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ORIGINAL ARTICLE

# Household food security status, food purchasing, and nutritional health of Saudi girls aged 6-12 years

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**Abstract.** *Background/Aim:* To assess the prevalence of food insecurity at the household level and to investigate its relationship with the anthropometric measurements and dietary intake of Saudi girls and the frequency of household food purchasing. *Material and Methods:* This cross-sectional study included 119 girls aged 6-12 years and their mothers who were recruited from four public schools in Madinah, Saudi Arabia. Sociodemographic data, anthropometric measurements (height and weight) for both mothers and girls, dietary intake of girls (expressed as energy-adjusted nutrient intake), and frequency of household food purchasing were evaluated. The Food Insecurity Experience Scale was utilized to evaluate the food security status. *Results:* Nearly one-quarter of the participants were experiencing food insecurity. Paternal education level and household income were positively associated with household food security status, whereas household crowding was negatively associated with food security ($p < .05$). Household food security status was not linked to weight status or height of girls. However, food security status was positively associated with energy-adjusted vitamin D intake (B= 2.02 (SE= 0.86), [95% CI 0.31 to 3.72], p= .021). Additionally, significantly lower frequencies of purchasing fruits and vegetables, milk and dairy products, and meat were observed among food insecure households compared to food secure households ($p < .05$). *Conclusion:* The high prevalence of food insecurity observed among our sample is concerning. Household food insecurity was linked to lower vitamin D intake among Saudi girls as well as lower purchasing of healthy foods. Interventions are needed to increase the accessibility of healthy food options among children experiencing food insecurity.

**Key words:** food insecurity; girls; weight status; stunting; nutrient intake; food purchasing

## Introduction

Adequate nutrition in childhood is essential for healthy growth and development (1). Undernutrition among children has been linked to a number of health-related consequences, such as impaired cognitive and neurological development, immunological alterations, gastrointestinal and respiratory infections, and risk of mortality (2–5). Although recent data suggested a declining rate of undernutrition among young children (< 5 years old), the global prevalence remains very high; The numbers of stunted and wasted children were estimated to be around 149 million and over 49 million, respectively (6). In Saudi Arabia, data of children aged < 5 years indicate high prevalence of moderate and severe underweight (6.9% and 1.3%), wasting (9.8% and 2.9%), and stunting (10.9% and 2.8%), respectively (7). Although previous studies have linked poor nutritional status of children with the socioeconomic status and ethnicity, the burden of undernutrition appears to be particularly high among children of food insecure families (8–13).

Food security focuses on the availability, accessibility, and utilization of food. At the household level, aspects of food insecurity include the limited access to adequate and nutritious foods required for healthy living due to lack of financial or other resources (14). An analysis of data across 149 countries revealed a prevalence of food insecurity ranging between 18% to 76% in East Asia and Sub-Saharan Africa, respectively (15). However, the reported numbers of food insecure households have widely varied between developed and developing countries. For instance, data from the United States indicated that 13% of the families were experiencing food insecurity in 2015, of whom approximately 5% were experiencing severe food insecurity (16). In Canada, 8% of the children were experiencing food insecurity (17). On the contrary, much higher prevalence of food insecurity was observed in developing countries such as in South Lebanon (42%) and South Sudan (98 %) (18,19).

In developed countries, consumptions of low-quality diets were frequently reported among individuals of food insecure households (20–22). It has been found that Canadian girls living in food insecure and low-income households consumed less milk and more sugar and sweetened beverages (22). However, it has been argued that children's dietary intake might be affected differently than adults by food insecurity; A study has found that mothers tend to feed the child while reducing their own food intake to secure the child (16). In developing countries, food insecurity has been linked to food diversity (23), but data regarding children's dietary intakes and the association with food security status are lacking in many developing countries, including Saudi Arabia.

Although food insecurity has been found to have negative impacts on health, data relating food insecurity to the nutritional status of children were inconsistent, possibly due to differences in settings and populations (24–26). For example, significant relationships between food insecurity and stunting and underweight were observed among children in Columbia and Tanzania, wherein stunting and underweight were found to be highly prevalent (27–29); on the other hand, no association was reported among children in settings wherein low prevalence of stunting and underweight were observed, such as in Brazil (30). Furthermore, the lack of the association between obesity among children and food insecurity has been frequently reported in the United States (31,32). However, the association between children's nutritional status and food insecurity in wealthy developing countries remains questionable. Hence, we aimed to evaluate the prevalence of household food insecurity and to investigate its relationship with the anthropometric measurements and dietary intake of Saudi girls and the frequency of household food purchasing.

## Materials and Methods

### *Sample*

A total of 200 envelops were given to girls (6 to 12 years of age) who were recruited from 4 elementary public schools in Madinah, Saudi Arabia. Schools were selected randomly from two wealthy neighborhoods and two relatively low-income neighborhoods. Each envelop contained a consent form along with descriptions of the study objectives and the required forms to be completed and signed by the mother. Data were only collected from girls who returned the signed consent form. Mothers were asked to fill out the information for one child if more than one child received an envelope. Ethical clearance was provided by the Ethics Committee, College of Applied Medical Sciences, Taibah University [CLN 201710].

