


Associations between diet quality and obesity in a nationally representative sample of Iranian households: A cross-sectional study

Sara Ebrahimi¹  | Rebecca M. Leech¹ | Sarah A. McNaughton¹ |
Morteza Abdollahi^{2,3}  | Anahita Houshiarrad³ | Katherine M. Livingstone¹

¹Institute for Physical Activity and Nutrition, School of Exercise and Nutrition Sciences, Deakin University, Geelong, Victoria, Australia

²Social Determinants of Health Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran

³Department of Nutrition Research, National Nutrition and Food Technology Research Institute, School of Nutrition Sciences and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Correspondence

Sara Ebrahimi, Institute for Physical Activity and Nutrition, School of Exercise and Nutrition Sciences, Deakin University, Melbourne Burwood Campus, 221 Burwood Highway, Melbourne, VIC 3125, Australia.
Email: sebrahimi@deakin.edu.au

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Abstract

Objective: Research examining associations between diet quality and obesity in Iranian adults is limited by small and non-representative samples. This study examined associations between two diet quality indices and obesity risk in a nationally representative sample of Iranian adults and interactions by sex and area of residence.

Methods: Data on 18,307 adults (mean age 37 [SD 15.2] years) were used from the Iranian National Survey 2001–2003. Two diet quality indices (Healthy Eating Index 2015, HEI-2015, and Diet Quality Index International, DQI-I) were calculated from household 24-h dietary recalls. Multi-level regression analyses were used to examine the association between household diet quality and individual-level obesity risk, with interaction terms for sex and area of residence.

Results: Higher household HEI-2015 and DQI-I were associated with higher risk of obesity (HEI-2015: relative risk ratio: 1.04, 95% CI: 1.03, 1.05; DQI-I: relative risk ratio: 1.02, 95% CI: 1.01, 1.02), with stronger effect sizes in adults living in rural areas.

Conclusions: Higher diet quality (HEI-2015 and DQI-I) was associated with higher obesity risk, which was stronger in adults living in rural areas. Due to the complexity of examining these associations in a Middle Eastern country undergoing a nutrition transition, longitudinal research is needed to confirm these findings.

KEYWORDS

body mass index, diet quality, Diet Quality Index International, Healthy Eating Index 2015, household, Iran, obesity

Abbreviations: BMI, body mass index; DQI-I, Diet Quality Index International; FFQ, Food Frequency Questionnaire; HEI, Healthy Eating Index; SFA, saturated fatty acids; UFA, unsaturated fatty acids.

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1 | INTRODUCTION

Iran, the second most highly populated country in the Middle East, has a high prevalence of obesity.¹ According to the latest available national estimates, the prevalence of obesity and overweight/obesity among Iranian adults is 23% and 59%, respectively.² As obesity risk is influenced by overall diet quality, an increasing number of studies are evaluating the association between diet

quality and obesity, rather than investigating associations with single foods or nutrients.³ Diet quality indices, that score dietary intake against dietary recommendations,³ have been used in Iranian populations to examine associations with sociodemographic characteristics, nutrient intake, and health outcomes.^{4,5}

Several studies in Iranian adults have applied diet quality scores to examine associations with obesity.⁵⁻¹⁰ Most research has used the Healthy Eating Index (HEI), created based on the Dietary

