European Journal of Pediatrics (2022) 181:225–234
https://doi.org/10.1007/s00431-021-04180-2

ORIGINAL ARTICLE

Associations between mother–child dyad dietary patterns and child anthropometric measures among 6-year-old children

Maedeh Moradi[1] · Yahya Jalilpiran[2,3] · Mohammadreza Askari[2] · Pamela J. Surkan[4] · Leila Azadbakht[2,5]

Received: 28 August 2020 / Revised: 17 June 2021 / Accepted: 18 June 2021 / Published online: 14 July 2021

Abstract

The goals of this study were to study relationships between maternal and children's dietary patterns (DPs) and to assess how children's DP was associated with child anthropometry. This cross-sectional study included 788 pairs of 6-year-old girls and mothers in health centers in Tehran, Iran. Information on dietary intake was collected with a 168-item food frequency questionnaire. Principal component factor analysis was performed to label different data-driven dietary patterns. Three different binary logistic regression models were used to evaluate the associations between child's DPs and child anthropometry. A positive correlation was found between all maternal patterns and child's Western DP ($p < 0.001$). Maternal prudent and Western DPs were correlated with child's high-protein DP ($p < 0.001$). Children's high-protein DP was negatively correlated with maternal high fat DP ($p < 0.001$). Maternal prudent and high fat DPs were correlated with prudent DP in children ($p < 0.001$). In adjusted models, a child being in the highest compared to the first quartile of the high-protein DP was associated with decreased odds of underweight and wasting (OR 0.43; 95% CI 0.23–0.80).

Conclusion: The present study showed inverse associations between a high-protein DP in children and being underweight and wasted. Also, a positive correlation was found between all maternal DPs and children's Western DPs. This correlation should be taken into account while managing child nutrition by means of educating parents on the influence of their own dietary pattern on their children. Moreover, getting enough protein through a balanced diet should be considered in children.

What is Known:
- *Some research exists on the intake of specific foods in relation to risk of abnormal growth in children.*
- *Less is known about the relationship between mothers' and children's food intake.*

What is New:
- *Better adherence to a high-protein dietary pattern was significantly associated with lower risk of being both underweight and wasted.*
- *This study suggests that correlation between mothers' and their children's dietary patterns exists, which should be taken into consideration when managing child nutrition.*

Keywords Dietary pattern · Children · Obesity · Underweight · Wasting

Communicated by Gregorio Paolo Milani.

✉ Leila Azadbakht
azadbakhtleila@gmail.com

Maedeh Moradi
mae_moradi@yahoo.com

Yahya Jalilpiran
yjalilpiran@razi.tums.ac.ir

Mohammadreza Askari
mohammadreza.ask@gmail.com

Pamela J. Surkan
psurkan@jhu.edu

1 Department of Community Nutrition, School of Nutrition and Food Science, Isfahan University of Medical Science, Isfahan, Iran

2 Department of Community Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences, Tehran, Iran

3 Students' Scientific Research Center (SSRC), Tehran University of Medical Sciences (TUMS), Tehran, Iran

4 Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

5 Diabetes Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran

Abbreviations

ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
BMI	Body mass index
DP	Dietary Pattern
FFQ	Food frequency questionnaire
IPAQ	International physical activity Questionnaire
PA	Physical Activity
SES	Socioeconomic status

Introduction

Adequate growth is considered one of the best indicators of physical well-being in children [1]. Important growth indices for children under age five include malnutrition (stunting, wasting, and underweight) and overweight [2, 3]. Stunting, or linear growth faltering, is a major public health problem most often occurring in lower-income regions such as Africa and Asia [4, 5], and that can lead to low academic performance [5]. In Asia and Oceania, wasting puts nearly one in ten children under five at increased risk of mortality, highlighting the need for preventive interventions and programs [6]. In terms of over-nutrition, children who are overweight tend to become obese in adulthood and are more likely to develop non-communicable diseases like diabetes and cardiovascular disease [7]. Along with a variety of health-related (e.g., infectious diseases, intrauterine growth retardation, low birth weight, insufficient exclusive breastfeeding) and social determinants (e.g., low socioeconomic status, low parental education, and poor health services), parental DP is a major factor influencing childhood growth [8–11]. Parents have the potential to play a major role in their child's diets by limiting their access to unhealthy products such as salty and processed foods, sweets, and sugar-sweetened beverages and by introducing healthy foods at home [12, 13].

A large study of 2692 mother–child pairs revealed that dietary quality scores for mothers and their children were weakly to moderately correlated [14]. However, the similarities in the maternal and child's DPs were stronger for total fat intake than they were for the overall dietary quality score [14]. Another study of 121 urban African-American adolescent-mothers pairs showed no correlation between nutrients and food groups for mothers and sons but a weak correlation in mother-daughter pairs [15]. A study of 1640 children showed a strong positive association between diet quality of 3-year-old children and maternal diet quality [16]. Ovaskainen et al. observed only a slight similarity between the dietary patterns of mothers and their pre-school aged children [17]. Regarding the association between child's DP and child anthropometry, Mehranfar et al. found an inverse association between a white meat dietary pattern in children who are both underweight and wasted and also a positive association between white meat protein intake in children and risk of overweight [18]. Also, in Iran, child's healthy beverages index (HBI) was associated with higher odds of wasting and underweight [19]. Moreover, high-fat milk intake was inversely associated with wasting among children [19]. Given these contrasting findings, more research is needed to understand how different dietary patterns are associated with child anthropometry. Moreover, most of the existing literature regarding the correlation between maternal and child's dietary patterns has been from western countries, while the current study evaluates the correlation in a different less-studies population. Therefore, we aimed to study the association between maternal and child's dietary patterns as well as how different dietary patterns are associated with child anthropometry in Tehran province, Iran.