### *Household food security status*

Mothers who signed the consent forms were contacted by a trained professional via WhatsApp messages to arrange for phone interviews to complete the study questionnaires. The Arabic version of the Food Insecurity Experience Scale (FIES) was utilized to evaluate food household food security status (33), which has been validated and used previously in the Middle East (34,35). Households were identified as mildly food insecure if mothers responded by at least one affirmative answer to the first three items (items 1-3). The first three items were questions about uncertainty and worry about food and inadequate food

quality. Households with moderate food insecurity were identified if the mother responded by at least one affirmative answer to the next three items (items 4-6). Households with severe food insecurity were identified if the mother responded to items 7-8 affirmatively. Items 4-8 were questions about insufficiency of food quantity. If no affirmative answer was provided to any of the items listed in the questionnaire, the household was identified as food secure (36).

*Sociodemographic characteristics, anthropometric measurements, dietary data, and frequency of household food purchasing*

The questionnaire also included sociodemographic data, such as the age of the child, maternal age, weight, and height, educational level of both parents (< high school degree; high school degree; diploma; ≥ university degree), household monthly income in Saudi Riyal (SR) (< SR 3,000; SR 3,000-6,000; SR 6,001-10,000; > SR 10,000), household crowding (determined based on family size divided by household room number), residence ownership (rent; own), and availability of food stores in the neighborhood (yes; no).

Maternal height and weight were self-reported during the phone interview, and the body mass index (BMI) was calculated. Anthropometric data of girls were objectively measured at schools; Girls' weight was measured using an electronic scale, and height was measured by a flexible measuring tape placed on a straight wall. Measured height was rounded to the nearest 0.5 cm. Height and weight of girls were measured shoeless with light clothing. The girls were given cards including their measured height and weight to take home. The World Health Organization (WHO) criteria were used to evaluate children's height and weight status; "Stunting was determined if a girl's height-for-age (HFA) z-score was < -2 SD; Girls with BMI-for-age z-score < -2 SD were classified as thin; BMI-for-age z-score > +1 SD suggested a status of overweight, whereas BMI-for-age z-score > +2 SD suggested a status of obesity" (37,38).

Dietary intakes of girls were collected from mothers over the phone. The existing evidence suggests that collecting dietary recalls over the phone is a practical and valid tool to evaluate dietary intakes (39,40). A single 24-hr dietary recall was reported by the mother; mothers were requested to report each food consumed by the child during the past 24 hours. Mothers were asked to allow their children to attend the interview to ensure that all foods consumed in school are reported. Pictures of food portions and food models were sent to mothers via WhatsApp to help in determining portion sizes of food consumed by their daughters. The dietary data were analyzed using the Diet Organizer software (version 3.1). Mean intakes of macro- and micronutrients were compared to the Dietary Reference Intake (DRI) and the Estimated Average Requirement (EAR), respectively (41). Macronutrient densities were calculated by expressing intake of macronutrients as proportions of energy, whereas densities of the other nutrients were expressed as intakes per units/1,000 kcal.

Household food purchase data were also collected. The collected data focused on the frequency of purchasing fresh food items, including fruit and vegetable, milk and dairy products, meats, and eggs. Households who purchased fresh food items once or twice a week were classified as weekly food purchasers.

*Statistical methods*

Descriptive data for continuous variables are presented in this study as mean ± standard deviation (SD), and data for categorical variables are presented as frequency (percentage). To compare means of symmetrical continuous variables among food insecure vs. food insecure households, independent t-test was used. All continuous variables were tested for normality, and Wilcoxon rank-sum test was used with asymmetric continuous variables. Associations of the categorical variables were evaluated using Fisher's Exact test. Linear regression analysis was conducted to determine the associations of food security status (the independent variable) (food secure= 1 and food insecure= 0) with energy intake, macronutrient intakes (carbohydrates, protein, and fat), saturated fat, unsaturated fat, fiber, total sugar and micronutrient intakes (calcium, iron, zinc, sodium, potassium, vitamin D, and vitamin C). All tests performed were

two tailed with a significance level of 95%, whereas the Bonferroni adjustment was adapted to correct for multiple comparisons of dietary intake in the univariate analysis. To analyze data presented in this study, SAS® software was used (version 9.4, 2013, SAS Institute Inc., Cary, NC, USA).

## Results

*Characteristics of the sample*

Data of 119 healthy girls and their mothers where included in this study. Mean age of girls was 9.08 ± 1.69; mean age of mothers was 37.4 ± 6.36 years. The mean BMI of mothers was 43.4 ± 7.58 kg/m$^2$, which fall within the obesity category (stage III). Ten percent of girls in this study (n= 12) lived with the mother only. Approximately half of the mothers (54.6%, n= 65) and fathers (47.9%, n= 57) held a high-school degree or less. Approximately one-third of the mothers (31.1%, n= 37) reported a monthly household income of > SR 10,000 (equivalent to > $ 2,667 per month). The mean household crowding among the study sample was 1.94 ± 1.03, see **Table 1**.

*Prevalence of food insecurity*

Based on the FIES assessment tool, 75.6% of the households were food secure (n= 90), 5.04% (n= 6) were experiencing mild food insecurity, 15.1% (n= 18) were experiencing moderate food insecurity, and 4.20% (n= 5) of the households were found experiencing severe food insecurity. Due to the small number of participants in each category of food insecurity, the food insecurity groups (mild, moderate, and severe food insecurity) were later collapsed into one group (food insecure households). Accordingly, the data indicated that 24.4% (n= 29) of girls were living in food insecure households.

