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Association between the socio-economic status of households and a more sustainable diet

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Abstract
Objective: A sustainable diet is an affordable diet with low environmental impact, high food security and sufficient healthiness. The present study aimed to assess the correlation between the socio-economic status of households and a sustainable diet.
Design: The food basket and socio-economic data of Iranian households were evaluated during 2016–2018. The households were classified based on the sustainability of their diet by determining the dietary carbon footprint, dietary water footprint, lower dietary costs of the household than the median and a higher dietary quality index than the median. Logistic regression was used with four models to calculate the OR of a more sustainable diet as the dependent variable regarding the different quartiles of socio-economic status (SES) as the independent variable.
Setting: Iran.
Participants: Iranian households (*n* 102 303), nationally representative, were studied.
Results: Lower SES was associated with the higher OR of a sustainable diet (OR: 0·90; (95 % CI 0·87, 0·91)). Higher quartiles of SES compared with the lower SES group indicated the higher energy intake and consumption of more dairies, meat, poultry, fish, eggs, legumes, nuts and fruits, as well as the lower intake of bread, cereal, rice and pasta.
Conclusion: In countries such as Iran, where nutrition transition occurs rapidly, better economic and social levels in the populations with a higher SES are associated with increased energy intake and higher consumption of animal-based foods, which decreases sustainable diets compared with the groups with a lower SES.

Keywords
Socio-economic status
Sustainable diet
Environmental impact
Food choice
Iran

Dietary patterns play a pivotal role in health status throughout life, and consumed foods and beverages have a significant environmental influence on ecosystems and financial resources[1]. The environmental effects of food manufacturing are intimidating; for instance, agriculture is responsible for approximately 25 % of greenhouse gas emissions (GHGE)[2]. Overall, the GHGE of various foods change extensively, and meat and dairy are considered to be the major causes of dietary GHGE[3]. Furthermore, agricultural activities occupy 40 % of the Earth's surface, using 70 % of the total water resources. The production of animal food also has the largest share in water consumption[4].

A sustainable diet refers to the integrated concept of inventing a food system that provides healthy regimens for a growing population while declining its environmental impact and staying within the planetary boundaries[5,6]. The concept of a sustainable diet was defined in 2010 from two entirely different perspectives, which were referred to as person-centred nutrition and global sustainability in social, economic and environmental dimensions. Based

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on the definition of the FAO, a sustainable diet has a low environmental impact and contributes to food and nutrition security and a healthy lifestyle for the present and future generations. Furthermore, Meybeck *et al.* defined a sustainable diet as a diet that contributes to a favourable nutritional status and long-term well-being of the individual or the community, which contributes to and is enabled by sustainable food systems; this will result in long-term food security and nutrition.

Sustainable diets are protective, observant of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable, nutritionally adequate, safe and healthy. In addition, such a diet optimises natural and human resources[5]. On the other hand, the main limitations of sustainable diets are associated with prevalent food systems such as climate crises, environmental destructions, extinction of biodiversity and pollution. All nationalities must strive for a more sustainable diet to promote economic sustainability through low-impact, affordable and accessible foods while also supporting community health through adequate nutrition[7,8].

Sustainable diets may be affected by several agricultural, health-related, socio-cultural, environmental and economic factors[9]. The predicted population growth and climate change in the next 10–50 years highlight the need to improve the quality and environmental sustainability of the food system[10]. The quality of diets is largely influenced by the crises in agriculture, poverty, urbanisation, lifestyle changes and food production consumption[11]. Dietary patterns could be affected by the socio-economic diversities within the population[12]. Furthermore, income and its distribution and agricultural conditions in an area significantly affect sustainability. High-income countries can buy more diverse foods, which enhances the dietary quality that indicates significant lifestyle changes[9].

Socio-economic status (SES) is a term widely and accepted expression frequently used in dietary studies as the descriptive variables of education, occupation and income status[13]. Education affects food selection by promoting the ability to recognise the information that is representative of the nutrition science or food labels[14,15]. Income and occupation also demonstrate the accessibility of monetary and food resources, explicitly defining dietary quality[16,17].

