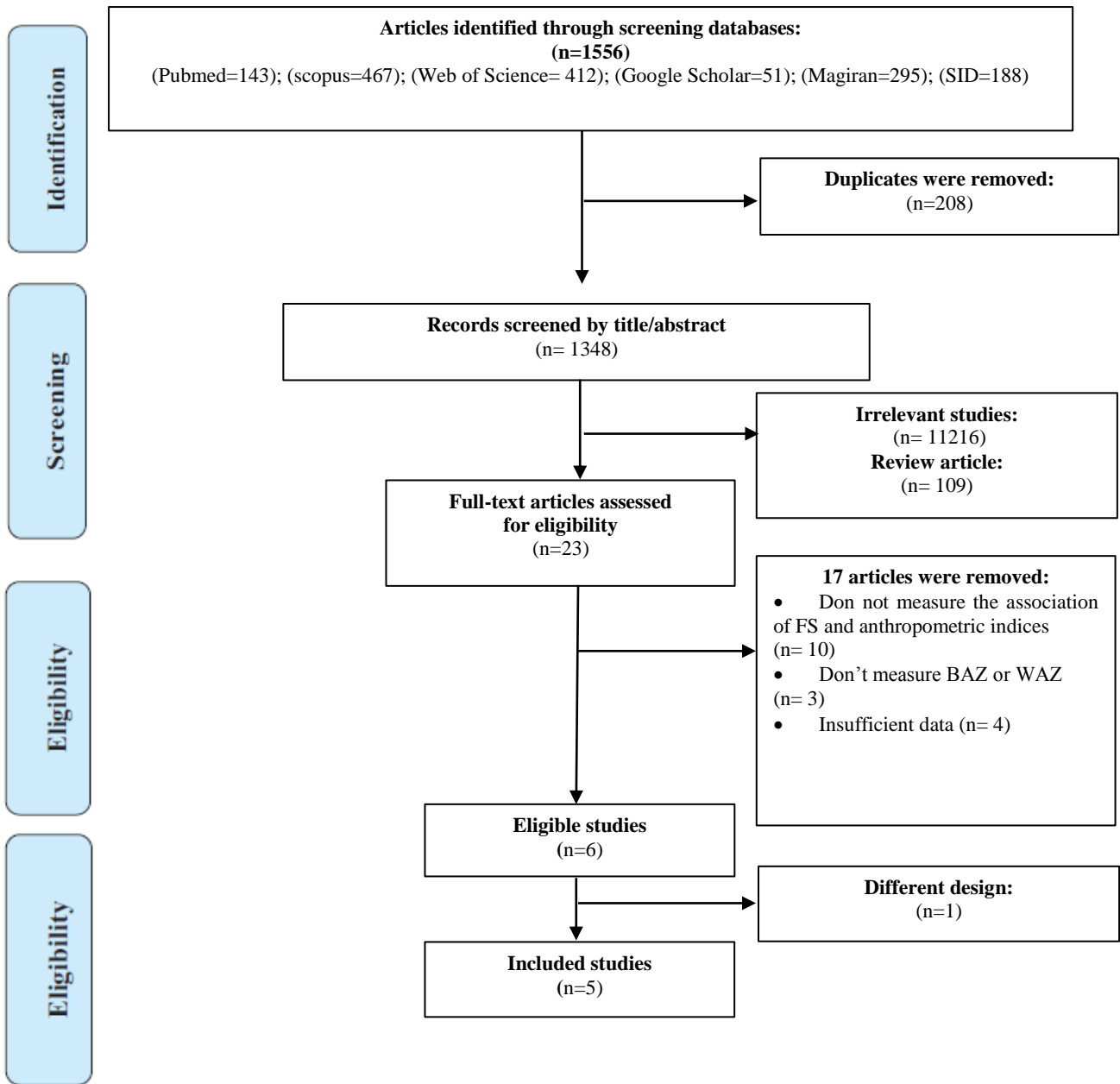


Figure 1. PRISMA diagram

Funnel plot with pseudo 