*Associations of sociodemographic and anthropometric variables with food security status*

The data indicated that paternal education levels and household income were positively associated with household food security status, whereas household crowding was negatively associated with food security. Anthropometric data showed high prevalence of stunting (21.9%, n= 26), while prevalence of thinness was 5.08% (n= 6). Overweight and obesity were observed among 14.4% and 16.1% of the sample, respectively. All anthropometric measurements were similar across girls in both food security groups, see **Table 2**.

*Dietary intakes and the associations with the food security status*

Dietary data obtained from the 24-hr dietary recalls are presented in **Table 3**. The mean macronutrient intakes of carbohydrate, protein, and fat among girls of food secure and food insecure households were within the DRI recommendations of 45-65%, 10-30%, and 25-35% of total energy intake, respectively. Energy-adjusted nutrient intakes were similar across girls of food secure and food insecure households ($p$> .003). Mean intakes of fiber, calcium, zinc, and vitamin D among girls of both food security groups were below the EAR (12.8 ± 13.1 g, 541 ± 411 mg, 3.87 ± 2.79 mg, and 2.34 ± 2.83 ug, respectively).

Linear regression analyses did not indicate an association between food security status and energy-adjusted nutrient intake, except vitamin D intake which was positively associated with the food security status (B= 2.02 (SE= 0.86), [95% CI 0.31 to 3.72], $p$= .021) (**Table 4**).

*Frequency of household food purchasing and the association with food security status*

Based on household food purchase data, mothers from food secure households reported purchasing fruits and vegetables more frequently than mothers of food insecure households (66.7%, n= 60 vs. 37.9%, n= 11, respectively; $p$= .010). Similar results were found for purchasing milk and dairy products (70.0%, n= 63 vs. 34.5%, n= 10, respectively; $p$< .001) as well as for purchasing meat (38.9%, n= 35 vs. 13.8%, n= 4, respectively; $p$= .037). The frequency of purchasing eggs did not statistically differ between food secure and food insecure households (44.8%, n= 52 vs. 57.8%, n= 13, respectively; $p$ = .774), see **Figure 1**.

**Table 1.** Characteristics of girls 6-12 years and their mothers based on household food security status.

| Characteristic | Food Secure (n= 90) | Food Insecure (n= 29) | Total (n=119) | *p* |
|---|---|---|---|---|
| Child's age, mean ± SD | 9.04 ± 1.77 | 9.21 ± 1.43 | 9.08 ± 1.69 | .633 |
| Maternal age, mean ± SD | 37.6 ± 6.72 | 36.8 ± 5.29 | 37.4 ± 6.36 | .819 |
| Maternal body mass index, mean ± SD | 43.5 ± 7.51 | 43.1 ± 7.93 | 43.4 ± 7.58 | .763 |
| Student lives with one parent, n (%)<br>Student lives with both parents, n (%) | 9 (10.0)<br>81 (90.0) | 5 (17.2)<br>24 (82.8) | 14 (11.8)<br>105 (88.2) | .526 |
| **Maternal education, n (%)** | | | | |
| < High school degree | 21 (23.3) | 9 (31.0) | 30 (25.2) | |
| High school degree | 27 (30.0) | 8 (27.6) | 35 (29.4) | .441 |
| ≥ University degree | 38 (42.2) | 10 (34.5) | 48 (40.3) | |
| Other | 4 (4.44) | 2 (6.90) | 6 (5.04) | |
| **Paternal education, n (%)** | | | | |
| < High school degree | 14 (15.6) | 13 (44.8) | 27 (22.7) | |
| High school degree | 23 (25.6) | 7 (24.1) | 30 (25.2) | .013 * |
| Diploma | 3 (3.33) | 1 (3.45) | 4 (3.36) | |
| ≥ University degree | 50 (55.6) | 8 (27.6) | 58 (48.7) | |
| **Family income, SR, n (%)** | | | | |
| < 3,000 | 10 (11.1) | 10 (34.5) | 20 (16.8) | |
| 3,000-6,000 | 24 (26.1) | 7 (24.1) | 31 (26.5) | .032 * |
| 6,001-10,000 | 24 (26.7) | 7 (24.1) | 31 (25.8) | |
| > 10,000 | 32 (35.6) | 5 (17.2) | 37 (31.9) | |
| Household crowding †, mean ± SD | 1.79 ± 0.85 | 2.39 ± 1.37 | 1.94 ± 1.03 | .037 * |
| **Residence rental, n (%)** | 44 (48.9) | 18 (62.1) | 64 (53.8) | .393 |
| **Availability of food stores in the neighborhood, n (%)** | | | | .059 |
| No | 3 (3.33) | 4 (13.8) | 7 (5.88) | |
| Yes | 87 (96.7) | 25 (86.3) | 112 (94.1) | |

*† Household crowding is calculated by dividing family size by room number.*
*SR: Saudi Riyals; (SR 3.75= $1).*
*Data presented in table were analyzed using Fisher's Exact test, independent t-test, and Wilcoxon rank-sum test.*
** Difference across groups is significant at the .05 level.*

## Discussion

High prevalence of household food insecurity was observed among our sample. Households with food insecurity had significantly lower paternal education levels, lower income, and higher household crowding than that of food secure households. The food security status was not linked to the growth parameters of girls; however, a positive association with the energy-adjusted vitamin D intake was observed. Additionally, food insecure households were found to purchase fruit and vegetable, milk and dairy products, and meat less frequently than the food secure households.