Methods and materials

Study population

Data for this cross-sectional study were collected from 788 mother–child dyads in 2017–2018. Cluster random-sampling methods were used to select mother–child peers who had attended public health centers in southern Tehran, Iran, for the screening of primary school entering and vaccination of 6-year-old children. A random sample of 1200 mothers with 6-year-old girls was contacted, out of which (75%) 900 mothers consented and completed the study questionnaire. Out of 900 subjects, data was driven from 788 mother–child peers. The main reason for this sample drop (12.4%) was lack of parental interest during the study.

Mothers provided written informed consent regarding publishing their and their child's data. The inclusion criteria of the research included: Six-year-old girls who did not have the prior chronic or malignant disease diagnoses were eligible for participation, female gender, Iranian, being in the age range of 20–50 years, women were not pregnant, breastfeeding or in post-menopausal status, women did not follow any specific diet (e.g., restriction diet due to allergies, celiac disease, weight loss, or weight gain diets), did not have any acute or chronic diseases (conditions such as diabetes, autoimmune diseases, cardiovascular disease, renal disease, liver disease, respiratory disease, hypertension, and allergy), and did not take medications for the mentioned diseases and medications for weight loss.

Children were excluded if their parents did not provide informed consent. This study was ethically approved (IR.NIMAD.REC.1398.211). Research reported in this publication was supported by Elite Researcher Grant Committee

under award number 983073 from the National Institute for Medical Research Development (NIMAD), Tehran, Iran.

Dietary intake assessment

Dietary intakes were assessed with a reliable and valid 168-item semi-quantitative Food Frequency Questionnaire (FFQ) [20, 21]. To describe the relative validity and reliability of the FFQ, usual dietary intake was assessed twice using a 168-item semi-quantitative FFQ, 1 year apart (FFQ1 and FFQ2). Dietary data was also collected by twelve 24-h dietary recalls (24hDR) and biochemical markers to compare nutrient intakes from the FFQ and 24hDR in a total population of 132 subjects (sixty-one males and seventy-one females). All food groups reached acceptable validity [22]. Trained nutritionists asked the mothers about the frequency of their own and their children's consumption of individual food items during the past year on a daily, weekly, or monthly basis. Portion sizes were converted to grams based on household measures. Individual dietary intake was analyzed using NUTRITIONIST 4 (First Data Bank, San Bruno, CA) software to estimate energy and nutrient intake.

Assessment of anthropometry, physical activity, and socioeconomic status

Anthropometric indices including weight and height were measured for all children and their mothers. Weight was measured on an electronic scale (Seca 753E; Seca Weighing and Measuring Systems, Hamburg, Germany) with a precision of 100 g. Children wore light clothes and no shoes or socks. Height was measured with 0.5-cm precision, while mothers and children stood with their shoulders in a normal position, without wearing shoes. Body mass index (BMI) was calculated by dividing weight (in kilograms) into height squared (in square meters). WHO criteria were used to define childhood growth indices. BMI-for-age and sex were categorized into obese (BMI-for-age $\geq$ 2SD), overweight (BMI-for-age $\geq$ 1SD), normal (BMI-for-age ≥ -1SD and $<$ 1SD), underweight (BMI-for-age < -1SD), and wasted (BMI-for-age < -2SD) [23]. Physical activity (PA) levels were measured for all children and their mothers using the International Physical Activity Questionnaire (IPAQ). IPAQ includes 16 questions about participation in three domains of physical activity (at work, traveling, and during recreational activities) as well as sedentary behavior. Scores were assigned based on the frequency, time, and intensity of activities (light, moderate, high, and very high-intensity activities) during the past year. For each participant, the amount of time for each PA was multiplied by their corresponding metabolic equivalent task value (MET-h/wk), and summed [24]. Socioeconomic status (SES) was evaluated using a valid and reliable scale developed to estimate SES and its relationship with health outcomes among Iranians [25]. This scale has several questions regarding occupation, academic education, vehicle ownership, home ownership, home appliances, number of people living in the household, number of rooms in the house, and domestic and international trips during the previous year which assess the socioeconomic status of the individuals. All the question, answer options, and scores given to each answer are listed in Supplementary Table 1. After filling the information, the scored items of each question were scored based on logical idea. In this regard, the lowest value was scored for the lowest important item and the highest value was scored for the most important item. The total score can be assembled by summing up the scores of individuals for all items. Classification was based on tertile cutpoints. The first was considered as low SES, the second tertile as middle SES, and the third tertile as the high SES.

