Health-Expenditure Burden and Below-Median Food Consumption: A Panel Study of Iranian Households

Abstract

Aims: This study examined the association between household health-expenditure burden and below-median food consumption across major food groups and protein-related subgroups in Iran. **Methods:** This analytical–explanatory observational study analyzed three waves (2022–2024) of Iran's Household Expenditure and Income Survey, comprising 5,288 households (15,864 household-year observations). Consumption was adjusted for adult male equivalents and assessed against 2022 food-group medians. Correlated random-effects ordered and binary logit models examined five main food groups and five disaggregated subgroups. **Findings:** Relative to a health-expenditure share below 10% of income, a share of at least 40% was associated with higher odds of a greater number of food groups with below-median consumption (β=0.220; p=0.007). The probabilities were higher for staple carbohydrates (4.28% points; 95% CI 0.93–7.64; p=0.013) and animal-source protein (3.34% points; 95% CI 0.19–6.49; p=0.038). The combined pulses, nuts and seeds association was less certain (3.49% points; 95% CI −0.09–7.07; p=0.056). Disaggregated models identified positive associations for pulses (4.44% points; 95% CI 0.90–8.00; p=0.013), red meat (4.00% points; 95% CI 0.70–7.30; p=0.018), and poultry (3.81% points; 95% CI 0.70–7.00; p=0.018), but not nuts or eggs. Intermediate-burden categories displayed different, sometimes opposite, associations. **Conclusion:** Health-related financial pressure may coincide with changes in household food-consumption patterns. Although these associations do not establish causality or nutritional inadequacy, they underscore the importance of strengthening financial protection against healthcare costs and integrating food-security considerations into health-promotion and social-protection policies.

Keywords: Health Expenditures, Food Insecurity, Iran, Logit Models

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Introduction

Catastrophic health expenditure, commonly defined as out-of-pocket healthcare spending that absorbs a substantial share of household resources, can force households to choose between obtaining necessary healthcare and meeting other basic needs. Food consumption is often one of the areas in which households adjust their spending. Reductions in food consumption or dietary quality may create a damaging feedback loop, as food insecurity is associated with poorer health, greater healthcare use, and higher subsequent medical expenditures (1,2). This issue is particularly notable in Iran, where the average annual inflation rate for food items over the past decade was 46.4%, compared with 36.7% for overall inflation (Statistical Center of Iran, July 2026). Against this inflationary backdrop, food insecurity remains a major concern, with separate estimates of 49% and 55.9% suggesting that approximately half of the population is affected (3,4). More recent evidence from indicated that 46.1% of households had daily per-capita calorie consumption below 2,100 kcal in 2023 (5). These concerns underscore the importance of examining how healthcare-related financial burdens are associated with household food-consumption patterns, a relationship increasingly explored in the existing literature.

Empirical evidence on the direct relationship between health spending and food insecurity remains limited. Nielsen et al. by using data from more than 16,000 families in the United States, found that higher out-of-pocket medical expenditures increased the probability of food insecurity, whereas there was no evidence for the reverse relationship (6). More recent longitudinal studies have reached similar results. Pak reported that catastrophic health expenditures were associated with higher odds of food insecurity among older cancer survivors in US (7). Likewise in US, Caniglia & Chavez found that households with children experiencing substantial out-of-pocket medical burdens in one year were more likely to become food insecure in the following year (8). A broader body of literature generally has identified a crowding-out mechanism through which rising medical costs reduce spending on food and other essential goods. In Mongolia, Batbold et al. found that out-of-pocket health expenditures crowded out several consumption categories, with the largest reduction in food spending occurring among the lowest-income households and those without social health insurance (9). Qiu & Zhang similarly showed that health shocks in China increased the share of medical expenditure while reducing allocations to food and education, particularly among financially vulnerable households (10). Evidence from Bangladesh also indicates that non-communicable-disease-related medical spending disproportionately reduced expenditure on food, especially protein-rich products, with stronger effects among low-income households (11). The study most closely related to food-group composition is Singh et al., who found that Indian households affected by major illness tended to protect staple foods such as cereals and pulses while reducing fruits, dairy products, vegetables, meat, and eggs (12).

The reverse relationship suggests that food insecurity and health spending may form a reinforcing cycle. Studies from the United States and Canada have consistently associated food insecurity with greater healthcare utilization and expenditure (1,13–15). Tarasuk et al. for example, documented a clear severity gradient, with healthcare costs rising progressively from marginal to severe food insecurity (15). Longitudinal evidence from Korea also linked severe food insecurity to greater outpatient and inpatient utilization, although moderate food insecurity was associated with lower personal health spending, possibly reflecting constrained access to care (16). Similarly, Johnson et al. provided evidence of bidirectionality: food insecurity predicted higher subsequent healthcare expenditures, while greater healthcare expenditures modestly increased the likelihood of later food insecurity (2). While these studies highlight the reverse relationship, less is known about how healthcare expenditure burdens are associated with household food consumption.