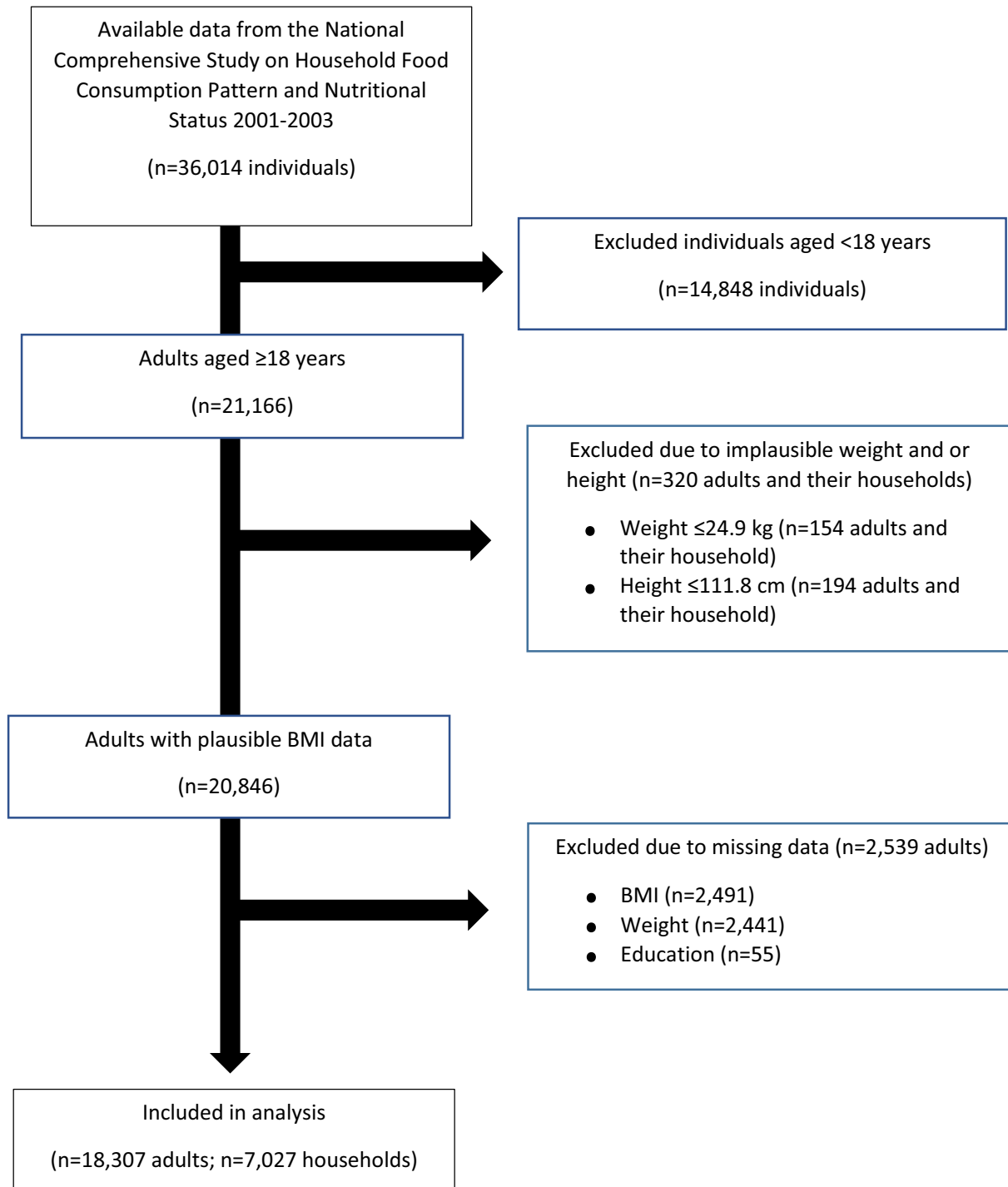


FIGURE 1 Participants flow diagram

Guidelines for Americans,¹¹ to evaluate the association between Iranian diet quality and obesity.⁵⁻¹⁰ Only one study has applied the Diet Quality Index International (DQI-I) to assess links between diet quality and obesity in Iranian adults.⁵ The DQI-I was developed based on international dietary guidelines to evaluate the adequacy, moderation, and balance of a diet.¹² While obesity is increasing in Iran, the problem of malnutrition and micronutrient deficiencies has persisted,¹³ thus the DQI-I may be useful for exploring aspects of diet quality related to under- and over-nutrition in the Iranian population.¹⁴ However, results from Iranian studies using HEI and DQI-I are inconsistent, which may be due to small sample sizes and non-nationally representative samples.⁵⁻⁹ Moreover, the association between diet quality and obesity in a representative sample of Iranian adults is unknown.