95% confidence limits

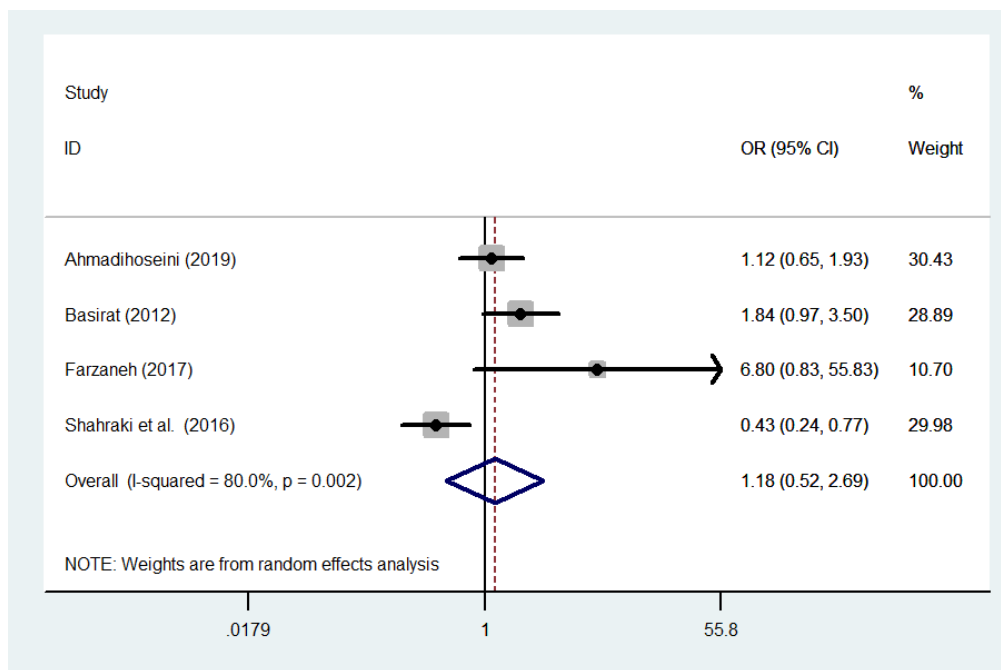
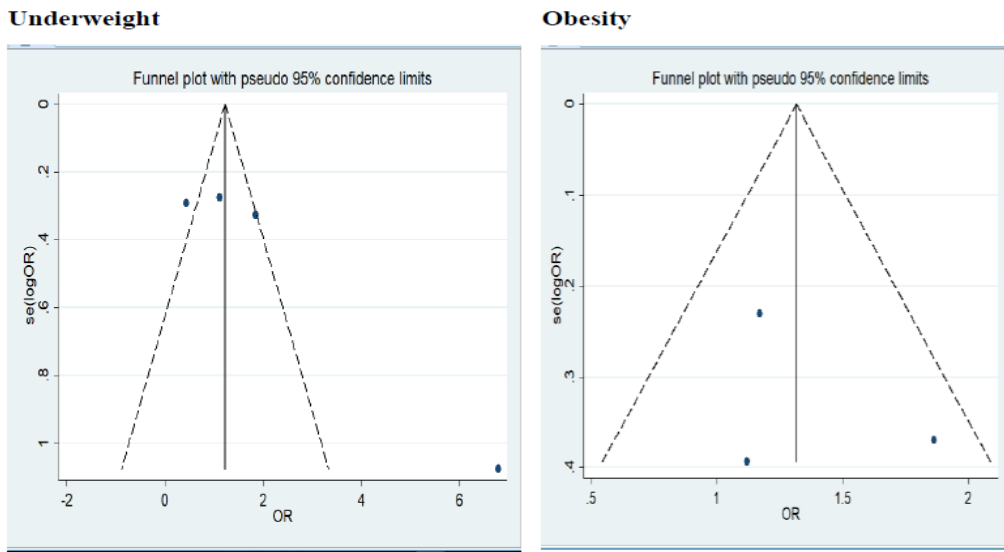


