

Are the price patterns of cardioprotective vs. unhealthy foods the same?

A report from Iran

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Original Article

Abstract

BACKGROUND: Although several studies have assessed the price of different food groups in developed countries, there is scarce evidence regarding developing countries. Also, there is no report regarding the price of cardioprotective compared with unhealthy foods. The aim of this study was to determine the trend of food cost across different food groups (cardioprotective vs. unhealthy) and to assess the association between food cost and nutritional quality of foods in Iran.

METHODS: A list of foods consumed frequently by Iranian population was provided. Nutritional quality of foods was assessed by energy density and nutrient rich foods (NRF) index. Food groups were defined according to the US Department of Agriculture (USDA) MyPlate food groups. The price of food groups was reported as kcal/price and price/serving.

RESULTS: Although a positive association between different types of nutrient rich foods, nutrient content of foods and food price was observed, there was an inverse relationship between food price and energy density. The kcal/price of "oils" was less than "whole grains" and "refined grains". "Sugar, sweets and beverages" and "beans and legumes" food groups had equal kcal/price media. Among healthy foods for cardiovascular system, nuts had the highest price/serving. On the other hand, among unhealthy foods for cardiovascular system, processed meat had the highest price/serving. The price/serving of healthy oils was similar to saturated and *trans* fatty acids rich oils. Also, the price/serving of low-fat (healthy) vs. high fat (unhealthy) dairy was not different. Similar finding was observed for white meat vs. red meat.

CONCLUSION: Our findings revealed that the pattern of food price in Iran is different from developed countries. Also, we found that Iranians can consume a cardioprotective diet without any economic pressure.

Keywords: Food Price, Nutritional Quality, Cardioprotective Agents, Unhealthy Foods, Developing Country

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Introduction

Socioeconomic status (SES) is inversely associated with risk behaviors for chronic diseases¹ including cardiovascular diseases,² diabetes,³ hypertension,⁴ kidney disease,⁵ and dental caries.⁶ The risk of dying due to ischemic heart disease is higher among subjects with lower SES.⁷ On the other hand, dietary intakes have an important role in incidence and progression of chronic diseases.⁸ Reports from western populations revealed that there was a direct association between SES and diet quality.⁹ Moreover, a strong relationship between income

and micronutrient content of the diet was observed in a developing country.¹⁰ Investigators have suggested that such direct association between SES and diet quality may be mediated by the food price.¹¹ Studies reported that there was an inverse association between diet cost and dietary energy density in a western population.¹²

Evidence showed that food price crisis might result in increased food insecurity and decreased intake of vegetables, fruits, meat products and dairy in a low-income country.¹³ Also, it was predicted that zinc intake was significantly influenced by rise in food price

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in a developing country.¹⁰ Previous studies from developed countries reported that diet cost was inversely related to intake of total fat and saturated fatty acids, and was directly associated with vitamin A and vitamin C intake.¹⁴ It was also revealed that the cost of an unhealthy diet rich in added sugar, added fat and refined grain was lower in the US.¹⁵ A favorable relationship between higher diet cost and dietary risk factors of cardiovascular diseases such as quality of diet, unhealthy food consumption, and obesity was observed among US adolescents.¹⁶ Although several studies assessed the relationship between economy and diet quality in developing countries,^{10,13,17} scarce data were reported regarding the association between economy and nutrient content of foods.

It was observed that high intake of several food groups such as refined grains,¹⁸ saturated and trans fatty acid rich oils,¹⁹ red meats,²⁰ processed meats,²¹ high-fat dairy²² and sugar sweetened foods²³ was unfavorably associated with the risk factors and mortality of cardiovascular diseases. Nevertheless, the price of unhealthy foods for cardiovascular system in comparison with healthy foods was not assessed in previous studies.

As reported by The World Bank (Middle East and North Africa Region), the food price change had a different pattern in Middle Eastern and North African countries²⁴ and it had significantly higher increase in Iran.²⁴ Therefore, the aim of present study was to compare the food cost across different food groups based on their effect on cardiovascular system and to assess the association between food cost and nutritional quality of foods in Iran.

Materials and Methods

A list of the names and foods extracted from different dietary assessment tools (i.e. food frequency questionnaire, food diary and dietary recall) consumed in different provinces of Iran was checked by expert nutritional epidemiologists in several meetings to provide a list of foods consumed frequently by Iranian population. Finally, 160 food items were selected (Table 1). Nutrient content of the foods was extracted using Nutritionist IV software (N-Squared Computing, Salem, OR). Data regarding the added sugar required to calculate the food quality indices was extracted from food labels.