Previous studies have demonstrated the burden of malnutrition in the Middle East and North Africa region, where undernutrition, micronutrient deficiencies, and overweight/obesity coexist (6). The Food and Agriculture Organization (FAO) has provided estimates for the prevalence of undernourishment among the population in Saudi Arabia; The most recent data indicated an increasing trend of undernourishment (7.1%) compared to previous years (5.3% in the year of

**Table 2.** Anthropometric measurements of girls 6-12 years based on household food security status

| Anthropometric Data | Food Secur (n= 90) | Food Insecure (n= 29) | Total (n=119) | *p** |
|---|---|---|---|---|
| Height-for-age z-score, mean ± SD | −0.86 ± 1.62 | −1.38 ± 1.70 | −0.98 ± 1.65 | .141 |
| Stunting, n (%) | 18 (20.0) | 8 (27.6) | 26 (21.9) | .441 |
| BMI-for-age z-score, mean ± SD | 0.22 ± 1.41 | 0.73 ± 2.09 | 0.34 ± 1.61 | .134 |
| Thinness, n (%) | 4 (4.49) | 2 (6.90) | 6 (5.08) | .346 |
| Healthy weight, n (%) | 61 (68.5) | 15 (51.7) | 76 (64.4) | |
| Overweight, n (%) | 11 (12.4) | 6 (20.7) | 17 (14.4) | |
| Obesity, n (%) | 13 (14.6) | 6 (20.7) | 19 (16.1) | |

*BMI: body mass index.*
*Data presented in table were analyzed using Fisher's Exact test and the independent t-test.*
** Difference across groups is significant at the .05 level.*

**Table 3.** Energy-adjusted nutrient intakes of girls 6-12 years based on household food security status

| Nutrient | Food Secure (n=90) | Food Insecure (n=29) | Total (n=119) | *p** |
|---|---|---|---|---|
| Energy, kcal | 1316 ± 497 | 1237 ± 448 | 1297 ± 485 | .463 |
| Carbohydrate, % | 49.6 ± 10.8 | 47.6 ± 9.48 | 49.1 ± 10.5 | .377 |
| Protein, % | 17.1 ± 6.50 | 17.1 ± 5.61 | 17.1 ± 6.27 | .575 |
| Fat, % | 36.4 ± 33.9 | 33.5 ± 5.44 | 35.7 ± 29.5 | .355 |
| Saturated fat, g/1,000 kcal | 28.0 ± 36.3 | 23.8 ± 19.7 | 27.0 ± 33.0 | .736 |
| Unsaturated fat, g/1,000 kcal | 25.6 ± 44.0 | 17.2 ± 15.6 | 23.5 ± 39.2 | .441 |
| Fiber, g/1,000 kcal | 20.7 ± 26.5 | 11.3 ± 7.80 | 18.4 ± 23.7 | .046 |
| Total sugar, g/1,000 kcal | 76.1 ± 72.9 | 53.8 ± 41.5 | 70.6 ± 67.1 | .160 |
| Iron, mg /1,000 kcal | 9.04 ± 8.35 | 8.66 ± 7.32 | 8.95 ± 8.08 | .934 |
| Calcium, mg/1,000 kcal | 855 ± 1193 | 692 ± 634 | 815 ± 1084 | .507 |
| Sodium, mg/1,000 kcal | 2554 ± 3650 | 2661 ± 3558 | 2580 ± 3613 | .387 |
| Potassium, mg/1,000 kcal | 1731 ± 1311 | 1609 ± 1789 | 1701 ± 1435 | .125 |
| Zinc, mg/1,000 kcal | 6.06 ± 7.63 | 4.39 ± 3.31 | 5.65 ± 6.86 | .491 |
| Vitamin D, ug/1,000 kcal | 3.72 ± 4.44 | 1.71 ± 2.36 | 3.23 ± 4.11 | .049 |
| Vitamin C, mg/1,000 kcal | 91.7 ± 124 | 69.5 ± 103 | 86.4 ± 119 | .196 |

*Values in cells are expressed in means ± SD.*
*Densities of macronutrients were expressed as proportion of energy, whereas densities of all other nutrients were expressed as intake per units/1,000kcal.*
*Data presented in table were analyzed using the independent t-test and Wilcoxon rank-sum test.*
** Difference across groups based on Bonferroni adjustment is significant at.003 level.*

**Table 4.** Linear regression analysis of the association between food security status and changes in energy-adjusted nutrient intakes of girls 6-12 years (n= 119)