Some studies have shown that higher SES improves dietary quality[13,18]. Nevertheless, a higher socio-economic status has been reported to increase the consumption of unhealthy food groups in some cases[19]. Since dietary behaviours are considerably associated with socio-economic indices[20], the sustainability of a diet may also be affected by the SES of the general population[21]. Given the novelty of the concept of diet sustainability, few studies have been conducted in this regard, and it is essential to determine the most nutritionally sustainable options in various socio-economic groups.

Data are scarce regarding SES and sustainable diet. Therefore, the present study aimed to evaluate the association between the SES of households and having a more sustainable diet.

Materials and methods

Data

In the current study, the food basket and socio-economic data of 102 303 Iranian households were obtained from the Households Income, and Expenditure Survey (HIES) performed during 2016–2018. The HIES is performed annually by the Statistical Center of Iran (SCI) through three-stage cluster sampling at private and collective settled households in the urban and rural areas of Iran. The household expenditure and income database provide relevant data in four major dimensions; the first dimension is the social characteristics of the household, which includes data on the number of the household members, as well as the age, gender, education level, activity status and marital status of each household member. The second dimension consists of data on residential and home facilities (i.e. details of accommodation and home facilities), and the third dimension measures household expenses, with food and non-food expenses considered as the household investments in various sectors. The fourth dimension evaluates the household income by collecting data on the income obtained from salaried jobs and employees, income obtained from self-employment and the miscellaneous income of all the working household members. In addition, the food costs in this dimension are measured by the data on the household foods and their consumed amounts and the details of their preparation to examine the changes in the household food basket. All income and expenses were converted from Rials (currency in Iran) to US dollars.

Since data on the household food basket were collected for the households as the sampling units, they were converted into individual amounts. Rather than calculating the per capita amount, adult male equivalent units (AME) were estimated for each household member[22]. AME is the ratio of the energy requirement of a household member of a particular age and gender to the energy requirement of an adult male aged 18–30 years with moderate physical activity as recommended by the FAO and WHO[23]. Unlike per capita measurements, this tool helps identify the share of each household member in the household food basket[24]. In the present study, the total AME of the households was calculated based on the age and gender of the household members. In addition, the AME of each food item was estimated by dividing the amount of each food item by the total AME of the household.

Since purchased food is partly wasted, we calculated the real amount of the consumed foods based on the FAO estimate of the waste percentage for each food group in

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the consumption step of 'from supply to consumption chain'[25]. The waste percentage is subtracted from the reported food purchased. In the present study, the AME of the energy, macronutrient and micronutrient intake was calculated using the Nutritionist IV software with adaptations to the Iranian food composition table. The households reporting the energy intake of less or more than three standard deviations from the mean energy intake (*n* 2729) were excluded from the study.

The diet quality index-international (DQI-I) was calculated to evaluate dietary quality using the method proposed by Kim *et al.*[26] The DQI-I was composed of four major categories, including variety (overall and protein sources; scores 0–20), adequacy (food/nutrient intake required to prevent undernutrition; scores 0–40), moderation (food/nutrient intake quality relative to chronic diseases; scores 0–30) and overall balance (macronutrient ratio and fatty acid composition; scores 0–10). The scores of each component were summarised in four main categories, and the scores of the categories were summed up to obtain the total DQI-I score within the range of 0–100 (zero showing the poorest and 100 showing the highest possible score). Higher DQI-I scores represented the higher quality of the diet with better variety, adequacy, moderation and overall balance.

Socio-economic status

The available socio-economic variables in the HIES included the characteristics of the head of the household (age, gender, education level and occupation status) and household variables (rural/urban, annual income, house area and number of household members). Based on the international standard classification of occupation (ISCO), the SCI occupation status category of the household head includes managers, professionals, technicians/associate professionals, clerical support workers, service/sales workers, skilled agricultural experts, forestry/fishery workers, crafts and related trades workers, plant and machine operators/assemblers, elementary occupations and armed forces. In the present study, the household education level was considered as the mean education level of the adult family members.