The food price was obtained from licensed retail sale outlets in which sale price was approved by central government and was constant among all provinces. The food price was corrected for edible portion and food weight changes due to cooking. The price of foods was presented as per 100 kcal (price/100 kcal) and per serving (price/serving).

The US Department of Agriculture (USDA) MyPlate serving sizes were used to calculate food cost per serving.²⁵ According to the USDA MyPlate food categories, following food groups were defined: whole grains (n = 2), refined grains (n = 13), beans and legumes (n = 8), red meats (n = 12), white meats (n = 4), processed meats (n = 4), dairy products (n = 16), oils (n = 9), vegetables (n = 21), fruits (n = 35), fruit juices and canned fruits (n = 6), nuts (n = 7), sugar, sweets and beverages (n = 19) and miscellaneous (n = 4).

Table 1. Macronutrients, vitamins and minerals to encourage and nutrients to limit used to calculate different versions of nutrient rich food (NRF) index

| Version of nutrient rich food (NRF) Index | Nutrients to encourage | Nutrient to limit |
|---|--|--|
| NRF 6.3 | Protein, fiber, vitamin A, vitamin C, calcium, iron | Saturated fatty acid, added sugar and sodium |
| NRF 9.3 | Protein, fiber, vitamin A, vitamin C, calcium, iron, vitamin E, magnesium, potassium | Saturated fatty acid, added sugar and sodium |
| NRF 11.3 | Protein, fiber, vitamin A, vitamin C, vitamin E, vitamin B-12, calcium, iron, zinc, magnesium, potassium | Saturated fatty acid, added sugar and sodium |
| NRF 15.3 | Protein, fiber, monounsaturated fat, vitamin A, vitamin C, vitamin E, vitamin D, vitamin B-12, thiamin, riboflavin, folate, calcium, iron, zinc, potassium | Saturated fatty acid, added sugar and sodium |

Nutritional quality of foods was evaluated by energy density and Nutrient Rich Food (NRF) index. Energy density of each food was calculated by dividing energy content (kcal) of food by unit weight (gram). Nutritive value of each food was assessed by NRF calculated by following formula:²⁶

$$\text{NRF} = \left[\frac{\sum \left(\frac{\text{nutrients to encourage}}{\text{reference daily value}} \right) - \sum \left(\frac{\text{nutrients to limit}}{\text{maximum recommended values}} \right)}{\right] \times 100$$

Nutrients to encourage and nutrients to limit used to calculate different versions of NRF are presented in table 1. Different macronutrients, vitamins and minerals as nutrients to encourage were considered in different versions of NRF. Nutrients to limit were constant in all versions and were saturated fatty acids, added sugar and sodium.²⁶ Reference daily values and maximum recommended values were based on the recommendations of Institute of Medicine.²⁷ The definition of healthy and unhealthy food groups were based on previous studies.¹⁸⁻²³

We analyzed data using SPSS software for windows (version 20.0, SPSS Inc., Chicago, IL, USA). Food price variable was presented as tertiles by following cut-points: ≤ 2630 , 2631-6460 and ≥ 6461 Rials for food price/serving, and ≤ 3290 , 3291-8470 and ≥ 8471 Rials for price/100 kcal. The results of the Kolmogorov-Smirnov test and histogram showed that the distribution of dependent variables was not normal. Therefore, we used nonparametric tests. Kruskal-Wallis H test was performed to compare the mean ranks of NRFs and energy density across tertiles of food price. The association between prices of foods

and nutrients were also tested using Spearman correlations. $P < 0.05$ was determined as level of statistical significance.

Results

The trend of different versions of NRF (presented per serving and per 100 kcal) across tertiles of food price is presented in table 2. Foods in the last tertile of the food price/serving had significantly higher NRF/serving in comparison to the first tertile. This finding was observed for all versions of NRF/serving. Similar result was found for the NRFs/100 kcal in the tertiles of the price/100 kcal (Table 2).

Results regarding the Spearman correlation between food price and nutrient content of the foods are displayed in table 3. There was a significant direct association between food price and protein, potassium, iron, calcium, magnesium, zinc, selenium, vitamin A, β -carotene, thiamin, riboflavin, niacin, vitamin B6, folate, vitamin C, poly-unsaturated fatty acids, mono-unsaturated fatty acids and dietary fiber content of foods ($P < 0.05$ for all). Added sugar, a cardiovascular risk factor, was inversely related to the food price ($P < 0.01$). Two other dietary cardiovascular risk factors (i.e. saturated fatty acids and cholesterol) had no significant association with the food price.

Energy density mean ranks of foods across tertiles of food price are illustrated in figure 1. As shown in the figure, the price of foods with lower energy density was more than foods with higher energy density ($P = 0.01$).