Dietary intake in Iran has been shown to vary across rural and urban areas and by sex.¹³ While some evidence suggests that Iranian adults living in provinces with a higher rate of urbanization consumed more fruits and vegetables,¹⁵ another study showed no difference.¹⁶ No studies have examined how the associations between HEI or DQI-I and obesity vary by area of residence. Given the ongoing nutrition transition in Iran and that urbanization is an important cause of obesity,¹³ an understanding of how area of residence impacts on the association between diet quality and obesity is needed to inform dietary policies in Iran. Moreover, although the prevalence of obesity is higher in Iranian females than males,¹⁷ females have higher diet quality than males.^{4,5} As females are the primary caregivers in Iranian households,¹⁸ the role of sex as an effect modifier warrant further investigation.^{4,5} Thus, this study aimed to investigate the association between two diet quality scores (HEI-2015 and DQI-I) and obesity, and interactions by area of residence and sex, in the National Comprehensive Study on Household Food Consumption Pattern and Nutritional Status 2001-2003.

2 | METHODS

2.1 | Participants and study design

The current study used dietary intake and anthropometric data collected from adult participants in the cross-sectional National Comprehensive Study on Household Food Consumption Pattern and Nutritional Status 2001-2003.¹⁹ A total of 7248 households, comprised of 21,166 adults aged 18 years and over and 18,484 children <18 years of age (Figure 1), were recruited from 28 provinces of Iran between March 2001 and November 2003 using a cluster sampling method. Interviewers, who were trained nutritionists, collected information on the dietary intake of households using three 24-h recalls and weight and height measurements for every member in the household.¹⁹ Individuals were excluded from the present analysis if they (i) were less than 18 years of age, (ii) had only one 24-h dietary recall, and/or (iii) had implausible weight and/or height data (Figure 1). For adults with implausible weight and/or height, the whole household was excluded. This manuscript

is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology—Nutritional Epidemiology (STROBE-Nut) reporting checklist (Table S1).²⁰ This study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences, and this secondary analysis of pre-existing and non-identifiable data, was granted an exemption from ethics review by the Deakin University Human Research Ethics Committee (Reference Number 2019-288).

2.2 | Study measures

2.2.1 | Anthropometric characteristics

The body weight of individuals in each household was measured twice, without shoes and to the nearest 100 g using a Seca scale, and the mean of these values was used. Height was measured without shoes to the nearest 0.1 cm with a tape measure. The body weight and height of individuals were measured in each household. For this analysis, adults with implausible weight and height were excluded based on established cut points by Cheng et al.:²¹ weight <24.9 kg or >453.6 kg and height <111.8 cm or >228.6 cm. BMI (weight kg/height m²) was calculated for every adult in the household. Adults were classified as having underweight and normal weight (<25 kg/m²), having overweight (≥ 25 kg/m² & <30 kg/m²), and having obesity (≥ 30 kg/m²).²²

2.2.2 | Dietary assessment

Three 24-h dietary recalls, collected over consecutive days, were used to estimate food and nutrient intakes of households. Households were included in the survey if they had complete data for two days (129 households) or three days (7,119 households) of these 24-h dietary recalls (Figure 1). To capture seasonal variation in dietary intake, sampling and data collection took place over a period of one year for each province and were designed to include the whole year. The sample households were spread through a whole week, therefore they included a combination of weekdays and weekends. Dietary data were not collected during Ramadan and the New Year public holiday period. This study used the per capita approach to collect dietary data at the household level, which assumes the equal distribution of intake of food between all members in the household.²³ Dietary data are often collected at the household-level in low-middle income countries rather than in individuals due to the high cost and complexity of dietary surveys at the individual level.²³ Evidence suggests that the per capita approach may overestimate individual dietary intake from 24-h dietary recalls.^{23,24}

The household member who was responsible for cooking in the household was interviewed by trained nutritionists.¹⁹ The calculation of food intake was based on each individual meal per day. Total food consumed in each meal was calculated by dividing the total gram of the food reported by the total number of present persons (including

visitors). Intakes for each food were summed to report the total intake for the day per person. The Iranian Food Composition Dataset was applied to evaluate food items and their energy (kcal/day) and nutrient content. Nutrients including sodium (mg/day), added sugars (% of energy), fibre (g/day), protein (% of energy), iron (mg/day), calcium (mg/day), vitamin C (mg/day), and total fat (% of energy) were estimated.¹⁹

To adjust for energy intake misreporting, an estimate of the ratio of household energy intake to household energy requirement was calculated. Based on estimates that over 50% of the Iranian adults population has insufficient physical activity,²⁵ and no information on physical activity were collected in this study, the energy requirement for every member in the household was calculated using World Health Organization/Food and Agriculture Organization 2002 (WHO/FAO) recommendations.¹⁹ To estimate the household energy requirement, data on the energy requirements for every household member were summed then divided by the number of household members.