Together, these findings indicate that health-related financial pressure can undermine households' ability to maintain adequate food access and may create a reinforcing cycle between food insecurity, poor health, and higher health expenditures. However, previous research has been limited in several important respects. Direct evidence on the effect of catastrophic health expenditure on food insecurity has largely focused on the United States and on specific population groups, while studies in developing countries have generally examined changes in aggregate household expenditure rather than the risk of inadequate food consumption. Although Singh et al. (12) considered changes across individual food items, their analysis was based on a cross-sectional, hospital-based sample and did not estimate how catastrophic health expenditure affects the probability of consumption shortfalls across nutritionally distinct food groups. Moreover, little attention has been paid to whether these effects differ systematically across food categories in highly

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inflationary settings such as Iran. Despite the continued erosion of Iranian households' purchasing power, the extent to which catastrophic health expenditure increases the likelihood of below-median food consumption across major food groups, and which food groups are most vulnerable to such financial shocks, remains largely unexplored.

This study contributes to the literature in three ways. First, it moves beyond aggregate food expenditure and conventional food-insecurity measures by examining both the number of food groups with below-median consumption and the consumption patterns of five distinct food groups. Second, it disaggregates broad protein-related categories into pulses, nuts, red meat, poultry, and eggs, allowing a more detailed examination of differences among foods with distinct economic and nutritional characteristics. Third, using three waves of Iranian household panel data, it applies the correlated random-effects approach to account for persistent household heterogeneity while examining contemporaneous associations between health-expenditure burden and food consumption. The analysis uses 15,864 household-year observations from the Household Expenditure and Income Survey (HEIS) covering 2022–2024. Two hypotheses are examined: (H1) higher health-expenditure burden is associated with a greater number of food groups exhibiting below-median consumption; and (H2) the associations between health-expenditure burden and below-median consumption differ across food groups and protein-related subgroups.

Method

Data and variable construction

The data used in this study were obtained from the Iranian Household Expenditure and Income Survey (HEIS), which is conducted annually and released by the Statistical Center of Iran. The Iranian HEIS employs a rotating panel design, with some households followed for up to three consecutive years. The HEIS included 37,951, 37,883, and 37,505 households in 2022 (Iranian solar year 1401), 2023 (1402), and 2024 (1403), respectively. Among these, 6,617 households were observed in all three years, yielding 19,851 household-year observations. Following data cleaning and outlier removal, the final balanced panel comprised 5,288 households and 15,864 household-year observations. Data cleaning and preparation were conducted using Stata 15.

Table 1: Descriptive statistics

Panel A. Continuous and count variables

Variable	Description	Mean	Std. Dev.	Min	Max
Staple carbohydrates	Cereals, starchy roots and tubers consumption in last month per AME in household (kg)	18.436	7.996	4	57.43
Pulses, nuts and seeds	Pulses, nuts and seeds consumption in last month per AMEq in household (kg)	0.653	0.709	0	5.246
Animal-source protein	Meat, fish and eggs consumption in last month per AMEq in household (kg)	3.268	1.898	0.156	15.318
Dairy	Milk and dairy consumption in last month per AMEq in household (kg)	2.623	2.183	0	16.009
Vegetables and Fruits	Vegetables and Fruits consumption in last month per AME in household (kg)	10.366	6.024	0.559	41.213
Pulses	Pulses consumption in last month per AMEq in household (kg)	0.519	0.61	0	5.246
Nuts	Nuts consumption in last month per AMEq in household (kg)	0.134	0.311	0	4.268
Red meat	Red meat consumption in last month per AMEq in household (kg)	0.515	0.871	0	12.563

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Poultry meat	Vegetables and Fruits consumption in last month per AMEq in household (kg)	1.907	1.29	0	12.874
Egg	Egg consumption in last month per AMEq in household (kg)	0.668	0.399	0	8.145
$AMEq_h$	Adult Male Equivalent of household h	2.885	1.156	0.75	12.473
Income	Real household last month income based on minimum wage in year 2022 (40 million Iranian Rials)	5.809	10.711	0	304.622
Age	head of the household age	51.943	14.476	18	99
Insured	Number of health-insured individuals in the household	1.89	1.965	0	13
Age under 5	Number of individuals under 5 years of age in the household	0.235	0.506	0	4
Age over 65	Number of individuals over 65 years of age in the household	0.304	0.599	0	3
Family size	Number of household members	3.499	1.399	1	16