Figure 2. Forest plot of the association between food insecurity and underweight status of children and adolescents based on BAZ

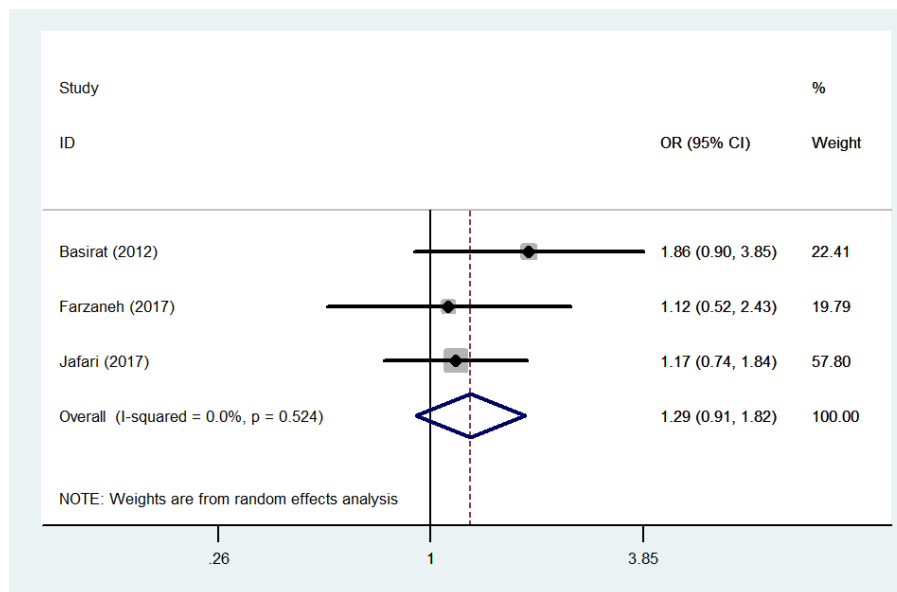


Figure 3. Forest plot of the association between food insecurity and obesity status of children and adolescents based on BAZ.

Discussion

In this meta-analysis, no association was found between food insecurity and obesity. Furthermore, the results indicated that there was no association between food insecurity and underweight of children and adolescents in Iranian population.

In developing societies, food insecurity is widespread which could be attributed to the food deprivation, poor healthy foods availability, and poor economic status (Chelule *et al.*, 2014, Hunter, 2014, Niknaz and Taj Aldini, 2006). Therefore, food insecure children and adolescents are prone to low or very low energy intake, which results in underweight (Chelule *et al.*, 2014, Hunter, 2014, Niknaz and Taj Aldini, 2006). Farzaneh *et al.* reported that in Iranian household population food insecurity was inversely associated with the consumption of healthy foods, such as low-fat dairy products, fruits and vegetables, meats, and legumes which have lower calories and higher prices. However, food insecurity was directly associated with the consumption of cereals and high calorie foods with lower prices. Thus, the availability of high energy density foods with lower price in food insecure regions with economic problems resulted in higher prevalence of

overweight and/or obesity (Farzaneh *et al.*, 2017). As a general assumption, food insecurity can increase the risk of overweight and/or obesity. It could be due to reasons, including higher consumption of inexpensive calorie-dense foods (Drewnowski and Specter, 2004), overeating at times of food availability (Scheier, 2005), changes in metabolic pathways for more efficient energy utilization (Alaimo *et al.*, 2001), changes in the standards of a healthy diet (Gundersen and Ribar, 2005), and urging children to overeat at the times of food availability by their parents to protect them (McIntyre *et al.*, 2003).