2.2.3 | Diet quality indices

The average of two or three 24-h dietary recalls was used to calculate the HEI-2015 and DQI-I for each household. The components of the original HEI-2015 include nine adequacy components (total and whole fruits, total vegetables, greens and beans, whole grains, dairy products, total protein foods, seafood, and plant proteins, the proportion of unsaturated fatty acids/saturated fatty acids (UFA to SFA)) and four moderation components (refined grains, sodium, added sugars, and SFA). The score of each component ranges from 0 to 10 and a total score ranges from 0 to 100 with a higher score reflecting a higher diet quality.¹¹ The present study used the cut points from Krebs-Smith et al.¹¹ that have been applied in previous Iranian research.⁶⁻⁸ For the purpose of this study, the adapted HEI-2015 was calculated based on 11 components, excluding the ratio of UFA to SFA and SFA due to no available data. The adapted total score ranged from 0 to 80 (Table S2).

The main components of DQI-I include variety, adequacy, moderation, and balance.¹² The variety component comprises food group variety and protein source variety with the score ranging from 0 to 20. Vegetables, fruits, grains, fiber, protein, iron, calcium, and vitamin C, with a score ranging from 0 to 40, are used to reflect the adequacy components. Total fat, SFA, cholesterol, sodium, empty calorie foods, with a score range from 0 to 30, are the moderation components. The balance components consist of the ratio of macronutrient ratio and fatty acid ratio and have a score ranging from 0 to 10. The total score range is between 0 and 100 and a higher score indicates higher diet quality.¹² The cut points were developed by Kim et al.¹² and have been applied to evaluate Iranian diet quality in previous studies.⁵ The adapted DQI-I was calculated based on 14 components, excluding SFA, and fatty acid ratio on account of non-availability of data. The total possible score

ranged from 0 to 84 (Table S3). The HEI-2015 is independent of energy intake and can be applied to evaluate the diet quality of individuals and households¹¹ while the DQI-I has been created based on age- and sex-specific recommendations to examine the diet quality of individuals.¹²

2.2.4 | Sociodemographic characteristics

Information on sociodemographic characteristics, including age, sex, education and area of residence were collected from each individual in the household. The age of adults was categorized into: 18-35 years (young adults), 36-55 years (middle-aged adults), ≥ 56 years (older adults). Education level was categorized into: low (0-5 years; equivalent to completed primary school), moderate (6-12 years; equivalent to completed secondary school), and high (more than 12 years; equivalent to university education). Area of residence was a binary variable: rural and urban areas.

2.3 | Data analysis

Stata (version 16.0; StataCorp) was used to perform the data analysis. A *p* value of <0.05 was considered statistically significant. The number and percentage of participants were reported for categorical variables and means and standard errors were reported for continuous variables. A multi-level modeling approach was used to account for the clustered nature of the data (individuals nested within households). Firstly, multi-level linear regression analyses were used to assess how individual-level BMI (continuous dependent variable) varied by household total diet quality score (continuous independent variable). To examine the relationship between each subcomponent and BMI, multi-level linear regression analyses were used to assess how individual BMI (continuous dependent variable) varied by sub-components of household diet quality score (continuous independent variable). To examine the association between total and sub-components of household diet quality scores (continuous independent variable) and individual-level categories of BMI (dependent variable), generalized structural equation modeling with the multi-level multinomial logistic regression function was used. Results are presented as relative risk ratios and 95% CI by exponentiating coefficients and 95% CIs. Confounders were identified using a Directed Acyclic Graph (Figure S1). Analyses were adjusted for age (continuous), sex (binary), education (categorical), area of residence (binary), and energy intake (continuous). A sensitivity analysis was conducted to examine whether adjusting analyses for reported household energy intake: predicted household energy expenditure (instead of adjusting for energy intake) changed the direction and strength of associations. The analysis of the association between subcomponents of household diet quality score and BMI and BMI categories was further adjusted for other components of the diet quality score. Interaction terms were added to the linear and logistic regression models to determine if the area of residence and sex modified the association between the HEI-