Panel B. Categorical variables

Variable	Description	Category	Frequency	Percentage	Cumulative Percent
Health share	Health expenditure share in household income in last month.	<10%	13042	82.21	82.21
		10% to <20%	1163	7.33	89.54
		20% to <40%	764	4.82	94.36
		≥40%	895	5.64	100
Marital status	Martial status of head of household	Single	2331	14.69	14.69
		Married	13533	85.31	100
Sex	Gender of the head of the household	Woman	2044	12.89	12.89
		Man	13819	87.11	100
Residence	Urban or rural residence of the household	Urban	7770	48.98	48.98
		Rural	8094	51.02	100
Season	Household statistics preparation season	Spring	4049	25.52	73.51
		Summer	3628	22.87	22.87
		Autumn	3985	25.12	47.99
		Winter	4202	26.49	100

Source: Research findings based on HEIS data

Health expenditure includes durable medical goods purchased during the preceding 12 months and non-durable medical goods and healthcare services purchased during the preceding month. These expenditures cover pharmaceutical and medical products, therapeutic devices and equipment, outpatient medical, dental, and paramedical services, hospital services, and addiction treatment services. The number of households with a health-expenditure share below 10% increased from 4,335 in 2022 to 4,370 in 2024, while those in the 10–<20% category declined from 421 to 360. The 20–<40% category remained relatively stable (252 to 251 households), whereas the ≥40% category increased from 280 to 307 households.

Food consumption measures include food obtained through purchases, own production, in-kind compensation for public or private services, agricultural and non-agricultural business activities, and

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gifts. Food items were aggregated into five nutrition-sensitive food groups based on the 19-group classification developed by Balcerzak et al. and published by FAO and WHO (17):

- Staple carbohydrates: cereals, starchy roots, and tubers, such as rice, wheat, bread, pasta, and potatoes. This group represents access to staple sources of energy and carbohydrates.
- Pulses, nuts and seeds: such as beans, lentils, chickpeas, soy products, nuts, and seeds. This group represents access to plant-based protein and nutrient-dense plant foods.
- Animal-source protein: all types of meat, fish, and eggs. This group represents access to animal-source protein and micronutrient-rich foods.
- Dairy: milk, yogurt, and cheese. Ice cream, cream, and powdered dairy products were excluded. This group represents access to major sources of calcium and high-quality protein.
- Vegetables and Fruits: such as leafy greens, tomatoes, cucumbers, carrots, other vegetables, fresh fruits, citrus fruits, and dried fruits. This group represents access to micronutrient-rich fruits and vegetables.

Household food consumption was converted into consumption per adult male equivalent (AMEq) to account for differences in energy requirements among household members by age and sex (18). For each member k of household h, the estimated energy requirement (EER_k) was obtained from the FAO, WHO and UNU reference tables (19), using Tables 4.5 and 4.6 for children and adolescents under moderate physical activity and Tables 5.4–5.9 for adults, with a reference adult male energy requirement of 2,800 kcal/day corresponding to a PAL of 1.75. The total number of adult male equivalents in each household was then calculated as follows:

$$AMEq_h = \sum_{k=1}^{nh} \frac{EER_{hk}}{EER_{ref}}$$

Where nh denotes the number of members in household h, and EER_{ref} represents the daily energy requirement of the reference adult male, set at 2,800 kcal/day. Household consumption of each food group was subsequently divided by AME_h to obtain consumption per adult male equivalent:

$$FC_{gh}^{AMEq} = \frac{FC_{gh}}{AMEq_h}$$

Where FC_{gh} denotes the total consumption of food group g by household h. Following adjustment for household composition, food-group below-median consumption were defined using the median of the corresponding AMEq-adjusted consumption distribution in the 2022 baseline sample. Among the disaggregated protein-related subgroups, the median nut consumption per AMEq was zero; therefore, the 75th percentile of the 2022 baseline distribution was used as the reference threshold for this subgroup. The baseline medians were 16.8 kg per month for staple carbohydrates, 0.5 kg for pulses, nuts, and seeds, 2.8 kg for animal-source protein, 2.0 kg for dairy products, and 9.0 kg for vegetables and fruits. Also, 0.37 kg for pulses 0.13 kg for nuts, 0.34 kg for red meat, 1.57 kg for Poultry meat, 0.58 kg for egg. These thresholds were held constant across all three survey waves. A household was classified as experiencing a below-median consumption in food group g when its monthly consumption per AMEq fell below the corresponding baseline. The five food-group-specific binary indicators were subsequently summed to construct an overall below-median food consumption index ranging from zero to five, with higher values indicating shortfalls across a larger number of food groups. Because the thresholds were derived from the sample distribution rather than from externally defined nutritional requirements, the resulting indicators measure relative consumption shortfalls and should not be interpreted as direct measures of nutritional inadequacy.