Statistical analysis

Statistical analyses were performed using SPSS software (version 23, SPSS Inc., Chicago, IL, USA). $p < 0.05$ was considered statistically significant. First, based on the similarity of foods consumed, the 168 daily consumed food items were categorized into 19 food groups (salty foods, soft drinks, hydrogenated fats, sweets and desserts, total grains, high-fat dairy products, low-fat dairy, starchy vegetables, red meats, egg, vegetable oils, poultry, legumes, fruits, nuts, olives, non-starchy vegetables, and fish). Then we used the residual method to adjust these food groups for total energy. Then, principal component analysis (PCA) was performed with rotated varimax to reduce the 19 food groups to three DPs. Eigenvalues > 1.00 and inflection in the scree plot were criteria used to select how many factors to retain from the factor analysis. A factor loading of > 0.3 was used as a criterion to define which food groups were dominant in each factor [26–28]. The Kolmogorov–Smirnov test was used to check the normality of the data for the original food groups. Then, factor scores for each participant and each DP were categorized into quartiles for further analysis. A comparison of the continuous variables across quartiles of the child's DPs was performed using an analysis of variance (ANOVA) test. Analysis of covariance (ANCOVA) was used for estimating energy-adjusted children's dietary intakes across quartiles of child's DPs. Dietary macro-nutrient and micro-nutrient intakes across the tertiles of dietary patterns were compared using analysis of covariance while adjusting for daily energy intake. Correlations between maternal and child's DPs were estimated using Pearson correlations. Finally, binary logistic regression was used to assess the associations between child's DPs and child anthropometric indices in three different models: (1) a crude model; (2) a model adjusted for energy intake, child PA, and SES (Model

1); and (3) a model adjusted those variables in Model 1 plus mother's age, mother's BMI, and mother's PA (Model 2).

Results

General characteristics of study participants (mother-daughter dyads) are presented in Table 1. The three major DPs labeled for children and their mothers are presented in Supplementary Table 2. The most relevant foods in the first child's DP included salty foods, soft drinks, hydrogenated fats, sweets and desserts, total grains, high-fat dairy products, and starchy vegetables. The most dominant foods in the second pattern consisted of red meats, egg, vegetable oils, poultry, and legumes. The last child DP's most relevant foods included fruits, nuts, olives, non-starchy vegetables, and fish. Non-starchy vegetables, legumes, red meats, egg, poultry, starchy vegetables, low-fat dairy products, salty foods, fruits, and olives were the major components in the maternal prudent DP. The most relevant foods in the Western DP included sweets and desserts, tea and coffee, soft drinks, and high-fat dairy products. Nuts, hydrogenated fats, and fish were the major components of the high fat DP.

Mother's characteristics across quartiles of child's DPs are shown in Supplementary Table 3. Maternal age ($p = 0.022$) and maternal PA ($p = 0.001$) were strongly inversely associated with child's Western DP. Maternal BMI ($p = 0.008$) and child energy intake ($p < 0.001$) were positively associated with child's Western DP. Further, a strong inverse association was labeled between mothers' age ($p = 0.024$) and child's high-protein DP. Maternal BMI ($p = 0.008$), SES ($p < 0.001$), and child BMI-for-age z-score ($p = 0.019$) were positively associated with child's high-protein DP. Child's prudent DP was positively associated with SES ($p < 0.001$) and child energy intake ($p < 0.001$). Participant dietary intakes in each quartile of child's DPs are presented in supplementary Table 4.

The correlations between maternal and their children's DPs are summarized in Table 2. We observed a positive correlation between the child's Western DP and all maternal DPs (correlation coefficient 0.201, 0.449, 0.253 and $p < 0.001$). Child's high-protein diet was positively correlated with maternal prudent and Western DPs (correlation coefficient 0.576, 0.111 and $p < 0.001$). In addition, this pattern was negatively correlated with maternal high fat DP (correlation coefficient −0.183 and $p < 0.001$). In addition, child's prudent DP was positively correlated with maternal prudent and high fat DPs (correlation coefficient 0.426, 0.396 and $p < 0.001$).

Table 3 displays the distribution of children with wasting, underweight, overweight, and obesity as well as odds ratios (OR) and 95% confidence intervals (CI) for crude

Table 1 General characteristics of study participants (mother-daughter dyads)

Mothers		Children
Variables	Mean ± SD/or number (%)	Mean ± SD/or number (%)
Age (year)	32.0 ± 8.5	6.0
18–28	321 (40.7)	
28–38	289 (36.7)	
38–48	155 (19.7)	
48–55	23 (2.9)	
BMI (kg/m^2)	24.8 ± 4.5	—
< 18.5	41 (5.2)	
25–18.5	399 (50.6)	
30–25	249 (31.6)	
˃30	99 (12.6)	
Physical activity (met/hr)	30.09 ± 3.82	9.50 ± 0.36
20–30	373 (47.3)	
30–40	403 (51.1)	
40–50	12 (1.5)	
Energy intake (kcal/day)	2267.33 ± 733.84	1014.75 ± 259.16
< 1800	223 (28.3)	
1800–2500	265 (33.6)	
˃2500	300 (38.1)	
SES	31.87 ± 6.81	
0–20	33 (4.2)	
20–40	665 (84.4)	
˃40	90 (11.4)	
HAZ (z-score)	——	−0.55 ± 0.42
BAZ (z-score)	——	0.37 ± 1.09

BMI body mass index, *BAZ*, *BMI-for-age*, *HAZ* height-for-age, *SES* socio-economic status

Table 2 Correlation between maternal and child's dietary patterns

Patterns	—-	Mother's prudent DP	Mother's Western DP	Mother's high fat DP
Child's Western DP	Correlation coefficient*	0.201	0.449	0.253
	P-value	< 0.001	< 0.001	< 0.001
Child's high-protein DP	Correlation coefficient	0.576	0.111	-0.183
	P-value	< 0.001	0.002	< 0.001
Child's prudent DP	Correlation coefficient	0.426	0.021	0.396
	P-value	< 0.001	0.559	< 0.001

Child's DP 1: salty foods, soft drinks, hydrogenated fat, sweets (Western DP); Child's DP 2: red meats, egg, poultry, vegetable oils (high-protein DP); Child's DP 3: fruits, nuts, olives, non-starchy vegetables, fish (prudent DP). Maternal DP 1: non-starchy vegetables, legumes, red meat, eggs, poultry, low fat dairy, olives, fruits (prudent DP); Maternal DP 2: sweets, tea and coffee, soft drinks, high fat dairy (Western DP); Maternal DP 3: nuts, hydrogenated fat (high fat DP)

*Calculated using Pearson's correlation coefficient

and adjusted models of child anthropometric outcomes in relation to child's DPs quartiles. A child being in the top compared to the lowest quartile of the high-protein DP was negatively associated with odds of underweight and wasting in the crude (OR 0.44; 95% CI 0.24–0.80) and adjusted (OR 0.43; 95% CI 0.23–0.80) models. No significant associations were found between child's prudent DP and child anthropometric outcomes. The association between Western DP and child anthropometry was also non-significant.