| | B | SE | 95% Confidence limits | *p* |
|---|---|---|---|---|
| Energy, kcal | 78.9 | 104 | −126 to 284 | .448 |
| Carbohydrate, % | 1.98 | 2.24 | −2.44 to 6.41 | .377 |
| Protein, % | 0.00 | 1.35 | −2.66 to 2.66 | 1.00 |
| Fat, % | 2.81 | 6.33 | −9.73 to 15.4 | .658 |
| Saturated fat, g/1,000 kcal | 4.20 | 7.08 | −9.82 to 18.2 | .555 |
| Unsaturated fat, g/1,000 kcal | 8.40 | 8.36 | −8.15 to 25.0 | .317 |
| Fiber, g/1,000 kcal | 9.47 | 5.01 | −0.46 to 19.4 | .061 |
| Total sugar, g/1,000 kcal | 22.3 | 14.3 | −5.91 to 50.6 | .120 |
| Iron, mg /1,000 kcal | 0.37 | 1.73 | −3.06 to 3.81 | .829 |
| Calcium, mg/1,000 kcal | 164 | 232 | −295 to 623 | .481 |
| Sodium, mg/1,000 kcal | −107 | 776 | −1643 to 1430 | .891 |
| Potassium, mg/1,000 kcal | 122 | 307 | −487 to 731 | .692 |
| Zinc, mg/1,000 kcal | 1.67 | 1.46 | −1.23 to 4.56 | .257 |
| Vitamin D, ug/1,000 kcal | 2.02 | 0.86 | 0.31 to 3.72 | .021* |
| Vitamin C, mg/1,000 kcal | 22.2 | 25.8 | −28.8 to 73.3 | .390 |

*B: beta estimate. SE: standard error.*
*Densities of macronutrients were expressed as proportion of energy, whereas densities of all other nutrients were expressed as intake per units/1,000kcal.*
** Difference across groups is significant at the .05 level.*

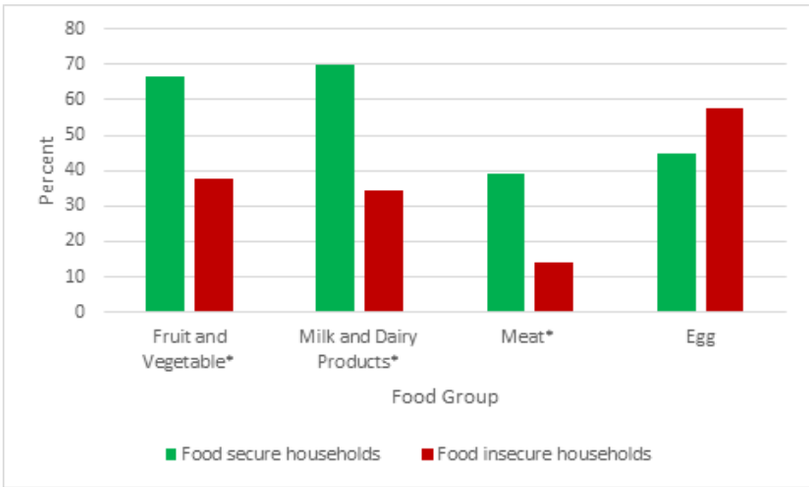


**Figure 1.** Proportions of households reporting weekly food purchasing according to food security status.
** Difference across groups is significant at the .05 level.*

2013-2015) (42). However, the current literature has recognized the need to utilize a comparable measure of food security to identify its magnitude, severity, and causes, and to incorporate nutrition as a fundamental dimension to indicate food security status at the household level. In fact, recent evidence highlight the need to have a global agreement on a definition of food security and its determinants to assist in reaching the desired outcomes (35).

Using the FIES, our results indicated that nearly one-quarter of the sample were experiencing food insecurity. Given that Saudi Arabia is a desert country, large proportions of food commodities are imported to meet the domestic demands. In fact, due to the limited agriculture production, Saudi Arabia is expected to import the majority of its food supplies by 2050 (43). The main concern of food insecurity is that families may struggle to make foods available, and consequently, they might be at high risk of undernourishment. Therefore, the Saudi government has set tremendous efforts to perceive the Zero Hunger goal, which was developed by the United Nations to support a sustainable future (44). Additionally, the government of Saudi Arabia has developed a strategic partnership with the FAO to reinforce food and nutrition security, while supporting the implementation of the National Transformation Program 2020 (45). By 2030, the government aims to support food security, improve nutrition, and to achieve a sustainable agriculture (44). Therefore, our data respond to the gap in the literature pertaining the need to quantify the magnitude of food insecurity in the nation of Saudi Arabia.

Findings of this study indicated positive associations between food security status and paternal education and household income, and negative association with household crowding. Previous studies have reported consistent findings, in which low socioeconomic status of families was associated with food insecurity. A recent study showed that households with lower income had higher prevalence of food insecurity (43%) than the higher income groups; The study also reported a significantly greater prevalence of food insecurity among families whose father had not completed high school degree (46). Another study also observed higher levels of household food insecurity among children of low income families, high household crowding, and less educated mothers (47). However, in the present study, paternal education, but not maternal education, was found to be significantly associated with the status of food security. In Saudi Arabia, this finding is expected, given that men are typically the main source for funding. Paternal education matters as the higher education increases opportunities for better careers and earnings.

In this study, anthropometric measurements of the sample were not found to be linked with household food security status. Previous studies have also investigated these associations and results were conflicting. For example, a study conducted among 4,719 children investigated the association of food security with the weight status, and no association was observed (48). Other studies suggested significant associations between food insecurity and childhood obesity (49) and stunted growth (50). The lack of the association between the growth parameters and the food security status among our sample might be explained by the high prevalence of stunting and overweight or obesity. These findings indicate the need to identify factors that could be related to stunted growth and overweight/obesity among children, and to initiate intervention programs to improve nutritional and health outcomes.