TABLE 1 Characteristics of Iranian adults overall and by weight status ($n = 18,307$)

Characteristics	Overall ($n = 18,307$)	Normal weight ^a ($n = 9712$)	Overweight ^b ($n = 5632$)	Obesity ^c ($n = 2963$)
Age group ^d , N (%)				
Young age	9814 (53.6)	6396 (65.6)	2446 (43.3)	999 (33.7)
Middle-aged	6093 (33.3)	2207 (22.7)	2305 (40.9)	1581 (53.4)
Older	2400 (13.1)	1136 (11.7)	881 (15.6)	383 (12.9)
Sex, N (%)				
Males	8248 (45.1)	4961 (51.1)	2534 (45.0)	753 (25.4)
Females	10,059 (55.0)	4751 (48.9)	3098 (55.0)	2210 (74.6)
Level of education ^e , N (%)				
Low	9137 (50.2)	4339 (44.7)	2955 (52.5)	1843 (62.2)
Moderate	7414 (40.5)	4306 (44.3)	2138 (38.0)	970 (32.7)
High	1756 (9.6)	1067 (11.0)	539 (9.6)	150 (5.1)
Area of residence, N (%)				
Rural	6475 (35.4)	3896 (40.1)	1757 (31.2)	822 (27.7)
Urban	11,832 (64.6)	5816 (59.9)	3875 (68.8)	2141 (72.3)
Anthropometric, mean (SD)				
Weight (kg)	66.2 (13.7)	57.6 (8.9)	71.6 (8.8)	84.0 (11.7)
BMI (kg/m ²)	25.2 (5.0)	21.5 (2.2)	27.3 (1.4)	33.6 (3.5)
Household diet quality, mean (SD)				
HEI-2015	33.9 (6.3)	33.3 (6.3)	34.5 (6.3)	34.7 (6.2)
DQI-I	38.1 (7.7)	37.7 (7.6)	38.4 (7.7)	38.7 (7.8)
Total energy intake (kcal/day), mean (SD)	2660 (695.9)	2654 (698.5)	2659 (692.7)	2681 (693.7)

Abbreviations: DQI_I, Diet Quality Index International; HEI, Healthy Eating Index.

^aNormalweight BMI < 25 kg/m².

^bOverweight BMI ≥ 25 kg/m² & BMI < 30 kg/m².

^cObese BMI ≥ 30 kg/m².

^dYoung aged (18–35 years old), Middle aged (36–56 years old), older (≥56 years old).

^eLow (no formal schooling, less than primary school, the primary school completed), medium (secondary school completed, high school completed), and high (college/university completed).

2015 and DQI-I and BMI and BMI categories. A complete case analysis approach was used to manage any missing data for dependent variables, independent variables, and confounders.

3 | RESULTS

A total of 7248 households (21,166 adults) participated in the National Comprehensive Study on Household Food Consumption Pattern and Nutritional Status 2001–2003. After excluding 320 adults and their households for implausible weight and height data and 2,539 individuals with missing data for BMI, weight, and education, 18,307 adults (7027 households) were included in the present analysis (Figure 1). The proportion of adults with normal weight, overweight, and obesity was 53.1%, 30.8%, and 16.2%, respectively.

Table 1 shows the characteristics of adults, overall and by weight status. The majority of participants were young (54%), female (55%), had low education (50%), and lived in urban areas (65%) with a mean energy intake of 2660 (695.94) kcal/day. The majority of participants with overweight were young (43%) and those with obesity were middle-aged (53%). The majority of participants with overweight and obesity were female (overweight = 55%, obese = 75%) and had a low level of education (overweight = 53%, obese = 62%) and lived in urban areas (overweight = 69%, obese = 72%). Mean energy intake was 2659 (692.7) kcal/day and 2681 (693.7) kcal/day in participants with overweight and obesity, respectively.