Discussion

This study is one of the first to investigate the associations between maternal and child's DPs as well as relationships between child's DPs and child anthropometric outcomes in Iran. We observed a significant positive correlation between the Western DP in children (salty foods, soft drinks, hydrogenated fat, sweets) and all three maternal DPs including prudent (non-starchy vegetables, legumes, red meat, eggs, poultry, low fat dairy, olives, fruits), Western (sweets, tea and coffee, soft drinks, high fat dairy), and high fat (nuts, hydrogenated fat) DPs. In addition, child's high-protein DP (red meats, egg, poultry, and vegetable oils) was positively associated with maternal prudent and Western DPs. Child's prudent DP (fruits, nuts, olives, non-starchy vegetables, fish) was also positively associated with maternal prudent and high fat DPs. However, there was a negative association between child's high-protein DP and maternal high fat DP. Moreover, in both crude and adjusted models, we observed that children in the highest quartile of the high-protein DP had a lower likelihood of being underweight and wasted compared to children in the lowest quartiles.

It has been noted that parental eating behaviors shape child's dietary intake [29–31]. Findings from a sample of African-American families from a US Midwestern city showed that mothers' intake of fruits, vegetables, and snack foods (i.e., cookies, cakes, chips, soda) were significantly correlated with their children's diets [32–34]. Results from Fisher et al. revealed that parents who consumed more fruits, vegetables, and milk had children with higher intake of these foods [29]. Klohe-Lehman and colleagues found that children of mothers who attended a weight loss program showed favorable dietary changes [35]. Longbottom et al. reported a significant correlation between fruits and chocolate intake in 5.5- to 8.5-year-old children and their mothers [36]. Several studies suggest that child's fruit intake is significantly associated with maternal/parental fruit intake [37–41]. However, in a study by Gibson et al., maternal vegetable intake was not associated with child's vegetable intake [42]. The present study showed significant associations between SES and child's prudent and high-protein DP, which is in line with previous studies. This finding may be explained by higher educational attainment in the high SES group, which has an important impact on mothers' food choices [43, 44]. Also, the maternal Western diet, characterized by high consumption of foods such as sweets, soft drinks, hydrogenated fat, and sugar, was more common in children who had younger mothers, overweight mothers, and mothers who participated in less physical activity [33, 42, 45]. These findings are consistent with a study from the Avon Longitudinal Study of Pregnancy and Childhood that showed similar results [46]. In the present study, maternal Western DP was not associated with the prudent diet in their children. Conversely, we found that having a mother following the prudent diet was positively associated with children having a prudent diet at age six. This finding is consistent with earlier studies that have found similar associations between parents' and young child's diets [33, 47–49]. However, results of a review and meta-analysis by Wang et al. demonstrate that the influence of parent's DP on young people's dietary intake is not as strong as many people have assumed [50]. This weak association may be partially due to the difficulties of assessing the association between DPs of mothers and their children [50].

Table 3 Multivariable odds ratio (OR) and 95% confidence intervals (CI) for risk of overweight/obesity and underweight/wasting in quartiles of child's dietary patterns

Outcomes	Chid's Western DP					Child's high-protein DP					Child's prudent DP				
	Q1	Q2	Q3	Q4	P trend	Q1	Q2	Q3	Q4	P trend	Q1	Q2	Q3	Q4	P trend
Overweight/obesity															
Cases/controls	64/133	70/127	52/145	71/126	–-	57/140	73/124	67/130	60/137	–-	68/129	58/139	69/128	62/135	–-
Model 1** (categorical)	1	1.15 (0.76–1.76)	0.76 (0.48–1.18)	1.19 (0.77–1.82)	0.84	1	1.45 (0.95–2.23)	1.28 (0.83–1.98)	1.08 (0.69–1.67)	0.90	1	0.79 (0.521.22)	1.04 (0.68–1.59)	0.89 (0.58–1.37)	0.91
Model 1** (continuous)	1.03 (0.88–1.20)				0.71	1.02 (0.88–1.19)				0.76	1.02 (0.88–1.19)				0.77
Model 2*** (categorical)	1	1.13 (0.74–1.73)	0.77 (0.49–1.20)	1.15 (0.74–1.77)	0.91	1	1.46 (0.95–2.24)	1.28 (0.83–1.99)	1.11 (0.71–1.72)	0.82	1	0.81 (0.53–1.24)	1.08 (0.70–1.65)	0.92 (0.59–1.42)	0.99
Model 2*** (continuous)	1.02 (0.87–1.19)				0.82	1.04 (0.89–1.21)				0.61	1.04 (0.89–1.21)				0.65
Underweight/wasting															
Cases/controls	29/168	21/176	24/173	31/166	–-	38/159	20/177	28/169	19/178	–-	20/177	27/177	30/167	28/169	–-
Model 1** (categorical)	1	0.64 (0.35–1.18)	0.71 (0.39–1.29)	0.97 (0.55–1.71)	0.95	1	0.47 (0.26–0.84)	0.67 (0.39–1.16)	0.43 (0.24–0.79)	0.02	1	1.35 (0.72–2.51)	1.49 (0.80–2.78)	1.36 (0.72–2.55)	0.33
Model 1** (continuous)	0.97 (0.78–1.20)				0.83	0.80 (0.64–1.01)				0.06	1.17 (0.95–1.43)				0.13
Model 2*** (categorical)	1	0.65 (0.35–1.20)	0.67 (0.36–1.23)	1.07 (0.60–1.91)	0.78	1	0.47 (0.26–0.85)	0.67 (0.39–1.17)	0.43 (0.23–0.80)	0.02	1	1.29 (0.69–2.42)	1.46 (0.78–2.71)	1.34 (0.71–2.52)	0.352
Model 2*** (continuous)	1.00 (0.80–1.25)				0.99	0.80 (0.63–1.00)				0.05	1.16 (0.94–1.43)				0.15