Principle component analysis was used to in our study extract the SES variable. Principle component analysis is a simple and potent method of dimensionality reduction, which employs the dependencies between variables for their representation in the lower dimensional form without a significant loss of data[27]. In the current research, the occupation status of the household head, household income, education level and house area were analysed using the principle component analysis to obtain one variable for the SES. In addition, the imputed variables were converted into *Z* scores to produce comparable metrics before performing the principle component analysis. In this regard, one factor with the higher eigenvalue was selected as the SES variable, and the imputed items were loaded at 0·40 or higher on this factor.

Environmental footprint

In the present study, water and carbon footprints were used to assess the environmental dimension of a sustainable diet. A water footprint is defined as the total volume of freshwater that is used to produce the goods and services consumed by an individual or the community. Footprint data for food items are often reported as the water volume in cubic meters per ton (m^3/ton); the water footprint data of Iran are available[28–30]. In the current research, the water footprint data were converted into the water volume in cubic metres per gram (m^3/g).

To calculate the level of carbon dioxide emission during food production, we applied the carbon footprint method, which is a measure of the exclusive total amount of the carbon dioxide emission that is directly and indirectly caused by an activity or is accumulated over the life stages of a product[31]. The required data on the carbon dioxide emissions of each food item were also obtained from the BCFN double pyramid database[32]. For each household, the AME of each food item was multiplied by its water and carbon footprint, and the sum of these values showed the total dietary water and carbon footprint of the households (AME).

Statistical analysis

Similar to the procedure used by Masset *et al.* in France[33] and Wrieden *et al.* in the UK[34], the median of the dietary carbon footprint, dietary water footprint, DQI (all standardised per an adult man) and dietary costs of the households were calculated for each year of the data in our study (2016, 2017 and 2018). In addition, the households were considered to have a more sustainable diet based on the dietary carbon footprint, dietary water footprint, dietary costs lower than the median and DQI higher than the median; the other households were assumed to have a less sustainable diet. The households were also classified based on the SES quartiles, and the share of the food groups in the total energy intake and socio-economic and demographic characteristics was compared in terms of the lower/higher median of the dietary carbon footprint, dietary water footprint, dietary costs, DQI and diet sustainability. For this purpose, a *t*-test was applied for the quantitative variables, and χ^2 was used for the qualitative variables.

Logistic regression was used to calculate the OR of having a more sustainable diet as the dependent variable based on various SES quartiles as the independent variable. In the second model, we adjusted the changing effects of the place of residence (rural/urban), the age of the household head and the number of the household members. In the third model, we adjusted the place of residence (rural/urban), age of the household head, the number of

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the household members and energy intake. In the fourth model, the place of residence (rural/urban), age of the household head, the number of the household members, total energy intake and the share of the food groups in the total energy intake were adjusted as well.

By considering the first SES quartile as the reference, the OR of having a more sustainable diet was determined at a 95 % CI. The mean data of 2016–2018 were also considered in the regression models. Figure 1 shows the share of various food groups in the total energy intake among the SES quartiles to determine the differences in the food group intakes that may lead to differences in the diet's sustainability by SES. Data analysis was performed in SPSS version 22.0 (SPSS Statistics, IBM).

Results

After excluding the households with lower or higher energy intakes than the three standard deviations from the mean energy intake, 100 500 households were selected for the current research. Table 1 shows the mean and median of the dietary carbon footprint, dietary water footprint, dietary costs, DQI, total energy intake, the share of the food groups in the total energy intake of the samples and the households with less and more sustainable diets. Among the studied households, 7·5 % had more sustainable diets. On the other hand, the total energy intake and share of meat, poultry, fish and eggs, legumes and nuts, fats, oils, sugars and sweets in the total energy intake were significantly higher in the households with less sustainable diets compared with those with more sustainable diets. The contribution of bread, cereal, rice, pasta, vegetables, fruits and dairies was also more significant in the households with more sustainable diets.