Healthier dietary behaviors and practices among food secure children compared to food insecure children have been reported in some studies, whereas similar dietary intakes have been observed in others. A study conducted by Saxe-Custack et al. did not find statistically significant differences in the consumption of fruits and vegetables among children of food secure vs. food insecure households (51). Another study reported lower intakes of whole grain and higher intakes of added sugar among children experiencing food insecurity compared to food secure children (52). In the present study, similar intakes of most nutrients were observed among girls of food secure and food insecure households. A positive association was found between energy-adjusted vitamin D intake and food security status, which could be linked to the higher frequency of purchasing milk and dairy products among the food secure households. Vitamin D food sources, such as oily fish, are relatively expensive, which may result in limited accessibility of these foods by the food insecure families.

Data regarding household food purchasing showed that food insecure families purchased fruits and vegetables, milk and dairy products, and meat in less frequency compared to food secure families. However, the relationship of food security status with the frequency of food purchasing did not seem to reflect any variations in dietary fiber intake among girls of food secure and food insecure households, which could be due to the poor intake of fruits and vegetables among girls included in this study. In fact, a previous study reported poor intakes of fruits and vegetables among children in Saudi Arabia (49). Given that the majority of the agricultural products in Saudi Arabia are imported, the prices might be unaffordable for lower income families. Hence, subsidizations of important food items including fruits, vegetables, and milk have been recommended (53).

To the best of our knowledge, this study was the first to evaluate household food security status in Saudi Arabia using a direct measure. Dietary intakes of Saudi girls were also evaluated to investigate whether household food insecurity is associated with specific nutrient deficiencies. Findings of the present study may assist in establishing intervention programs aiming to improve the nutritional status of girls experiencing food insecurity. Further, weight and height of the participants were objectively measured using a standardized procedure, allowing for better accuracy of data.

## Limitations

In the present study, we were unable to infer any causal relationships due to the nature of its study design. Further longitudinal research is needed to investigate possible health consequences of food insecurity among individuals from different age groups. Another limitation of this study includes the use of a single 24-hr dietary recall. However, using one 24-hr dietary recall has been considered an acceptable method to evaluate dietary intakes at the population level (54). Larger studies are warranted to investigate the nationwide prevalence of food insecurity among the Saudi population.

## Conclusion

The high prevalence of food insecurity observed among our sample is concerning. Our findings indicated an association between food security status and vitamin D intake of Saudi girls, whereas no associations with intakes of other nutrients or anthropometric measurements were observed. Additionally, food insecure households were found to purchase fruits and vegetables, meat, and dairy products less frequently than the food secure households. Community-based interventions are needed to improve children's diet especially those experiencing food insecurity. Additionally, subsidization programs for essential food items including fruit, vegetable, and milk and dairy products could promote intakes of these items among the food insecure families.

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## Conflict of Interest

No potential conflict of interest relevant to this article was reported by the authors.

## References

1. World Health Organization. Early child development-nutrition and the early years. 2020. Available from: https://www.who.int/topics/early-child-development/child-nutrition/en/. Accessed Apr 23, 2020.
2. Olofin I, McDonald CM, Ezzati M, Flaxman S, Black RE, Fawzi WW, et al. Associations of suboptimal growth with all-cause and cause-specific mortality in children under five years: a pooled analysis of ten prospective studies. PLoS One 2013;8(5):e64636. https://doi.org/10.1371/journal.pone.0064636.