The association between total HEI-2015 and total DQI-I and BMI is presented in Table 2. Higher household HEI-2015 was associated with higher individual-level BMI. A one-unit increase in HEI-2015 was associated with a 0.07-unit increase in BMI. Higher household

TABLE 2 Multi-level regression analysis between household total HEI-2015 and DQI-I and individual BMI (continuous and categorical) overall and by area of residence and sex ($n = 18,307$ individuals)

Diet quality	BMI			Overweight ^a			Obesity ^b		
	β - Coeff	95% CI	<i>p</i> -value	Relative risk ratio	95% CI	<i>p</i> -value	Relative risk ratio	95% CI	<i>p</i> -value
HEI-2015	0.07	0.06, 0.09	<0.001 ^c	1.03	1.02, 1.04	<0.001 ^d	1.04	1.03, 1.05	<0.001 ^d
Rural ($n = 6475$)	0.10	0.08, 0.13	<0.001	1.04	1.03, 1.06	<0.001	1.06	1.05, 1.08	<0.001
Urban ($n = 11,832$)	0.06	0.04, 0.07	<0.001	1.02	1.01, 1.03	<0.001	1.03	1.02, 1.04	<0.001
Males ($n = 8248$)	0.06	0.05, 0.08	<0.001	1.04	1.03, 1.05	<0.001	1.04	1.04, 1.06	<0.001
Females ($n = 10,059$)	0.08	0.06, 0.10	<0.001	1.03	1.02, 1.04	<0.001	1.04	1.03, 1.05	<0.001
DQI-I	0.03	0.02, 0.04	<0.001 ^c	1.01	1.00, 1.02	0.001 ^d	1.02	1.01, 1.02	<0.001 ^d
Rural ($n = 6475$)	0.03	0.01, 0.05	0.001	1.01	1.00, 1.02	0.027	1.02	1.01, 1.04	0.001
Urban ($n = 11,832$)	0.03	0.01, 0.04	<0.001	1.01	1.00, 1.02	0.009	1.02	1.01, 1.02	<0.001
Males ($n = 8248$)	0.02	0.01, 0.04	<0.001	1.01	1.00, 1.02	0.002	1.02	1.01, 1.03	0.003
Females ($n = 10,059$)	0.03	0.02, 0.05	<0.001	1.01	1.00, 1.02	0.018	1.02	1.01, 1.03	<0.001

Abbreviations: BMI, body mass index; HEI, healthy eating index.

^aBMI ≥ 25 kg/m² & BMI < 30 kg/m².

^bBMI ≥ 30 kg/m².

^cWald test in multi-level linear regression analysis for the association between HEI and DQI-I total score (continuous independent) and BMI (continuous dependent), adjusted for age (continuous), sex (except when used to stratify), education, area of residence (except when used to stratify) and energy, with a mean energy of 2660 kcal (SD 696).

^dWald test in generalized structural equation modeling with multi-level multinomial logistic regression function for the association between HEI and DQI-I total score (continuous independent) and overweight and obesity (categorical dependent variables), adjusted for age (continuous) sex (except when used to stratify), education, area of residence (except when used to stratify) and energy intake; normal weight considered as the reference group (Relative risk ratio 1.00).

DQI-I was associated with higher individual-level BMI, where a one-unit increase in DQI-I was associated with a 0.03-unit increase in BMI. Adults in households with higher HEI-2015 and DQI-I were more likely to have overweight and obesity. The direction and strength of associations were comparable for overweight (HEI 2015: relative risk ratio: 1.03, 95% CI: 1.02, 1.04; DQI-I: relative risk ratio: 1.02, 95% CI: 1.01, 1.02) and obesity (HEI: relative risk ratio: 1.04, 95% CI: 1.03, 1.05; DQI-I: relative risk ratio: 1.03, 95% CI: 1.03, 1.04) when models were adjusted for energy intake: energy requirement.

The association between the HEI-2015 and DQI-I sub-components and BMI and obesity are presented in Tables S4 and S5. The adequacy components of HEI-2015, including total fruits, total vegetables, greens and beans, and total protein foods, had positive associations with BMI, whereas added sugars had a negative association with BMI. DQI-I components for variety food groups, vegetables, protein, vitamin C, empty-calorie foods, and macronutrient ratio had a positive association with BMI, while grains, iron and total fat had a negative association with BMI.