Table 2 shows the comparison of the socio-economic and demographic variables between the groups with lower and higher dietary carbon footprint, dietary water footprint, dietary costs, DQI and diet sustainability. Although the households with a female head had significantly higher dietary carbon footprint and dietary water footprint and lower dietary costs and DQI, no significant differences were observed between the two groups in terms of diet sustainability.

In terms of the place of residence, the rural households had significantly lower dietary carbon footprint, dietary water footprint, dietary costs and DQI and higher diet sustainability. In addition, the heads of the households with higher dietary carbon footprint, dietary water footprint and DQI and lower dietary costs and diet sustainability were significantly older. The number of the household members was significantly lower in the households with higher dietary carbon footprint, dietary water footprint, DQI, diet sustainability and dietary costs. Also, the households with higher dietary carbon footprint, dietary water footprint, dietary costs and DQI and lower diet sustainability had significantly higher income and house area.

According to the obtained results, the score of adult education level was significantly higher in the households with higher dietary carbon footprint and dietary costs and lower dietary water footprint, DQI and diet sustainability. On the other hand, the households with higher dietary carbon footprint, dietary water footprint, dietary costs and DQI, and lower diet sustainability had a significantly better occupation status and higher SES quartiles.

Our findings demonstrated that energy intake increased with the higher SES. As is shown in Fig. 1, higher SES quartiles compared with the lower quartiles were associated with a more significant share of dairies, meat, poultry, fish, eggs, legumes, nuts and fruits and a smaller share of bread, cereal, rice and pasta in the total energy intake.

Table 3 shows the OR of having a more sustainable diet based on different SES quartiles as the independent variable in the four models. In the first model and without controlling the other variables, the households in the third and fourth SES quartiles were significantly less likely to have a more sustainable diet compared with the first quartile. In the second model, the place of residence,

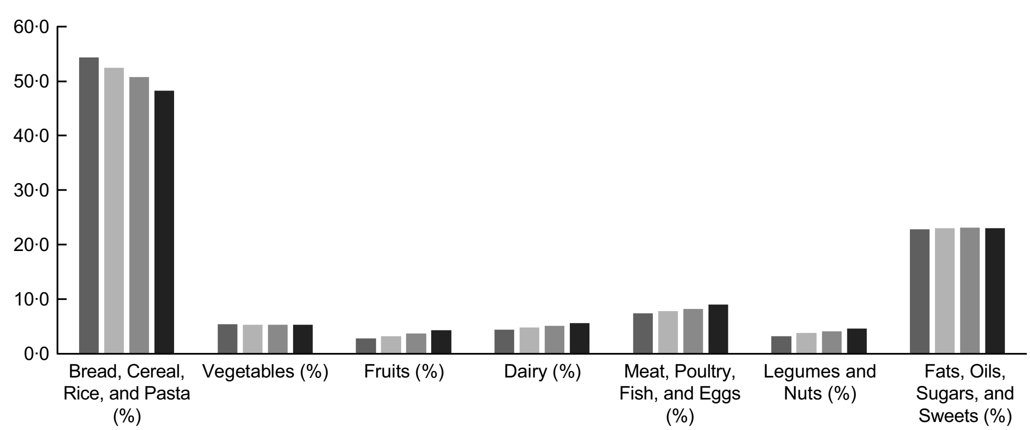

Fig. 1 The share of food groups in total energy intake among different quartiles of socio-economic status (SES). ■, First quartile; ■, second quartile; ■, third quartile; ■, fourth quartile

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Table 1 Characteristics of the whole sample, less sustainable diets and more sustainable diets