Table 2. The of different versions of Nutrient Rich Food (NRF) index across tertiles of food price

| Variables | Tertile 1 (n = 54) | Tertile 2 (n = 54) | Tertile 3 (n = 55) | P* |
|---|-------------------------------|-----------------------|-------------------------------|--------|
| Price per serving (Iranian Rials) | ≤ 2630 | 2631-6460 | ≥ 6461 | |
| NRF 6.3/serving | 5.5 (-9.2, 18.3)† | 21.5 (-5.3, 70.3) | 20.8 (8.1, 55.7) | 0.02 |
| NRF 9.3/serving | 10.8 (-7.9, 29.5) | 33.0 (-0.8, 88.7) | 36.7 (17.6, 82.7) | < 0.01 |
| NRF 11.3/serving | 11.8 (-6.4, 31.5) | 43.2 (3.4, 100.0) | 57.7 (37.5, 98.5) | < 0.01 |
| NRF 15.3/serving | 19.5 (1.5, 42.5) | 58.3 (23.9, 122.0) | 75.8 (51.9, 133.0) | < 0.01 |
| Price per 100 kcal (Iranian Rials) | ≤ 3290 | 3291-8470 | ≥ 8471 | |
| NRF 6.3/100 kcal | 3.61 (-13.6, 17.6) | 24.2 (-2.9, 88.2) | 53.3 (23.0, 157.0) | < 0.01 |
| NRF 9.3/100 kcal | 13.7 (-10.4, 28.5) | 38.0 (2.0, 97.0) | 75.5 (31.5, 190.0) | < 0.01 |
| NRF 11.3/100 kcal | 18.9 (-7.3, 34.0) | 52.2 (14.6, 110.0) | 86.7 (45.6, 214.0) | < 0.01 |
| NRF 15.3/100 kcal | 37.3 (6.7, 53.1) | 76.8 (32.9, 141.0) | 105.0 (61.0, 242.0) | < 0.01 |

* P value was calculated by Kruskal-Wallis H test

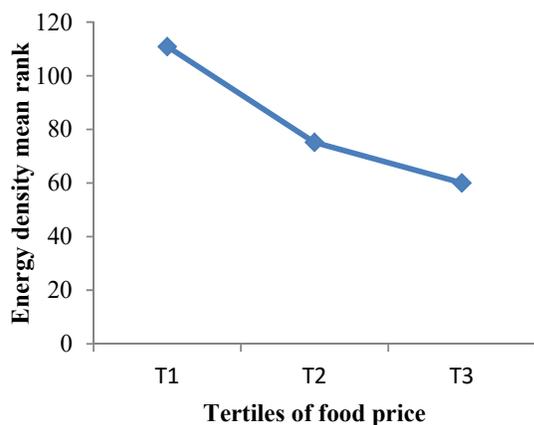
† All values are medians (interquartile range)

NRF: Nutrient Rich Foods Index

Table 3. Spearman correlation between food price and nutrient content of the foods

| Nutrient | Spearman's rho | P | Nutrient | Spearman's rho | P |
|--------------|----------------|--------|-------------------|----------------|--------|
| Protein | 0.208 | < 0.01 | Vitamin A | 0.283 | < 0.01 |
| Carbohydrate | 0.118 | 0.13 | β -carotene | 0.159 | 0.04 |
| Fat | 0.030 | 0.70 | Thiamin | 0.226 | < 0.01 |
| Cholesterol | 0.034 | 0.67 | Riboflavin | 0.394 | < 0.01 |
| SFA | 0.035 | 0.76 | Niacin | 0.383 | < 0.01 |
| Potassium | 0.544 | < 0.01 | Vitamin B6 | 0.369 | < 0.01 |
| Iron | 0.279 | < 0.01 | Folate | 0.306 | < 0.01 |
| Calcium | 0.285 | < 0.01 | Vitamin B12 | 0.032 | 0.68 |
| Magnesium | 0.386 | < 0.01 | Vitamin C | 0.509 | < 0.01 |
| Zinc | 0.311 | < 0.01 | Dietary fiber | 0.247 | < 0.01 |
| Selenium | 0.231 | < 0.01 | Added sugar | -0.225 | < 0.01 |
| Sodium | 0.042 | 0.60 | MUFA | 0.403 | < 0.01 |
| PUFA | 0.359 | < 0.01 | | | |