Model specification

Two complementary modeling strategies were employed to examine the association between household health-expenditure burden and below-median food consumption. First, the number of main food groups with below-median consumption (0–5) was modeled using panel ordered logit, which accommodates ordinal outcomes without assuming equal distances between categories (20). Second, panel binary logit models assessed below-threshold consumption across five main food groups and five disaggregated subgroups (21). Binary-response specifications are well established in the food-security literature (6,22,23). The same set of explanatory variables was included across all 11 models to facilitate comparability of the estimates.

Control variables were selected a priori based on their conceptual relevance and established associations with household food consumption. Real household income was included to reflect

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purchasing power, while family size accounted for resource allocation and household economies of scale beyond adult male equivalent adjustments. Marital status captured household structure, residence reflected urban–rural differences in food access, and seasonal indicators accounted for variations in food availability and consumption. Previous studies have identified household economic status, marital status, and family size as correlates of food insecurity in Iran (24,25). alongside residential differences and seasonal variations in food consumption (26,27).

Let $Y_{it} \in 0, \dots, 5$ denote the number of food groups in which household i experienced below-median consumption in period t. The ordered logit model was specified as:

$$Pr(Y_{it} \le j \mid \eta_{it}) = \Lambda(\kappa_j - \eta_{it}), \qquad j = 0, \dots, 4 \tag{1}$$

where $\Lambda(z) = \frac{exp(z)}{1+exp(z)}$

where $\Lambda(z)$ is the logistic cumulative distribution function and κ_j denotes the threshold parameters. The linear predictor was defined as:

$$\begin{aligned}\eta_{it} = {} & \beta_1 H_{1it} + \beta_2 H_{2it} + \beta_3 H_{3it} + \gamma_1 Income_{it} + \gamma_2 Married_{it} + \gamma_3 Residence_{it} + \gamma_4 Age_{it} \\ & + \gamma_5 Sex_{it} + \gamma_6 Under\ 5_{it} + \gamma_7 Over\ 65_{it} + \gamma_8 Insured_{it} + \gamma_9 Fsize_{it} \\ & + \gamma_{10} Year_t + \delta_1 Autumn_{it} + \delta_2 Spring_{it} + \delta_3 Winter_{it} + \alpha_i + u_i\end{aligned} \tag{2}$$

where H_{1it} for a health-expenditure share of 10% to less than 20%, H_{2it} for a share of 20% to less than 40%, and H_{3it} for a share of 40% or more. Households with a health-expenditure share below 10% constituted the reference category.

For food-group estimations, Let S_{git} equal 1 when household i experienced a below-median consumption in food group g during period t, and zero otherwise. The corresponding probability was specified as:

$$Pr(S_{git} = 1 \mid \eta_{git}) = \Lambda(\eta_{git}), \qquad g = 1, \dots, 5 \tag{3}$$

with the following group-specific linear predictor:

$$\begin{aligned}\eta_{git} = {} & \beta_{1g} H_{1it} + \beta_{2g} H_{2it} + \beta_{3g} H_{3it} + \gamma_{1g} Income_{it} + \gamma_{2g} Married_{it} + \gamma_{3g} Residence_{it} \\ & + \gamma_{4g} Age_{it} + \gamma_{5g} Sex_{it} + \gamma_{6g} Under\ 5_{it} + \gamma_{7g} Over\ 65_{it} + \gamma_{8g} Insured_{it} \\ & + +\gamma_9 Fsize_{it} + \gamma_{10} Year_t + \delta_{1g} Autumn_{it} + \delta_{2g} Spring_{it} + \delta_{3g} Winter_{it} + \alpha_i \\ & + u_{ig}\end{aligned} \tag{4}$$

The residual household effect, u_i was assumed to be uncorrelated with the observed explanatory variables after conditioning on the household means.

Conventional random-effects estimation assumes that household-specific effects are uncorrelated with the observed explanatory variables. This assumption may be restrictive because persistent household characteristics, including health needs, preferences, and resource-management capacity, may simultaneously influence health expenditure and food consumption. The correlated random-effects approach proposed by Mundlak (28) was therefore employed to allow the household-specific effects to be correlated with the observed regressors. The contemporaneous association between health-expenditure burden and food-consumption outcomes was modeled using three categorical indicators. The Mundlak component additionally included the household-specific mean of the underlying continuous health-expenditure-to-income ratio:

$$\begin{aligned}\alpha_i = {} & \theta_1 \overline{HR_i} + \pi_1 \overline{Income_i} + \pi_2 \overline{Married_i} + \pi_3 \overline{Fsize_i} + \pi_4 \overline{Insured_i} + \pi_5 \overline{Under\ 5_i} \\ & + \pi_6 \overline{Over_i}\end{aligned} \tag{5}$$

where HR_i denotes the household-specific mean of the health-expenditure ratio over the observed periods. The remaining barred variables similarly denote household means over time.