3. Rytter MJH, Kolte L, Briend A, Friis H, Christensen VB. The immune system in children with malnutrition - a systematic review. PLoS ONE 2014; 9(8): e105017. https://doi.org/10.1371/journal.pone.0105017.
4. Casale D, Desmond C, Richter L. The association between stunting and psychosocial development among preschool children: a study using the South African Birth to Twenty cohort data. Child Care Health Dev 2014; 40(6):900–10. https://doi.org/10.1111/cch.12143.
5. Ginsburg AS, Izadnegahdar R, Berkley JA, Walson JL, Rollins N, Klugman KP. Undernutrition and pneumonia mortality. The Lancet Global Health 2015; 3(12):e735-6. https://doi.org/10.1016/S2214-109X(15)00222–3.
6. UNICEF. The State of Food Security and Nutrition in the World 2018 - UNICEF DATA. UNICEF Data: Monitoring the situation of children and women. 2018.
7. El Mouzan M, Foster P, Al Herbish A, Al Salloum A, Al Omar A, Qurachi M. Prevalence of malnutrition in Saudi children: a community-based study. Ann Saudi Med 2010; 30(5): 381–385. https://doi.org/10.4103/0256-4947.67076
8. Christian AK, Marquis GS, Colecraft EK, Lartey A, Soueida R. Household food insecurity but not dietary diversity is associated with children's mean micronutrient density adequacy in rural communities across Ghana. Nutrition 2019;65: 97-102. https://doi.org/10.1016/j.nut.2019.03.006
9. Hasan MT, Soares Magalhaes RJ, Williams GM, Mamun AA. The role of maternal education in the 15-year trajectory of malnutrition in children under 5 years of age in Bangladesh. Matern Child Nutr 2016; 12(4):929-39. https://doi.org/10.1111/mcn.12178.
10. Lawson DW, Mulder MB, Ghiselli ME, Ngadaya E, Ngowi B, Mfinanga SGM, et al. Ethnicity and child health in northern tanzania: Maasai pastoralists are disadvantaged compared to neighbouring ethnic groups. PLoS One 2014; 9(10):e110447. https://doi.org/10.1371/journal.pone.0110447.
11. McDonald CM, McLean J, Kroeun H, Talukder A, Lynd LD, Green TJ. Household food insecurity and dietary diversity as correlates of maternal and child undernutrition in rural Cambodia. Eur J Clin Nutr 2015; 69(2):242-6. https://doi.org/10.1038/ejcn.2014.161.
12. McDonald CM, McLean J, Kroeun H, Talukder A, Lynd LD, Green TJ. Correlates of household food insecurity and low dietary diversity in rural Cambodia. Asia Pac J Clin Nutr 2015; 24(4):720-30. https://doi.org/10.6133/apjcn.2015.24.4.14.
13. Wong HJ, Moy FM, Nair S. Risk factors of malnutrition among preschool children in Terengganu, Malaysia: a case control study. BMC Public Health 2014; 14:785. https://doi.org/10.1186/1471-2458-14-785.
14. Summit WF. Rome Declaration on World Food Security and World Food Summit Plan of Action Rome Declaration on World Food Security. World Food Summit. 1996.
15. Jones AD. Food insecurity and mental health status: a global analysis of 149 countries. Am J Prev Med 2017;53(2):264-273. https://doi.org/10.1016/j.amepre.2017.04.008
16. Coleman-Jensen A, Rabbitt M, Gregory C, Singh A. Household food security in the United States in 2015. 2016. Available from: https://www.ers.usda.gov/webdocs/publications/79761/err-215.pdf?v=42636. Accessed Apr 23, 2020.
17. Statistics Canada. Household food insecurity, 2011-2012. Data from the 2011-2012 Canadian Community Health Survey. 2012.
18. Sahyoun NR, Nord M, Sassine AJ, Seyfert K, Hwalla N, Ghattas H. Development and validation of an Arab family food security scale. J Nutr 2014; 144(5):751–7. https://doi.org/10.3945/jn.113.187112
19. Tappis H, Doocy S, Paul A, Funna S. Food security and development in South Sudan: a call to action. Public Health Nutr 2013;16(9): 1631-1636. https://doi.org/10.1017/S1368980013000669.
20. Kendall A, Olson CM, Frongillo EA. Relationship of hunger and food insecurity to food availability and consumption. J Am Diet Assoc 1996; 96(10):1019–24; quiz 1025–6. https://doi.org/10.1016/S0002-8223(96)00271-4.
21. Kirkpatrick SI, Tarasuk V. Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents. J Nutr 2008; 138(3):604–12. https://doi.org/10.1093/jn/138.3.604
22. Mark S, Lambert M, O'Loughlin J, Gray-Donald K. Household income, food insecurity and nutrition in Canadian youth. Can J Public Heal 2012; 103(2):94–9. https://doi.org/10.1007/BF03404210
23. Rammohan A, Pritchard B, Dibley M. Home gardens as a predictor of enhanced dietary diversity and food security in rural Myanmar. BMC Public Health 2019; 19(1):1145. https://doi.org/10.1186/s12889-019-7440-7.
24. Whitaker RC, Phillips SM, Orzol SM. Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children. Pediatrics 2006; 118(3):e859–68. https://doi.org/10.1542/peds.2006-0239
25. Alaimo K, Olson CM, Frongillo EA. Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. Pediatrics 2001;108(1):44–53.
26. Ryu JH, Bartfeld JS. Household food insecurity during childhood and subsequent health status: the early childhood longitudinal study - kindergarten cohort. Am J Public Health 2012; 102(11): e50–e55. https://doi.org/10.2105/AJPH.2012.300971.
27. Cordeiro LS, Wilde PE, Semu H, Levinson FJ. Household food security is inversely associated with undernutrition among adolescents from Kilosa, Tanzania. J Nutr 2012; 142(9):1741–7. https://doi.org/10.3945/jn.111.155994.
28. Hackett M, Melgar-Quiñonez H, Álvarez MC. Household food insecurity associated with stunting and underweight