	Whole sample (*n* 100 500)			Less sustainable (*n* 92 989)			More sustainable (*n* 7511)		
	Mean	Median	SE	Mean	Median	SE	Mean	Median	SE
Carbon footprint (g CO_2)	2414·0	2121·2	4·2	2477·5	2209·5	4·5	1628·4	1663·3	3·5
2016	2454·4	2163·1	7·1	2519·8	2253·8	7·5	1650·2	1687·8	6·1
2017	2427·9	2124·1	7·2	2494·2	2218·8	7·7	1629·1	1664·4	5·8
2018	2348·6	2066·8	7·5	2406·6	2148·0	7·9	1600·0	1625·2	6·3
Water footprint (m^3)	4·15	3·81	0·01	4·25	3·95	0·01	2·92	2·95	0·01
2016	4·22	3·88	0·01	4·31	4·02	0·01	2·99	3·04	0·01
2017	4·14	3·79	0·01	4·24	3·94	0·01	2·89	2·91	0·01
2018	4·08	3·75	0·01	4·18	3·87	0·01	2·88	2·91	0·01
Daily food cost of household (US dollars), (1 US dollars = 42 105·00 Iranian Rial)	4·501	3·934	0·009	4·648	4·113	0·009	2·686	2·744	0·011
2016	3·868	3·456	0·012	3·993	3·624	0·012	2·336	2·424	0·014
2017	4·34	3·876	0·013	4·485	4·072	0·014	2·600	2·709	0·016
2018	5·461	4·754	0·019	5·634	4·987	0·021	3·239	3·379	0·022
Dietary quality index (score)	70·93	71·24	0·03	70·56	70·49	0·03	75·50	74·80	0·04
2015	70·95	71·22	0·04	70·58	70·49	0·05	75·40	74·72	0·06
2016	71·09	71·45	0·04	70·69	70·66	0·05	75·84	75·20	0·06
2017	70·73	71·01	0·05	70·39	70·29	0·05	75·20	74·45	0·07
Energy (kcal)	2932·1	2717·3	3·5	2997·22	2795·06	3·72	2126·51	2103·08	5·43
Bread, cereal, rice and pasta									
%	51·41	51·76	0·04	50·94	51·21	0·04	57·28	57·75	0·13
Vegetables									
%	5·33	4·86	0·01	5·27	4·81	0·01	6·13	5·54	0·04
Fruits									
%	3·54	2·97	0·01	3·48	2·91	0·01	4·28	3·70	0·03
Dairy									
%	5·00	4·32	0·01	4·99	4·30	0·01	5·13	4·64	0·04
Meat, poultry, fish and eggs									
%	8·14	7·59	0·01	8·15	7·58	0·01	8·00	7·71	0·04
Legumes and nuts									
%	3·96	2·94	0·01	4·01	3·00	0·01	3·32	2·19	0·05
Fats, oils, sugars and sweets									
%	23·04	22·82	0·03	23·58	23·28	0·03	16·35	16·68	0·10

age of the household head and the number of the household members were added to the first model and demonstrated significant, diminishing effects on having a more sustainable diet. Notably, the effects of the SES quartiles remained significant in this model.

In the third model, total energy intake was added to the previous model and exerted a significant, diminishing effect on having a more sustainable diet. In this model, the households in the second quartile (OR = 1·15; (95 % CI 1·07, 1·22)) were more likely to have a more sustainable diet compared with the first quartile, while the OR was less than one in the fourth quartile (OR = 0·66; (95 % CI 0·61, 0·72)). In the fourth model, the share of the food groups in total energy intake was adjusted as well. The share of vegetables and fruits in total energy intake had a significant, increasing effect on having a more sustainable diet. On the other hand, the contribution of dairies, meat, poultry, fish, eggs, fats/oils, sugars and sweets in total energy intake had a significant, diminishing effect on having a more sustainable diet.

Although the OR of having a more sustainable diet was significantly more than one in the second SES quartile, the households in the fourth quartile were less likely to have a sustainable diet compared with those in the first quartile (OR = 0·7; (95 % CI 0·66, 0·74)).