The use of HR_i captures persistent differences in households' average health-expenditure burden while retaining the categorical specification of the contemporaneous health-expenditure effect. Residence was not included among the Mundlak means because it exhibited no meaningful within-household variation, while the season indicators were treated as survey-timing controls. The inclusion of the household means permits unobserved household heterogeneity to be correlated with the observed covariates while retaining both within- and between-household information (28,29). Joint Wald tests rejected the null hypothesis that the household-mean coefficients were jointly equal to zero, supporting the correlated random-effects specification. Robust standard errors were clustered at the household level.

Results

Table 2 presents the estimates from the correlated random-effects ordered logit model for the overall below-median food consumption index. The model was jointly statistically significant ($Wald\chi 2 =$ 1,303.23, $p < 0.001$). Compared with households with a health-expenditure share below 10%, the

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coefficient for the 10–<20% category was statistically insignificant. The 20–<40% category was negatively associated with the below-median index ($\beta = -0.219, p = 0.008$), whereas the ≥40% category showed a positive association ($\beta = 0.220, p = 0.007$).

Table 2. Correlated random-effects ordered logit estimates

	Coef.	St.Err.	t-value	p-value	[95% Conf.	interval]	Sig
Health share:							
10% - 20%	-0.079	0.073	-1.09	0.275	-0.222	0.063	
20% - 40%	-0.219	0.083	-2.64	0.008	-0.383	-0.056	***
40%<	0.22	0.082	2.68	0.007	0.059	0.381	***
Income	-0.021	0.003	-6.8	0	-0.027	-0.015	***
Married	-0.29	0.166	-1.74	0.081	-0.616	0.036	*
Residence:							
Urban	-0.124	0.054	-2.3	0.022	-0.23	-0.018	**
Family size	0.678	0.042	16.05	0	0.595	0.761	***
Season:							
Autumn	0.275	0.074	3.71	0	0.13	0.421	***
Spring	0.23	0.074	3.09	0.002	0.084	0.376	***
Winter	0.345	0.075	4.62	0	0.198	0.491	***
Insured	-0.003	0.018	-0.16	0.873	-0.038	0.032	
Sex	-0.011	0.127	-0.09	0.931	-0.259	0.237	
Age	-0.01	0.003	-3.84	0	-0.016	-0.005	***
Under 5	-0.287	0.074	-3.89	0	-0.432	-0.143	***
Over 65	-0.006	0.086	-0.07	0.944	-0.175	0.163	
$\overline{HR}$	0.017	0.013	1.28	0.201	-0.009	0.043	
$\overline{Income}$	-0.017	0.004	-4.05	0	-0.026	-0.009	***
$\overline{Married}$	-0.035	0.175	-0.2	0.842	-0.378	0.308	
$\overline{Family\ Size}$	-0.028	0.049	-0.57	0.568	-0.123	0.067	
$\overline{Insured}$	0.054	0.025	2.17	0.03	0.005	0.104	**
$\overline{Under\ 5}$	-0.27	0.098	-2.76	0.006	-0.463	-0.078	***
$\overline{Over\ 65}$	-0.088	0.096	-0.93	0.355	-0.276	0.099	
Year	-0.033	0.019	-1.76	0.078	-0.07	0.004	*
Mean dependent var	2.446			SD dependent var		1.495	
Number of obs	15864			Chi-square		1303.238	
Prob. > χ^2	0			Akaike crit. (AIC)		50843.449	

*** p<.01, ** p<.05, * p<.1

Source: Research findings

Among the covariates, income, urban residence, age, and the number of children under five showed negative and statistically significant coefficients, while household size and the three seasonal indicators showed positive and significant associations. Among the household-mean variables, income and the number of children under five were negatively associated with the below-median index, whereas the number of insured members showed a positive association.

The tetrachoric correlations among the five binary food-consumption indicators were all positive, ranging from 0.119 to 0.557. Most correlations were weak, while moderate associations were observed among animal-source protein, dairy, and vegetables and fruits.

Table 3 reports the average marginal effects (AME) of the health-expenditure share on the probabilities of experiencing zero to five below-median food group consumption. The marginal effects of the 10–<20% category were insignificant at all outcome levels. For the 20–<40% category, the probabilities of experiencing zero, one, and two below-medians were higher by 1.6, 1.5, and 0.4 percentage points, respectively, while the probabilities of experiencing three, four, and five below-medians were lower by 0.7, 1.4, and 1.4 percentage points, respectively. For households with a health-expenditure share of 40% or higher, the estimated probabilities of experiencing zero, one, and two food-group shortfalls were lower by 1.5, 1.5, and 0.5 percentage points, respectively. The corresponding probabilities of experiencing three, four, and five below-median were higher by 0.5, 1.4, and 1.5 percentage points, respectively. All six marginal effects for the ≥40% category were statistically significant at the 5% level or better, with five significant at the 1% level.