Data are presented as OR (95% CI)

**Model 1: Adjusted for energy intake, children's physical activity, and socio-economic status

***Model 2: Adjusted for model 1 + mother's age, mother's BMI, and mother's physical activity

Our results showed an inverse association between child's high-protein DP and odds of being underweight and wasted. This could be attributable to a significantly more favorable crude nitrogen balance caused by essential amino acids and high quality proteins [51]. Previous findings are inconsistent with our results; we found no association between the Western DP and the odds of being simultaneously underweight and wasted. Findings from a study by Sobhani et al. revealed that the modern DP (which is the same as the Western DP in our study) can lead to thinness in rural areas [52]. While our study adjusted for socio-economic factors, differences in our results and theirs may be due to the fact that some socio-economic factors were not controlled for in their study, like parental education and maternal age (which may affect the association between DPs and weight status). It should be noted that there are just a few studies documenting DPs and odds of underweight and wasting in children. Hence, more research may be needed to make firm conclusions regarding these results.

Results of the present study showed no significant association between DPs in children and odds of child obesity or overweight. Findings of Chong et al. and Norimah et al. revealed that the frequency of fruit and vegetable intake may not significantly influence children anthropometric status [53, 54]. However, a study by Matthews et al. in children aged 6.0–19.0 years in Southern California showed that higher intake of vegetables, but not fruits, was positively associated with a lower risk of overweight [55]. It should be noted that most of these studies had cross-sectional designs and failed to adequately adjust for potential confounders. Additionally, fruits and vegetables only account for a small component of the "prudent DP," which was considered as a separate DP in our study. Our results are inconsistent with results of several studies that reported that the consumption of soft drinks (one of the main components of the Western DP) was positively associated with a higher total energy intake, leading to higher odds of obesity in children [56–58]. However, these studies evaluated the effect of only soft drinks, rather than the overall Western DP, on weight status.

Bahreynian et al. derived three major food patterns; "healthy," "Western," and "sweet-dairy" among 7- to 11-year-old children in Isfahan and found positive significant associations between the three DPs and obesity among girls [59]. These results are inconsistent with those of our study, as we found that children in the highest quartile of Western and prudent DPs did not tend to be overweight and obese compared to their counterparts in the lowest quartile. This difference in results may be due to differences in children's ages. Another study by Johnson et al. showed that a high fat diet was positively associated with a higher risk of obesity and overweight in childhood [60]. However, one notable limitation of the mentioned study was that it had insufficient data on children's physical activity. Also, the DP was considered a Western diet but only included some components of the Western diet. Contrary to our findings, Zhang et al. found that the modern DP (rich in milk, fast foods, eggs, other livestock meat, poultry, and cake) and the traditional north DP (rich in wheat flour-like noodles, other cereals, along with low consumption of rice, pork, and poultry) were positively associated with higher risk of obesity among 7- to 17-year-old children and adolescents [61]. The differences in the DPs reflect differences in types of foods consumed (including traditional foods) across different cultures. Moreover, dietary intake was assessed by using three consecutive 24-h dietary recalls which differed from our method of assessing dietary intake.

Literature has been inconsistent regarding the nature of the relationship between maternal and child's DPs. Based on previous research, parents have a clear influence on their children's dietary intake [62]. However, reverse causation cannot be disregarded, i.e., that child's diet will influence their mother's dietary intake, especially in disadvantaged families where mothers may make sacrifices their diet to improve the adequacy of their children's diets [62]. The mechanism underlying the association between parents' and their children's dietary intake may be due to covert or overt types of food restrictions or incentives. Covert food restrictions involve keeping restricted foods (like unhealthy foods) out of children's reach so that they cannot see or eat them [63]. The overt type of dietary restriction results from interactions between parents and children to decrease the available options and amounts of the restricted food items [64, 65]. Moreover, research has revealed that the opposite practice is also beneficial in stimulating the intake of healthy foods, i.e., when parents increase the portion sizes of healthy foods and enhance the diversity of healthy foods offered to children [66]. Experimental research has shown that parents can also promote children's food preferences for healthy foods (such as some vegetables) by means of rewards, facial expressions, and repeated exposures [67–71].