among preschool children in Antioquia, Colombia. Rev Panam Salud Publica/Pan Am J Public Heal 2009;25(6):506-10. https://doi.org/10.1590/s1020-49892009000600006.
29. Isanaka S, Mora-Plazas M, Lopez-Arana S, Baylin A, Villamor E. Food insecurity is highly prevalent and predicts underweight but not overweight in adults and school children from Bogotá, Colombia. J Nutr 2007; 137(12):2747–55. https://doi.org/10.1093/jn/137.12.2747
30. Cordeiro M de M, Monego ET, Martins KA. Overweight in Goiás' quilombola students and food insecurity in their families. Rev Nutr 2014;27(4). https://doi.org/10.1590/1415-52732014000400002.
31. Bhargava A, Jolliffe D, Howard LL. Socio-economic, behavioural and environmental factors predicted body weights and household food insecurity scores in the early childhood longitudinal study-kindergarten. Br J Nutr 2008; 100(2):438–44. https://doi.org/10.1017/S0007114508894366.
32. Eisenmann JC, Gundersen C, Lohman BJ, Garasky S, Stewart SD. Is food insecurity related to overweight and obesity in children and adolescents? a summary of studies, 1995-2009. Obesity Reviews 2011;12(5):e73–83. https://doi.org/10.1111/j.1467-789X.2010.00820.x.
33. Food and Agriculture Organization of the United Nations. The food insecurity experience scale. 2020. Available from: http://www.fao.org/in-action/voices-of-the-hungry/fies/en/. Accessed Apr 27, 2020.
34. Naja F, Hwalla N, Fossian T, Zebian D, Nasreddine L. Validity and reliability of the Arabic version of the Household Food Insecurity Access Scale in rural Lebanon. Public Health Nutr 2015; 18(2):251–8. https://doi.org/10.1017/S1368980014000317.
35. Food and Agriculture Organization of the United Nations. Rural transformation-key for sustainable development in the near east and North Africa. Overview of food security and nutrition 2018. Cairo; 2019. Available from: http://www.fao.org/3/ca3817en/ca3817en.pdf. Accessed Apr 23, 2020.
36. Food and Agriculture Organization of the United Nations. Applying the FIES. 2020. Available from: http://www.fao.org/in-action/voices-of-the-hungry/using-fies/en/. Accessed Apr 27, 2020.
37. Onis Bm de, Blössner M. WHO Global Database on Child Growth and Malnutrition. World Heal Organ. 2016.
38. World Health Organization. Growth reference data for 5-19 years. WHO. 2007. Available from: https://www.who.int/growthref/en/. Accessed Apr 27, 2020.
39. Kirkpatrick SI, Gilsing AM, Hobin E, Solbak NM, Wallace A, Haines J, et al. Lessons from studies to evaluate an online 24-hour recall for use with children and adults in Canada. Nutrients 2017;9(2):100. https://doi.org/10.3390/nu9020100.
40. Casey PH, Goolsby SLP, Lensing SY, Perloff BP, Bogle ML. The use of telephone interview methodology to obtain 24-hour dietary recalls. J Am Diet Assoc 1999; 99(11):1406-11. https://doi.org/ 10.1016/S0002-8223(99)00340-5.
41. U.S. Department of Agriculture. Dietary Reference Intakes for Energy, Carbohydrate. Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (2002/2005). 2020. https://www.nal.usda.gov/sites/default/files/fnic_uploads/macronutrients.pdf. Accessed Aug 25, 2020.
42. Food and Agriculture Organization of the United Nations. Food and agriculture organization statistics. 2020. Available from: http://www.fao.org/faostat/en/#country/194. Accessed Apr 27, 2020.
43. Fiaz S, Noor MA, Aldosri FO. Achieving food security in the Kingdom of Saudi Arabia through innovation: Potential role of agricultural extension. Journal of the Saudi Society of Agricultural Sciences 2018; 17(4): 365–375. https://doi.org/10.1016/j.jssas.2016.09.001.
44. Alharthi S, Alharthi A, Alharthi M. Sustainable development goals in the Kingdom of Saudi Arabia's 2030 vision. WIT Trans Ecol Environ. 2019;238:455–67.
45. Food and Agriculture Organization of the United Nations. Partnering for strengthened food security and sustainable agricultural and rural development. 2007. Available from: http://www.fao.org/3/ax278e/AX278E.pdf. Accessed Apr 27, 2020.
46. Orr CJ, Ben-Davies M, Ravanbakht SN, Yin HS, Sanders LM, Rothman RL, et al. Parental feeding beliefs and practices and household food insecurity in infancy. Acad Pediatr 2019; 19(1):80–89. https://doi.org/10.1016/j.acap.2018.09.007.
47. Jamaluddine Z, Choufani J, Sahyoun N, Ghattas H. A child-administered food security scale is associated with household socio-economic status, household food security and diet diversity. FASEB J 2017;31:297–302.
48. Nguyen BT, Ford CN, Yaroch AL, Shuval K, Drope J. Food security and weight status in children: interactions with food assistance programs. Am J Prev Med 2017; 52(2S2):S138–S144. https://doi.org/10.1016/j.amepre.2016.09.009.
49. Papas MA, Trabulsi JC, Dahl A, Dominick G. Food insecurity increases the odds of obesity among young Hispanic children. J Immigr Minor Heal 2016; 18(5):1046–1052. https://doi.org/10.1007/s10903-015-0275-0.
50. Htet MK, Dibley M, Rammohan A, Vicol M, Pritchard B. Factors associated with stunting of under five-year children: findings from panel surveys in Mountains, Dry Zone and Delta Regions of Rural Myanmar (2016–17) (P04-039-19). Curr Dev Nutr 2019. https://doi.org/10.1093/cdn/nzz051.P04-039-19.
51. Saxe-Custack A, Lachance J, Hanna-Attisha M, Ceja T. Fruit and vegetable prescriptions for pediatric patients living in flint, Michigan: a cross-sectional study of food security and dietary patterns at baseline. Nutrients 2019;11(6):1423. https://doi.org/10.3390/nu11061423.
52. Rossen LM, Kobernik EK. Food insecurity and dietary intake among US youth, 2007-2010. Pediatr Obes 2016; 11(3):187–93. https://doi.org/10.1111/ijpo.12044.

53. Black AP, Brimblecombe J, Eyles H, Morris P, Vally H, O Dea K. Food subsidy programs and the health and nutritional status of disadvantaged families in high income countries: a systematic review. BMC Public Health 2012;12-1099. https://doi.org/10.1186/1471-2458-12-1099.
54. Beaton G, Milner J, McGuire V, Feather T, Little J. Source of variance in 24-hour dietary recall data: Implications for nutrition study design and interpretation. carbohydrate sources, vitamins, and minerals. Am J Clin Nutr 1983;37(6):986–95. https://doi.org/10.1093/ajcn/37.6.986.

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