Tests for interaction by area of residence and sex showed a significant interaction for the area of residence on the association between HEI-2015 and BMI (P -interaction <0.001) and overweight (P -interaction = 0.009) and obesity (P -interaction <0.001) while the interaction for area of residence on the association between DQI-I and BMI and DQI-I and overweight and obesity was non-significant. The effect size was larger for the association between

HEI-2015 and BMI and overweight and obesity in rural areas (Table 2). Sex did not modify the association between HEI-2015 and BMI, and DQI-I and BMI, while sex modified the association between HEI-2015 and overweight ($P = 0.003$).

4 | DISCUSSION

This study aimed to assess the cross-sectional associations between HEI-2015 and DQI-I and BMI and obesity risk in Iranian adults. Contrary to expectations, the findings showed that in households with higher diet quality, adults had higher BMI and were more likely to have overweight or obese. With rising rates of obesity in Iran, these findings provide nationally representative insights into the role of two diet quality indices for assessing obesity risk in a Middle Eastern country undergoing a nutrition transition. Furthermore, the results of this study show that sex and area of residence modified the association between HEI-2015 and BMI and indicates the necessity of examining associations according to sex and region of residence. Further research is needed to understand the comparability of our findings with individual-level estimates of diet quality and prospective associations with obesity.

The association between HEI and obesity in Iranian studies is mixed.^{5,7-9} In line with our findings, a study in 9568 adults from Isfahan, Iran showed a positive association between HEI and BMI.

However, the authors partially attributed this finding to a higher dietary diversity score, a subcomponent of HEI not included in the present study.⁹ In contrast, other studies have found an inverse association between HEI and BMI,^{7,8} while another study reported no significant association between HEI and BMI.⁵ The discrepancy could be attributed to different sample sizes, participants, and study design. For example, the sample size varied between 152 adults⁸ and 9568 adults⁹ that were recruited from two big cities in Iran, Tehran^{5,8} and Isfahan^{7,9} and participants were only women⁷ and adults.^{5,8,9} Another explanation might be that the confounders included in these studies were different. Yosae et al. (2017)⁸ adjusted the analysis for age and sex and found an inverse association, while Asghari et al. (2012)⁵ adjusted the analysis for age, sex, and energy intake and found no association. However, our finding is unexpected and could be attributed to the lack of data on physical activity and some components of the diet quality scores, or the lower accuracy of household dietary data compared to individual-level data. Similarly, evidence from non-Iranian studies is also inconsistent. While many studies have reported an inverse association between HEI and BMI,^{26–28} a study of 660 American females found no significant association between HEI and BMI.²⁹ Moreover, a cross-sectional study on 494 Turkish adults demonstrated that a higher HEI was associated with higher BMI.³⁰

The number of studies that have applied DQI-I to evaluate Iranian diet quality is limited.⁵ To our knowledge, the only existing study in Iranian adults found no significant association between DQI-I and BMI.⁵ While Asghari et al.⁵ included 192 adults from Tehran and calculated the DQI-I for individuals, the present study included a large nationally representative sample of Iranian adults and calculated the DQI-I for households, making comparisons challenging. Consistent with our findings, a study on 1220 Guatemalan adults showed a positive association between DQI-I and BMI.³¹ A possible explanation for the positive association between DQI-I and BMI is that the DQI-I includes a variety of food groups and protein sources, gives higher scores to higher serving sizes, and is not energy intake adjusted. Consumption of a variety of different food groups has been associated with a higher intake of energy and thus a higher prevalence of obesity³² and is why we adjusted for overall household energy intake and energy misreporting in the current analysis. Furthermore, previous studies have reported a positive association between dietary diversity and obesity.^{33,34} This is consistent with our findings of a positive association between DQI component scores for a variety of food groups and a variety of protein sources and BMI.