Using a large sample size to evaluate of the relationship between major DPs and wasting among children along with the odds of overweight and obesity is one of the merits of the present study. A major limitation is that the dietary intake data were reported by the mother, since the children were not mature enough to provide accurate self-reports. Given this fact, these dietary data may reflect what the mothers imagine their children are eating rather than the children's actual diets [72]. According to a study by Murakami et al. [73], subjects were identified as under or over-reporters of energy intake based on the ratio of reported energy intake to estimated energy requirement acceptable reporters were defined as having a ratio of 0.76 to 1.24. This ration was < 0.76 for under-reporters and ratio of > 1.24 for over-reporters. Based on these criteria, we did not have any misreporting of energy intake among children in the current study [74]. Also, we did not have any misreporting with energy intake of less than 500 and more than 3500 among mothers. In our study, given the mother reported both her own and her child's food intake, the correlation between maternal and child dietary patterns may be overestimated. There is some evidence suggesting that what is reported as a child's diet closely resembles the diet of the parent reporting their food intake [74]. Also, since our study only included girls, we are not able to generalize our findings to boys. Without longitudinal data, it is not possible to establish a true cause and effect relationship. Therefore, prospective studies are warranted to assess these associations over longer time periods. Results of the current study, regarding the association between child's high-protein DP and decreased odds of children who are both underweight and wasted, suggest that better educating parents to assist their children to eat healthier foods such as enough high quality protein via a balanced diet should be encouraged. To improve our understanding of this issue, the larger picture should be considered, with attention to other influences on child's eating patterns such as that of schools, the local food environment, peer influences, government's policies that regulate school snacks and meals, and advertisements [75, 76].

Data transparency

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00431-021-04180-2.

Authors' contributions The authors' responsibilities were as follows—LA, MM, and YJP: developed the idea for the study and analysis; MM and PS drafted the manuscript; YJP: analyzed the data; LA: provided statistical expertise; MM and YJP: designed and managed the entry and collection of the dietary data. All authors were responsible for critical revisions and final approval of the manuscript.

Funding Research reported in this publication was supported by Elite Researcher Grant Committee under award number 983073 from the National Institute for Medical Research Development (NIMAD), Tehran, Iran.

Declarations

Ethical approval This study was conducted according to the guidelines of the Declaration of Helsinki and all procedures involving research study participants. This study was ethically approved by the National Institute for Medical Research Development (NIMAD) (IR.NIMAD.REC.1398.211).

Consent to participate Written informed consent was obtained from all participants.

Consent for publication Mothers signed informed consent regarding publishing their and their child's data and information.

Conflict of interest The authors declare no competing interests.

References

1. De Onis M (2017) Child growth and development. Nutrition and health in a developing world. Humana Press, Cham, 119–141.
2. Mistry SK, Hossain MB, Khanam F et al (2019) Individual-, maternal-and household-level factors associated with stunting among children aged 0–23 months in Bangladesh. Public Health Nutr 22(1):85–94
3. De Onis M, Dewey KG, Borghi E et al (2013) The World Health Organization's global target for reducing childhood stunting by 2025: rationale and proposed actions. Matern Child Nutr 9:6–26
4. Del Carmen CM, Lutter CK, Mangasaryan N et al (2013) Multisectoral interventions for healthy growth. Matern Child Nutr 9:46–57
5. Unicef (2018) Levels and trends in child malnutrition. eSocialSciences
6. World Health Organization (2019) Levels and trends in child malnutrition: key findings of the 2019 edition. World Health Organization
7. Olstad DL, McCargar L (2009) Prevention of overweight and obesity in children under the age of 6 years. Appl Physiol Nutr Metab 34(4):551–570
8. McGowan L, Croker H, Wardle J et al (2012) Environmental and individual determinants of core and non-core food and drink intake in preschool-aged children in the United Kingdom. Eur J Clin Nutr 66(3):322–328
9. Ferriman A (1840) BMJ readers choose the "sanitary revolution" as greatest medical advance since. Eur J Clin Nutr 2007:111–111
10. Esrey SA, Potash JB, Roberts L et al (1991) Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. Bull World Health Organ 69(5):609
11. Cameron AJ, Crawford DA, Salmon J, Campbell K, McNaughton SA, Mishra GD, Ball K (2011) Clustering of obesity-related risk behaviors in children and their mothers. Ann Epidemiol 21(2):95–102
12. Larsen JK, Hermans RC, Sleddens EF et al (2015) How parental dietary behavior and food parenting practices affect children's dietary behavior. Interacting sources of influence? Appetite 89:246–57.
13. Tinsley BJ (2003) How children learn to be healthy: Cambridge University Press; 2003.
14. Beydoun MA, Wang Y (2009) Parentechild dietary intake resemblance in the United States: evidence from a large representative survey. Soc Sci Med 68:2137e44.
15. Wang Y, Li J, Caballero B (2009) Resemblance in dietary intakes between urban low-income African-American adolescents and their mothers: the healthy eating and active lifestyles from school to home for kids study. J Am Diet Assoc 109:52–63
16. Fisk CM, Crozier SR, Inskip HM, Godfrey KM, Cooper C, Robinson SM (2011) Southampton Women's Survey Study Group. Influences on the quality of young children's diets: the importance of maternal food choices. Br J Nutr 105(2):287–96.