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Table 3. Average marginal effects of health-expenditure share on the probability of each count of food groups with below-median consumption

Health-expenditure share	No shortfalls	1 shortfall	2 shortfalls	3 shortfalls	4 shortfalls	5 shortfalls
10% – 20%	0.006	0.005	0.002	-0.002	-0.005	-0.005
20% – 40%	0.016**	0.015***	0.004***	-0.007**	-0.014***	-0.014***
40%≤	-0.015***	-0.015***	-0.005**	0.005***	0.014***	0.015***

Source: Research findings

Table 4 reports the average marginal effects from the correlated random-effects binary logit models for the five main food groups. All five models were jointly statistically significant (Wald χ^2 ranging from 170.04 to 891.18, p<0.001).

Compared with the reference category (health-expenditure share below 10% of household income), the 10–20% category was associated with a 3.33-percentage-point lower probability of a dairy below-median consumption (AME=−0.0333, p<0.05), while the estimates for the other food groups were not statistically significant. For the 20–40% category, statistically significant negative marginal effects were observed for animal-source protein (AME=−0.0341, p<0.05), dairy (AME=−0.0399, p<0.05), and vegetables and fruits (AME=−0.0403, p<0.05). For households with a health-expenditure share above 40%, positive marginal effects were observed for staple carbohydrates (AME=0.0428, p<0.05), pulses, nuts and seeds (AME=0.0349, p<0.10), and animal-source protein (AME=0.0334, p<0.05). The estimates for dairy and vegetables and fruits were not statistically significant in this category.

Table 4. Average marginal effects from the food-group-specific binary logit models

	Staple carbohydrates		**Pulses, nuts and seeds**		**Animal-source protein**		**Dairy**		**Vegetables and Fruits**	
	dy/dx	**sig**	**dy/dx**	**sig**	**dy/dx**	**sig**	**dy/dx**	**sig**	**dy/dx**	**sig**
Baseline	0.4924	***	0.4757	***	0.4871	***	0.4981	***	0.4964	***
Health share:										
10% - 20%	−0.0070		0.0164		−0.0223		−0.0333	**	−0.0154	
20% - 40%	−0.0143		0.0069		−0.0341	**	−0.0399	**	−0.0403	**
40%<	0.0428	**	0.0349	*	0.0334	**	0.0069		0.0197	
Income	−0.0009		−0.0020	***	−0.0043	***	−0.0029	***	−0.0026	***
Married	−0.0149		−0.0642	*	0.0579	*	−0.0355		−0.0950	***
Residence:										
Urban	0.032	***	0.0051		−0.0340	***	−0.0187	*	−0.0536	***
Family size	0.0735	***	0.0139	*	0.1194	***	0.0712	***	0.1014	***
Season:										
Autumn	−0.0068		−0.0399	***	0.0035		0.0351	**	0.1769	***
Spring	0.0325	**	0.0295	**	0.0219		−0.0224		0.0798	***
Winter	0.052	***	−0.0646	***	−0.0095		0.0105		0.2144	***
Insured	0.0032		0.0041		0.0021		−0.0084	**	−0.0004	
Sex	0.0704	***	−0.0292		−0.0250		−0.0215		−0.0020	

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Age	−0.0013	**	−0.0002		−0.0014	***	−0.0020	***	−0.0011	**
Under 5	−0.0302	**	0.0302	*	−0.0516	***	−0.0708	***	−0.0383	***
Over 65	0.0119		−0.0159		−0.0007		−0.0063		0.0099	
$\overline{HR}$	0.0003		−0.0001		0.0096	**	0.0019		0.0018	
$\overline{Income}$	0.0017	*	0.0002		−0.0025	***	−0.0049	***	−0.0055	***
$\overline{Married}$	−0.0336		0.0019		−0.0329		−0.0163		0.0366	
$\overline{Family\ Size}$	0.0056		0.0186	**	−0.0153		0.0012		−0.0090	
$\overline{Insured}$	−0.0206	***	0.0018		0.0016		0.0269	***	0.0232	***
$\overline{Under\ 5}$	−0.0481	**	−0.0539	***	−0.0259		−0.0275		−0.0097	
$\overline{Over\ 65}$	−0.0529	***	0.0318	*	−0.0219		−0.0010		−0.0060	
Year	0.0074	*	−0.0024		−0.0257	***	0.0018		0.0059	
Wald χ^2	507.89		170.04		860.69		533.95		891.18	
Prob. > χ^2	0		0		0		0		0	
Log pseudolikelihood	−9744.3352		−10469.9080		−9281.1245		−9783.6684		−9069.2464	
ρ	0.4855		0.3278		0.5109		0.4565		0.5479	

**** p<.01, ** p<.05, * p<.1*

Source: Research findings

To further examine the food-group-specific associations, additional correlated random-effects binary logit models were estimated for the disaggregated food categories. Table 5 presents the corresponding average marginal effects. All five models were jointly statistically significant (Wald χ^2 ranging from 77.42 to 976.50, p<0.001).