Discussion

According to the results of the present study, the higher SES of the households decreased the possibility of having a more sustainable diet. On the other hand, higher SES quartiles compared with the group with a lower SES were associated with the higher energy intake and consumption of dairy, meat, poultry, fish, eggs, legumes, nuts and fruits and lower consumption of bread, cereal, rice and pasta.

As mentioned earlier, the households with a higher SES had a less sustainable diet in the present study. To the best of our knowledge, the association of the SES and a sustainable diet has not been described in previous studies, and our findings are a novel contribution to the literature in this regard. Only Wrieden *et al.* have reported that families with lower income tend to have a more sustainable diet[21]. Moreover, Vázquez-Rowe *et al.* observed significant correlations between higher income, higher GHGE and a balanced diet in the Lima metropolitan area[35].

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Table 2 Comparison socio-economic and demographic variables between lower and higher groups of carbon footprint, water footprint, cost of diet, diet quality index and sustainability of diet

	Dietary carbon footprint				Dietary water footprint				Dietary cost				Dietary quality index				Sustainability of diet			
	Lower		Higher		Lower		Higher		Lower		Higher		Lower		Higher		Lower		Higher	
Household Head sex (female)	5542	11·0	7184	14·3*	5087	10·1	7639	15·2*	9920	19·7	2806	5·6*	6463	12·9	6263	12·5	11 707	12·6	1019	13·6
Place (rural)	25 188	50·1	20 842	41·5*	23 427	46·6	22 603	45·0*	24 374	49·1	21 374	42·5*	21 668	43·1	24 362	48·5*	42 605	45·7	3524	46·9*
Household Head age (years)	49·6	0·07	51·7	0·07*	49·2	0·06	52·2	0·07*	51·8	0·08	49·6	0·06*	50·5	0·07	50·9	0·07*	50·8	0·05	49·0	0·18*
Number of household member	3·96	0·01	3·19	0·01*	3·99	0·01	3·16	0·01*	3·06	0·01	4·08	0·01*	3·73	0·01	3·41	0·01*	3·59	0·01	3·26	0·01*
Household income (US dollars), (1 US dollars = 42 105·00 Iranian Rial)	5420·113	18·114	7173·991	26·392*	5867·420	19·736	6726·703	25·659*	4449·008	14·566	8144·764	26·591*	5690·661	20·370	6903·503	25·014*	6404·560	17·226	4966·298	38·696*
Adult education score	5·0	0·19	5·4	0·02*	5·2	0·02	5·1	0·02*	4·4	0·02	6·0	0·02*	5·0	0·02	5·4	0·02*	5·2	0·01	5·00	0·01*
House area (m^2)	90·9	0·17	100·2	0·18*	92·6	0·17	98·5	0·18*	85·8	0·16	105·4	0·18*	91·8	0·17	99·4	0·18*	96·2	0·13	88·4	0·40*
Household head occupational category																				
Managers	1147	2·3	2263	4·5	1389	2·8	2021	4·0	767	1·5	2643	5·3	1393	2·8	2017	4·0	3280	3·5	130	1·7
Professionals	5246	10·4	6644	13·2	5505	11·0	6385	12·7	4576	9·1	7314	14·6	5408	10·8	6482	12·9	11 113	12·0	777	10·3
Technicians and associate professionals	2293	4·6	3527	7·0	2641	5·3	3179	6·3	1980	3·9	3840	7·6	2499	5·0	3321	6·6	5500	5·9	320	4·3
Clerical support workers	1159	2·3	1508	3·0	1285	2·6	1382	2·8	1166	2·3	1501	3·0	1188	2·4	1479	2·9	2476	2·7	191	2·5
Services and sales workers	8401	16·7	7800	15·5	8641	17·2	7560	15·0	7778	15·5	8423	16·8	8101	16·1	8100	16·1	14 915	16·0	1286	17·1
Skilled agricultural, forestry and fishery workers	5751	11·4	7054	14·0	5426	10·8	7379	14·7	5305	10·6	7500	14·9	6296	12·5	6509	13·0	12 048	13·0	757	10·1
Craft and related trades workers	8991	17·9	9053	18·0	8875	17·7	9169	18·2	10 251	20·4	7793	15·5	9125	18·2	8919	17·7	16 654	17·9	1390	18·5
Plant and machine operators and assemblers	5670	11·3	5197	10·3	5707	11·4	5160	10·3	5567	11·1	5300	10·5	5326	10·6	5541	11·0	9966	10·7	901	12·0
Elementary occupations	11 415	22·7	6905	13·7	10 574	21·0	7746	15·4	12 687	25·3	5633	11·2	10 719	21·3	7601	15·1	16 590	17·8	1730	23·0
Armed forces occupations	176	0·4	300	0·6*	206	0·4	270	0·5*	168	0·3	308	0·6*	196	0·4	280	0·6*	447	0·5	29	0·4*
Socio-economic class																				
First quartile	14 333	28·5	9977	19·9	12 942	25·8	11 368	22·6	19 083	38·0	5227	10·4	14 341	28·5	9969	19·8	22 051	23·7	2259	30·1
Second quartile	13 964	27·8	11 406	22·7	13 605	27·1	11 765	23·4	14 010	27·9	11 360	22·6	13 162	26·2	12 208	24·3	23 125	24·9	2245	29·9
Third quartile	12 289	24·5	13 201	266·3	12 696	25·3	12 794	25·5	10 583	21·1	14 907	29·7	12 180	24·2	13 310	26·5	23 689	25·5	1801	24·0
Fourth quartile	9659	19·2	15 665	31·2*	11 002	22·0	14 322	28·5*	6563	13·1	18 761	37·3*	10 564	21·0	14 760	29·4*	24 119	25·9	1205	16·0*