17. Ovaskainen ML, Nevalainen J, Uusitalo L, Tuokkola JJ, Arkkola T, Kronberg-Kippilä C, Veijola R, Knip M, Virtanen SM (2009) Some similarities in dietary clusters of pre-school children and their mothers. Br J Nutr 102(3):443–452
18. Mehranfar S, Jalilpiran Y, Surkan PJ, Azadbakht L (2020) Association between protein-rich dietary patterns and anthropometric measurements among children aged 6 years. Nutr Diet 77(3):359–367
19. Jalilpiran Y, Mozaffari H, Askari M, Jafari A, Azadbakht L (2020) The association between Healthy Beverage Index and anthropometric measures among children: a cross-sectional study. Eat Weight Disord-St 10:1–9
20. Mirmiran P, Esfahani FH, Mehrabi Y, Hedayati M, Azizi F (2010) Reliability and relative validity of an FFQ for nutrients in the Tehran lipid and glucose study. Public Health Nutr 13(5):654–662
21. Asghari G, Rezazadeh A, Hosseini-Esfahani F, Mehrabi Y, Mirmiran P, Azizi F (2012) Reliability, comparative validity and stability of dietary patterns derived from an FFQ in the Tehran Lipid and Glucose Study. Br J Nutr 108(6):1109–1117
22. Esmaillzadeh A (2012) Final report of "relative validity and reproducibility of a semi-quantitative food frequency questionnaire to assess long-term dietary intakes in children." Deputy for Research
23. Organization WH, Organization WH (2006) WHO Multicentre Growth Reference Study Group: WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. WHO, Geneva, p 2007
24. Craig CL, Marshall AL, Sjöström M et al (2003) International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 35(8):1381–1395
25. Saraf-Bank S, Haghighatdoost F, Esmaillzadeh A et al (2017) Adherence to Healthy Eating Index-2010 is inversely associated with metabolic syndrome and its features among Iranian adult women. Eur J Clin Nutr 71(3):425–430
26. Betancourt-Nuñez A, Márquez-Sandoval F, González-Zapata LI, Babio N, Vizmanos B (2018) Unhealthy dietary patterns among healthcare professionals and students in Mexico. BMC Public Health 18(1):1–4
27. Adriano LS, de Carvalho Sampaio HA, Arruda SP, de Melo Portela CL, de Melo ML, Carioca AA, Soares NT (2016) Healthy dietary pattern is inversely associated with non-alcoholic fatty liver disease in elderly. B J Nutr 115(12):2189–2195
28. Cai H, Zheng W, Xiang YB, Xu WH, Yang G, Li H, Shu XO (2007) Dietary patterns and their correlates among middle-aged and elderly Chinese men: a report from the Shanghai Men's Health Study. B J Nutr 98(5):1006–1013
29. Fisher JO, Mitchell DC, Smiciklas-Wright H et al (2001) Maternal milk consumption predicts the tradeoff between milk and soft drinks in young girls' diets. J Nutr 131(2):246–250
30. Savage JS, Fisher JO, Birch LL (2007) Parental influence on eating behavior: conception to adolescence. J Law Med Ethics 35(1):22–34
31. Birch LL, Fisher JO (1998) Development of eating behaviors among children and adolescents. Pediatrics 101(Supplement 2):539–549
32. Fisher JO, Mitchell DC, Smiciklas-Wright H et al (2002) Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes. J Am Diet Assoc 102(1):58–64
33. Cooke L, Wardle J, Gibson E et al (2004) Demographic, familial and trait predictors of fruit and vegetable consumption by preschool children. Public health nutr 7(2):295–302
34. Arcan C, Neumark-Sztainer D, Hannan P et al (2007) Parental eating behaviours, home food environment and adolescent intakes of fruits, vegetables and dairy foods: longitudinal findings from Project EAT. Public health nutr 10(11):1257–1265
35. Klohe-Lehman DM, Freeland-Graves J, Clarke KK et al (2007) Low-income, overweight and obese mothers as agents of change to improve food choices, fat habits, and physical activity in their 1-to-3-year-old children. J Am Coll Nutr 26(3):196–208
36. Longbottom P, Wrieden W, Pine C (2002) Is there a relationship between the food intakes of Scottish 5½– 8½-year-olds and those of their mothers? J Hum Nutr Diet 15(4):271–279
37. Pearson N, Biddle SJ, Gorely T (2009) Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. Public health nutr 12(2):267–283
38. Rasmussen M, Krølner R, Klepp KI et al (2006) Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies. Int J Behav Nutr Phys Act 3(1):22.
39. Van Der Horst K, Oenema A, Ferreira I et al (2007) A systematic review of environmental correlates of obesity-related dietary behaviors in youth. Health Educ Res 22(2):203–226
40. Vereecken C, Rovner A, Maes L (2010) Associations of parenting styles, parental feeding practices and child characteristics with young children's fruit and vegetable consumption. Appetite 55(3):589–596
41. Zeinstra GG, Koelen MA, Kok FJ et al (2010) Parental child-feeding strategies in relation to Dutch children's fruit and vegetable intake. Public health nutr 13(6):787–796
42. Gibson EL, Wardle J, Watts CJ (1998) Fruit and vegetable consumption, nutritional knowledge and beliefs in mothers and children. Appetite 31(2):205–228
43. Hardcastle SJ, Blake N (2016) Influences underlying family food choices in mothers from an economically disadvantaged community. Eat Behav 20:1–8
44. Da Veiga GV, Sichierib R (2006) Correlation in food intake between parents and adolescents depends on socioeconomic level. Nutr Res 26:517–523
45. Hendricks K, Briefel R, Novak T et al (2006) Maternal and child characteristics associated with infant and toddler feeding practices. J Am Diet Assoc 106(1):135–148
46. North K, Emmett P (2000) Multivariate analysis of diet among three-year-old children and associations with socio-demographic characteristics. Eur J Clin Nutr 54(1):73–80
47. Oliveria SA, Ellison RC, Moore LL et al (1992) Parent-child relationships in nutrient intake: the Framingham Children's Study. Am J Clin Nutr 56(3):593–598
48. Vereecken CA, Keukelier E, Maes L (2004) Influence of mother's educational level on food parenting practices and food habits of young children. Appetite 43(1):93–103
49. Bere E, Klepp K-I (2004) Correlates of fruit and vegetable intake among Norwegian schoolchildren: parental and self-reports. Public health nutr 7(8):991–998
50. Wang Y, Beydoun MA, Li J et al (2011) Do children and their parents eat a similar diet? Resemblance in child and parental dietary intake: systematic review and meta-analysis. J Epidemiol Community Health 65(2):177–189
51. Beasley JM, Shikany JM, Thomson CA (2013) The role of dietary protein intake in the prevention of sarcopenia of aging. Nutr Clin Pract 28(6):684–690
52. Sobhani SR, Keshtkar A, Dorosty AR et al (2017) The association between dietary pattern and weight status in school-aged children: a cross-sectional study. J Compr Ped 8(4).
53. Chong KH, Lee ST, Ng SA et al (2017) Fruit and vegetable intake patterns and their associations with sociodemographic characteristics, anthropometric status and nutrient intake profiles among Malaysian children aged 1–6 years. Nutrients 9(8):723
54. Norimah A, Mohd Nasir M, Hazizi A et al (2014) Association of body weight status and socio-demographic factors with food habits among preschool children in Peninsular Malaysia. Malays J Nutr 20(3):303–315
55. Matthews VL, Wien M, Sabaté J (2011) The risk of child and adolescent overweight is related to types of food consumed. Nutr J 10(1):71