Table 5. Average marginal effects from the protein group-specific binary logit models

	Pulses		**Nuts**		**Red Meat**		**Poultry meat**		**Egg**	
	dy/dx	**sig**	**dy/dx**	**sig**	**dy/dx**	**sig**	**dy/dx**	**sig**	**dy/dx**	**sig**
Baseline	**0.4931**	***	**0.7315**	***	**0.5326**	***	**0.4582**	***	**0.4752**	***
Health share:										
10% - 20%	0.0092		0.0310	**	-0.0266	*	-0.0021		-0.0541	***
20% - 40%	0.0064		0.0336	**	0.0105		-0.0111		-0.0100	
40%<	0.0444	**	0.0261		0.0400	**	0.0381	**	-0.0045	
Income	-0.0009		-0.0018	***	-0.0043	***	-0.0016	***	-0.0017	***
Married	-0.0887	**	0.0414		0.0028		-0.0071		-0.0114	
Residence:										
Urban	0.0188	*	-0.0454	***	-0.0610	***	-0.0167	*	-0.0075	
Family size	0.0011		-0.0250	***	0.0131		0.1360	***	0.1148	***
Season:										
Autumn	-0.0165		-0.0761	***	0.0130		-0.0116		-0.0084	
Spring	0.0338	**	0.0149		0.0311	**	0.0102		0.0014	
Winter	0.0045		-0.1439	***	0.0242	*	-0.0225		-0.0234	*
Insured	0.0054		0.0004		0.0053		-0.0056		0.0008	

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Sex	0.0065		-0.0621	***	-0.0802	***	-0.0196		0.0221		
Age	-0.0008		0.0020	***	-0.0001		-0.0007		-0.0008		
Under 5	0.0036		0.0317	**	0.0151		-0.0582	***	-0.0826	***	
Over 65	-0.0006		0.0114		0.0224		-0.0225		-0.0399	**	
$\overline{HR}$	-0.0018		0.0227	***	0.0001		0.0120	**	0.0003		
$\overline{Income}$	0.0006		-0.0022	***	-0.0035	***	-0.0033	***	-0.0014	*	
$\overline{Married}$	-0.0080		-0.0583	*	-0.1041	***	0.0320		0.0271		
$\overline{Family\ Size}$	0.0181	*	0.0219	***	0.0174	*	-0.0235	**	-0.0059		
$\overline{Insured}$	-0.0011		0.0031		0.0252	***	-0.0017		0.0129	***	
$\overline{Under\ 5}$	-0.0300		-0.0150		-0.0027		-0.0106		-0.0159		
$\overline{Over\ 65}$	0.0041		0.0268		-0.0139		-0.0086		-0.0228		
Year	0.0041		-0.0173	***	0.0253	***	-0.0410	***	-0.0286	***	
Wald χ^2	77.42		526.53		485.91		918.93		976.5		
Prob. $> \chi^2$	0		0		0		0		0		
Log pseudolikelihood	-10549.316		-8040.8166		-9815.4614		-9221.9252		-9085.961		
ρ	0.32		0.50		0.44		0.52		0.52		

**** p<.01, ** p<.05, * p<.1*

Source: Research findings

Relative to households with a health-expenditure share below 10% of income, the 10–20% category was associated with a 3.10 percentage-point higher probability of a nut consumption shortfall (AME=0.0310, p<0.05), a 2.66-percentage-point lower probability of a red-meat shortfall (AME=−0.0266, p<0.10), and a 5.41 percentage-point lower probability of egg-consumption shortfall (AME=−0.0541, p<0.01). For the 20–40% category, a statistically significant positive association was observed only for nuts (AME=0.0336, p<0.05). For the above-40% category, positive marginal effects were observed for cereals (AME=0.0444, p<0.05), red meat (AME=0.0400, p<0.05), and poultry meat (AME=0.0381, p<0.05). The remaining associations were not statistically significant.

Discussion

This study examined the association between household health-expenditure burden and below-median food consumption among Iranian households. Its main contribution is threefold: first, it extends previous research beyond aggregate food expenditure and general food-insecurity measures by examining food-group-specific consumption patterns; second, it uses three waves of household panel data and a correlated random-effects approach to account for persistent household heterogeneity; and third, it disaggregates broad protein-related categories into pulses, nuts, red meat, poultry, and eggs. These contributions provide more detailed evidence on the relationship between health-expenditure burden and food consumption in Iran's inflationary economic environment. The findings can be interpreted within the WHO social determinants of health framework, which emphasizes the interconnected roles of household resources, material circumstances, and healthcare access (30).