In accordance with the present study findings, two other studies with limited number of participants in Middle East showed no significant association between food insecurity and obesity (Basirat *et al.*, 2012, Jafari *et al.*, 2017). Conversely, Jafari *et al.* reported that after adjusting for all potential confounders, food insecurity significantly increased the odds of abdominal obesity in school-aged Iranian children (Jafari *et al.*, 2017). Through a cross-sectional study, using the data from Korean National Health and Nutrition Examination Survey, Bae *et al.* concluded that food insecure girls had three times

higher risk of obesity than food secure ones, while food insecure boys were less likely to be obese (Bae and Choi, 2021). Another study in the United States reported a significant relationship between food insecurity and overweight only in girls, but not in boys (Jones *et al.*, 2003). Also, Esfandiari *et al.* found that food insecure status of children was associated with overweight only in girls (Esfandiari *et al.*, 2018). Another study which was conducted on 8 to 16 years old children from National Health and Nutrition Examination Survey (NHANES) demonstrated that according to BAZ, food insecure girls were 3.5 times more likely to be overweight than food secure girls (Alaimo *et al.*, 2001). Moreover, in the present study, the non-significant association between food insecurity and child underweight was inconsistent with the findings of two other studies (Isanaka *et al.*, 2007, Naser *et al.*, 2014). Isanaka *et al.* conducted a study in Colombia and reported that the odds of being underweight were three times higher in food insecure households than food secure ones, but there was no significant association between food insecurity and stunting (Isanaka *et al.*, 2007).

Non-significant association between food insecurity and underweight, overweight, and obesity were determined due to some reasons. First, according to Food and Agriculture Organization (FAO), food security has four dimensions that include “availability, access, use, and stability”; variations of “food stability” in different regions can affect other parameters of food insecurity (Food Agriculture Organization of the United States, 2013). Accordingly, food security and adequate nutrition availability in childhood depend upon nutrition and non-nutrition factors. It was assumed that food insecurity and poverty may happen temporarily in some families for the reasons of job loss, seasonal changes, and economic burdens which could lead to non-significant association between food insecurity and weight disorders in the specific point of time. As a result of economic burden or seasonal changes, which could restrict the access to foods, some

children use insufficient, unexpensive or non-nutritious foods to deal with hunger. However, these crises may not be long-lasting enough to affect weight status of children and adolescents significantly. Second, there was insufficient information about the gender of children and adolescents of the eligible studies. According to Alipour *et al.* and Hinton *et al.* gender is a significant determinant of food insecurity. Accordingly, boys have faster growth rate, and total energy needs, so they are more prone to food insecurity than girls (Alipour *et al.*, 2016, Hinton, 2009). Third, variation in the methods and questionnaires, used for food insecurity assessments. Fourth, lacking information about the grade of food insecurity in some studies. Fifth, insufficient sample size of some of the included studies. Sixth, in the case of underweight, parents try to meet their children's needs, even under the pretext of the parent's hunger, so the actual link between food insecurity and child/adolescent underweight cannot be detected.

The present systematic review and meta-analysis has some strengths. It included available cross-sectional studies regarding the association between food insecurity and weight disorders of children and adolescents in Iranian population, and it is the latest systematic review and meta-analysis on this issue. Other strengths include detection of the biases like small-study effect, or defaults in methods, analysis, and interpretation.

However, the present study has some limitations that must be considered in interpreting the results. First, lack of sex-specific data and diversity in the questionnaires used for assessing food security that may cause significant heterogeneity in the results. Second, more than eighty percent of the participants were school-aged children and only one study included pre-school children, which limited conducting any subgroup analysis according to age. Third, the small sample size of the included studies made it difficult to find a significant relationship.

Conclusion

The present study showed that there was no association between food insecurity and obesity of children and adolescents in Iran. Furthermore, there was no significant association between food insecurity and underweight among the Iranian children and adolescents.

Authors' contribution

Derakhshandeh-Rishehri SM cooperated in study conduction, screening, data extraction, data analysis and wrote the paper; Hassanzadeh-Rostami Z cooperated in study conduction, screening, data extraction, and data analysis; and Faghih S cooperated in research design, study conduction, and had primary responsibility for final content. All authors read and approved the final manuscript

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Conflicts of Interest

None

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