*Difference between two groups is significant ($P < 0{\cdot}001$).

Table 3 Binary logistic regression between having a 'more sustainable diet' as a dependent variable and socio-economic status (SES) quartiles of households as an independent variable

	Model 1		Model 2		Model 3		Model 4	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
SES quartiles								
First quartile	1		1		1		1	
Second quartile	0·95	0·89, 1·01	0·98	0·92, 1·05	1·15	1·07, 1·22	1·21	1·13, 1·30
Third quartile	0·74	0·70, 0·79	0·79	0·74, 0·85	0·94	0·88, 1·01	0·99	0·92, 1·07
Fourth quartile	0·49	0·45, 0·52	0·54	0·50, 0·58	0·66	0·61, 0·72	0·70	0·64, 0·76
Place (rural = 0)			0·91	0·87, 0·96	0·82	0·78, 0·86	0·84	0·79, 0·88
Household head age (years)			0·987	0·985, 0·988	0·988	0·986, 0·990	0·985	0·983, 0·987
Number of household member			0·83	0·82, 0·85	0·67	0·65, 0·68	0·69	0·67, 0·70
Energy (kcal)					0·999	0·998, 0·999	0·999	0·998, 0·999
Bread, cereal, rice and pasta							1·01	0·98, 1·02
Vegetables							1·04	1·02, 1·06
Fruits							1·09	1·07, 1·11
Dairy							0·95	0·93, 0·97
Meat, poultry, fish and eggs							0·94	0·93, 0·96
Legumes and nuts							1·00	0·98, 1·02
Fats, oils, sugars and sweets							0·94	0·92, 0·96

In another research, Vieux *et al.* demonstrated positive, significant associations between dietary GHGE and the excessive consumption of energy (regardless of food source), fats (saturated), animal protein, alcohol and less vegetable protein and carbohydrates in a typical sample population of French adults[36]. In India, a higher socio-demographic status has been significantly associated with dietary blue water footprint considering the type of the consumed portion and food[37]. According to the results of the present study, higher SES was associated with the higher consumption rate of energy and animal-based foods, which would, in turn, lead to a less sustainable diet.