The ordered-logit results indicated that households in the highest health-expenditure category were more likely to experience a greater number of simultaneous below-median food-consumption outcomes. This finding is broadly consistent with previous evidence linking out-of-pocket healthcare expenditure to food insecurity and household consumption adjustments (6–10). Competition between healthcare and food expenditures represents one plausible explanation, particularly when households face financial constraints. However, the observed associations do not establish a causal crowding-out mechanism.

The food-group-specific results revealed substantial heterogeneity. In the highest health-expenditure category (≥40% of income), the probabilities of below-median consumption were higher for staple carbohydrates (4.28 percentage points), pulses, nuts and seeds (3.49 percentage points), and animal-source protein (3.34 percentage points). No statistically significant associations were observed for dairy or vegetables and fruits. Conversely, the 20–40% category was associated with lower probabilities of below-median consumption of animal-source protein, dairy, and

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vegetables and fruits. These findings indicate that the relationship is neither linear nor consistent across food groups and that aggregate food-consumption indicators may obscure substantial differences in household dietary patterns.

The disaggregated analysis further clarified these differences. In the highest health-expenditure category, the probability of below-median pulse consumption was 4.44 percentage points higher, whereas the association for nuts was not statistically significant. For nuts, significant positive associations were observed only in the 10–20% and 20–40% categories. This distinction is important because pulses represent a relatively affordable source of plant protein, while nuts are generally more expensive and may occupy a different position in household diets. Thus, the positive association observed for the aggregated pulses, nuts and seeds category at the highest expenditure level cannot be attributed exclusively to nuts.

Similarly, the highest health-expenditure category was associated with higher probabilities of below-median consumption of red meat (4.00 percentage points) and poultry (3.81 percentage points), but not eggs. These differences may reflect variation in food prices, preferences, and possible substitution between animal-source foods. The results are broadly consistent with previous evidence suggesting heterogeneous food-consumption adjustments among households facing healthcare-related financial constraints (11,12). However, the present results do not directly identify substitution between foods or establish the mechanisms underlying these associations.

The interpretation of staple-carbohydrate consumption requires particular caution. Lower consumption of cereals does not necessarily indicate nutritional inadequacy, since it may also reflect dietary diversification or substitution toward other foods. This distinction is relevant because the household-mean income coefficient for staple below-median consumption was positive and marginally significant at the 10% level. Such an association is compatible with differences in dietary composition across income groups. Consequently, the positive association between severe health-expenditure burden and below-median staple consumption should be interpreted as a relative consumption pattern rather than evidence of insufficient calorie intake.

The Mundlak specification provides additional insight by accounting for persistent household characteristics alongside contemporaneous explanatory variables. The health-expenditure-category estimates reflect conditional associations informed by within-household changes, particularly among households moving between categories across survey waves. The household-mean terms capture additional associations related to persistent between-household differences, although their coefficients do not represent a simple decomposition into pure between-household effects in this nonlinear specification.

Several household-mean coefficients were statistically significant. The mean health-expenditure ratio was positively associated with below-median consumption of aggregated animal-source protein and, in the disaggregated models, nuts and poultry. Household-mean income was negatively associated with below-median consumption of animal-source protein, dairy, and vegetables and fruits, while its association with staple carbohydrates was weakly positive. These differences suggest that persistent household circumstances may relate to food consumption differently from contemporaneous health-expenditure categories. Moreover, the estimated intra-household correlations indicate substantial residual household-level heterogeneity on the latent scale, supporting the relevance of accounting for persistent household characteristics.

Among the control variables, income was generally negatively associated with below-median consumption across most food groups, while larger household size was positively associated with several outcomes. Urban residence and seasonal indicators showed heterogeneous associations. These patterns are broadly consistent with Iranian research emphasizing the importance of socioeconomic circumstances and household characteristics in food insecurity (24,25), although the present consumption indicators are not equivalent to established food-insecurity measures. Seasonal variations were particularly pronounced for vegetables and fruits, with the probability of below-median consumption being 17.69 and 21.44 percentage points higher in autumn and winter, respectively, compared with summer. Conversely, the probability of below-median nut consumption was 14.39 percentage points lower in winter, potentially reflecting increased purchases ahead of the Nowruz celebrations. These patterns highlight the importance of seasonality and the limitations of using a single annual consumption threshold.

The Iranian health-system context is also relevant to these findings. The Health Transformation Plan, introduced in 2014, sought to improve healthcare access and financial protection through expanded insurance coverage and reduced patient payments for selected services. Nevertheless,

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