Some limitations should be considered in the interpretation of the present findings. Firstly, this study collected dietary data at the household level using the per capita approach, which assumes equal access to intake of food between household members. While household dietary data is less accurate than individual dietary data, low and middle-income countries such as Iran often use this method to collect dietary data in the population due to the high cost and complexity of dietary surveys.^{23,24} While evidence on the validity of a household dietary assessment methodology for estimating individual

dietary intake is limited, two previous studies have demonstrated that the per capita approach might overestimate individual dietary intake from 24-h dietary recalls.^{23,24} Furthermore, the dietary data were collected based on food prepared in the home and thus did not include foods eaten outside of the home, including restaurant and fast foods, that are linked with weight gain.³⁵

A second limitation is that this study is cross-sectional and is susceptible to reverse causality when assessing associations between diet quality and obesity. Moreover, evidence suggests that individuals with overweight and obesity are more likely to under-report food intakes.³⁶ Future research should examine these associations prospectively. Moreover, we cannot discount the possibility that these findings are the result of a large sample size given that the effect sizes are small and may not be clinically significant.³⁷ Thirdly, contrary to the HEI, which is independent of energy intake¹¹ and has previously been applied to evaluate diet quality of households,³⁸ no studies have applied the DQI-I to assess household diet quality.¹² Given the present findings report household diet quality, this limitation needs to be considered when comparing the present findings with studies that measure individual DQI-I. Fourthly, this study adapted the HEI-2015 and DQI-I due to the lack of information on certain components, including the UFA:SFA ratio, SFA, and cholesterol, which might be contributors to obesity risk.³⁹ Furthermore, this study did not collect information on alcohol intake, a common limitation in Middle-East studies due to religious or legal barriers.⁴⁰ This study also did not collect information on supplement use, and given significant nutrient inadequacies have been identified in Iranian adults,⁴¹ the contribution of vitamin and mineral supplements to overall diet quality warrants further investigation. Fifthly, information on physical activity was not available and so we cannot discount confounding.

A final limitation of this study is that while it used data from the most recent nationally representative dietary survey of Iranian households, this survey was conducted in 2001–2003. Nonetheless, this is an important period as a nutrition transition was taking place in Iran during that time. As Iran has experienced a nutrition transition over the last 3 decades and the tendency towards consumption of a Western diet has increased,¹³ the results need to be interpreted by considering these changes in dietary intake.

The present study has a number of strengths. This study included multiple days of 24-h dietary recalls to measure dietary intake and applied two diet quality indices, HEI-2015 and DQI-I. These diet quality indices captured a variety of nutrients and food groups and have a continuous and proportional score approach, which is a more effective scoring system compared to cut-off scores.⁴² These indices also include key components important to health, such as whole grains and sodium, which are components in the Iranian Dietary Guidelines.⁴³ Moreover, the HEI is an appropriate index to measure household diet quality due to the density standardized scoring system that is independent of energy intake.⁴⁴ Lastly, this study included a nationally representative sample of 18,307 Iranian men and women across 7027 households from all provinces in Iran, which enabled interaction analyses by area of residence and sex.

5 | CONCLUSIONS

The present study identified that higher household diet quality was associated with higher BMI and obesity in Iranian adults. The link between diet quality and obesity was stronger in rural areas, suggesting that nutrition policies may benefit from being targeted to these population groups. As the direction of the relationship between diet quality and obesity risk was unexpected, these findings demonstrate the complexity of examining these associations in a Middle Eastern country undergoing a nutrition transition. Further research is needed to understand the comparability of these findings with individual-level estimates of diet quality and prospective associations with obesity.

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CONFLICT OF INTEREST

Dr. Livingstone reports personal fees from HeadUp Labs Ltd, outside the submitted work. All other authors have nothing to disclose.

AUTHOR CONTRIBUTIONS

Morteza Abdollahi and Anahita Houshiarrad *designed and carried out* the National Comprehensive Study on Household Food Consumption Pattern and Nutritional Status 2001–2003. Sara Ebrahimi, Rebecca M. Leech, Sarah A. McNaughton, and Katherine M. Livingstone *designed the analysis*. Sara Ebrahimi *conducted the statistical analysis and drafted the manuscript*. All authors contributed to the critical review of the manuscript and approved the final version of the manuscript.

ORCID

Sara Ebrahimi  <https://orcid.org/0000-0001-8439-5684>

Morteza Abdollahi  <https://orcid.org/0000-0003-0310-2021>

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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