According to the literature, decreased energy intake and energy density are important indicators of a more sustainable diet[36]. Changes in dietary patterns towards higher total energy intake and animal-based food consumption increase the dietary water footprint and GHGEs. In addition, higher SES and urban areas have been significantly associated with the higher consumption of protein and animal-based foods[38]. More sustainable diets are accommodated with the highest amount of plant-based foods, especially starchy foods[33,39].

Due to the impact of globalisation, socio-economic changes and urbanisation, significant lifestyle changes are observed in middle-income countries, which is indicative of nutrition transition; the Middle East region is also affected by this transition. Some of the changes in this process include dietary shifts from traditional to Western diets (high-fat, high-sugar, industrial foods), which may reduce the overall quality of the diet[40]. In recent decades, the transitions in global dietary patterns within food sources, processing methods and allotment have led to the dramatic growth of processed food and beverage consumption[41].

Nutrition transition refers to a wide range of demographic and socio-economic changes that lead to rapid shifts in dietary patterns and physical activity levels in major parts of the world, especially in low-income countries[42]. Despite the decline in population growth, population development is constantly on the rise, and such a demographic change alters the food consumption of individuals. Urbanisation is another aspect of the global transition, which is as intense in most developing countries as the Middle East where the urban population is estimated to be over 50 %. Changes in the rural to the urban lifestyle are characterised by changes in eating habits and patterns of physical activity. Developing countries have come to substitute their old-fashioned diets (rich in grains and fibres) with diets containing significant amounts of energetic sweeteners, fats, meat and dairies[43]. Similarly, the nutrition transition in Iran as a middle-income country has been occurring rapidly due to the changes in the per capita income and urbanisation[44]. Although the per capita gross domestic product in Iran has fluctuated noticeably in recent years, it increased from 1080·5 US dollars in 1990 to 5593 US dollars in 2017[45]. The high rate of rural–urban migration, along with rapid socio-economic changes, has caused the urbanisation trend to accelerate in Iran in recent decades[46]. It seems that the individuals with a higher SES in Iran have experienced this dietary change faster through the higher energy intake and animal-based food consumption, as well as the subsequently less sustainable diets, compared with the populations with a lower SES.

Without proper policymaking and interventions to promote nutritional behaviours, nutrition transition in developing countries such as Iran leads to a less sustainable diet. Therefore, effective and efficient policies and interventions are needed to promote healthy and sustainable eating behaviours. These policies and interventions can be including banning unhealthy food advertisements, public information campaigns, nutritional labelling, nutritional information on menus, fiscal measures (e.g. taxes

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or subsidies) and regulation of meals in schools and workplaces. Also, develop and implement nutrition-related standards, healthy and sustainable eating guidelines and agricultural policy should be considered[47,48].

The main strength of the present study was its novelty to investigate the association between the SES of the households with a more sustainable diet. Furthermore, the sample size was large and on a national level, while no specific data were available on the carbon footprint of food in Iran. However, the GHGE data were obtained from the global data, which is considered the main limitation of our study. In addition, the food expenditure data of the households were used for food consumption calculation, despite the AME units and FAO estimates of the waste percentages used to calculate the real consumption rates of the individuals, underestimation and overestimation are possible.

Conclusion

According to the results, the households with a higher SES had less sustainable diets compared with those with a lower SES. Moreover, the better economic and social status of the households with a higher SES increased the consumption of energy and animal-based food, which in turn influenced water footprint, carbon footprint and dietary costs, thereby decreasing diet sustainability. As a consequence of economic development and social changes, Iran has recently experienced a rapid nutrition transition. By considering the populations with a higher SES in Iran, the impact of nutrition transition could be determined more accurately on the groups whose diets commonly contain higher energy and animal-based foods. It also seems that nutrition transition in developing countries such as Iran may lead to dietary unsustainability as these countries have mostly undergone dietary changes without proper policymaking and interventions to promote nutritional behaviours.

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