56. Ludwig DS, Peterson KE, Gortmaker SL (2001) Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. The lancet 357(9255):505–508
57. Malik VS, Schulze MB, Hu FB (2006) Intake of sugar-sweetened beverages and weight gain: a systematic review. Am J Clin Nutr 84(2):274–288
58. O'Connor TM, Yang S-J, Nicklas TA (2006) Beverage intake among preschool children and its effect on weight status. Pediatrics 118(4):e1010–e1018
59. Bahreynian M, Paknahad Z, Maracy MR (2013) Major dietary patterns and their associations with overweight and obesity among Iranian children. Int J Prev Med 4(4):448
60. Johnson L, Mander AP, Jones LR et al (2008) Energy-dense, low-fiber, high-fat dietary pattern is associated with increased fatness in childhood. Am J Clin Nutr 87(4):846–854
61. Zhang J, Wang H, Wang Y et al (2015) Dietary patterns and their associations with childhood obesity in China. Br J Nutr 113(12):1978–1984
62. McIntyre L, Glanville NT, Raine KD, Dayle JB, Anderson B, Battaglia N (2003) Do low-income lone mothers compromise their nutrition to feed their children? CMAJ 168(6):686–691
63. Mitchell GL, Farrow C, Haycraft E et al (2013) Parental influences on children's eating behaviour and characteristics of successful parent-focussed interventions. Appetite 60:85–94
64. Rodenburg G, Kremers SP, Oenema A et al (2014) Associations of parental feeding styles with child snacking behaviour and weight in the context of general parenting. Public Health Nutr 17(5):960–969
65. Rodgers RF, Paxton SJ, Massey R et al (2013) Maternal feeding practices predict weight gain and obesogenic eating behaviors in young children: a prospective study. Int J Behav Nutr Phys Act 10(1):24
66. Nicklaus S (2009) Development of food variety in children. Appetite 52(1):253–255
67. Wardle J, Herrera ML, Cooke L et al (2003) Modifying children's food preferences: the effects of exposure and reward on acceptance of an unfamiliar vegetable. Eur J Clin Nutr 57(2):341–348
68. Anzman-Frasca S, Savage JS, Marini ME et al (2012) Repeated exposure and associative conditioning promote preschool children's liking of vegetables. Appetite 58(2):543–553
69. Hausner H, Olsen A, Møller P (2012) Mere exposure and flavour–flavour learning increase 2–3 year-old children's acceptance of a novel vegetable. Appetite 58(3):1152–1159
70. Barthomeuf L, Droit-Volet S, Rousset S (2012) How emotions expressed by adults' faces affect the desire to eat liked and disliked foods in children compared to adults. Br J Dev Psychol 30(2):253–266
71. Frazier BN, Gelman SA, Kaciroti N et al (2012) I'll have what she's having: The impact of model characteristics on children's food choices. Dev Sci 15(1):87–98
72. Drewnowski A (2001) Diet image: a new perspective on the food-frequency questionnaire. Nutr Rev 59(11):370–372
73. Murakami K, Miyake Y, Sasaki S, Tanaka K, Arakawa M (2012) Characteristics of under-and over-reporters of energy intake among Japanese children and adolescents: The Ryukyus Child Health Study. Nutrition 28(5):532–538
74. Vepsäläinen H, Nevalainen J, Fogelholm M, Korkalo L, Roos E, Ray C, Erkkola M (2018) Like parent, like child? Dietary resemblance in families. Int J Behav Nutr Phys Act 15(1):62
75. French SA, Story M, Jeffery RW (2001) Environmental influences on eating and physical activity. Annu Rev Public Health 22:309–335
76. Vereecken CA, Inchley J, Subramanian SV et al (2005) The relative influence of individual and contextual socio-economic status on consumption of fruit and soft drinks among adolescents in Europe. Eur J Public Health 15:224–232