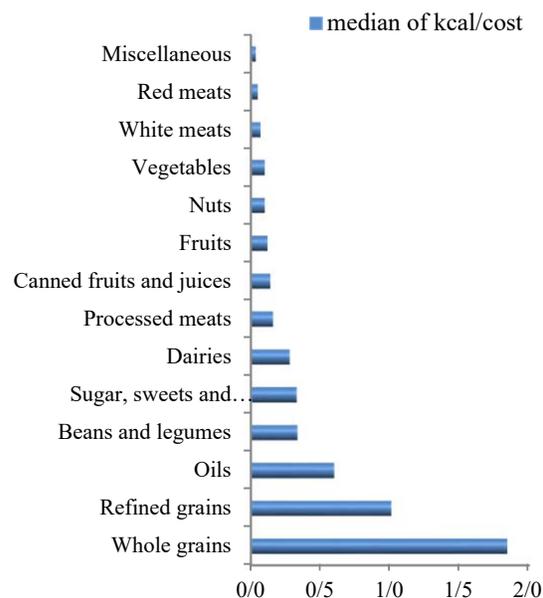
MUFA: Mono-unsaturated fatty acid; PUFA: Poly-unsaturated fatty acid; SFA: Saturated fatty acid

**Figure 1.** Energy densities mean ranks of foods across tertiles of food price

The food price in different food groups was assessed by two variables, i.e. kcal per price (kcal/price) and price per serving (price/serving). Medians of kcal/price in fourteen defined food groups are shown in figure 2. The results revealed that "whole grains" had the highest kcal/price median. The kcal/price of "oils" was less than "whole grains" and "refined grains". "Sugar, sweets and beverages" and "beans and legumes" food groups had equal kcal/price median. Similar finding was observed for "nuts" and "vegetables" food groups. Among animal sources of protein (i.e. "dairy products", "red meats", "white meats" and "processed meats"), "dairy products" had the lowest kcal/price.

Medians of price/serving are illustrated in figure 3. The findings showed that the highest

price/serving was in "nuts" food group. "whole grains" and "refined grains" had lower price/serving than "oils". Although "sugar, sweets and beverages" and "vegetables" food groups had equal price/serving median, this value was lower in "beans and legumes" food group. Similarly, the price/serving in "fruit juices and canned fruits" and "white meats" was equal and higher than "fruits". The price/serving of "red meats" food group was sharply increased compared with "white meats" food group.

**Figure 2.** Medians of kcal/price in fourteen defined food groups

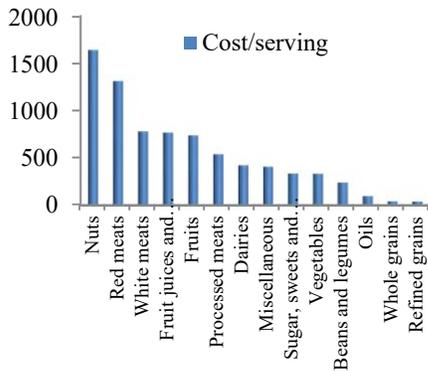


Figure 3. Price/serving medians in fourteen defined food groups

Figure 4 shows the price/serving of healthy and unhealthy foods for cardiovascular system. Among healthy foods for cardiovascular system, nuts had the highest price/serving. On the other hand, among unhealthy foods for cardiovascular system, processed meat had the highest price/serving. The price/serving of healthy oils was similar to saturated and *trans* fatty acid rich oils. Also, the price/serving of low fat (healthy) vs. high fat (unhealthy) dairy was not different. Similar finding was observed for white meat vs. red meat.

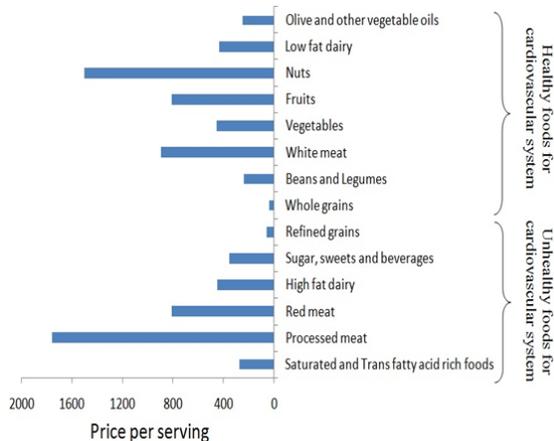


Figure 4. Price/serving of healthy and unhealthy foods for cardiovascular system

Discussion

The findings showed that higher food price had a favorable association with nutritional quality, nutrient content and energy density of foods. Moreover, results revealed that in this developing country, the price of healthy food groups was equal to unhealthy food groups in several cases. To the best of our knowledge, this study is the first study

from Middle East which reports food price in different food groups.

We found that foods in the last tertile of the food price/serving had significantly higher NRF in comparison with the first tertile. This finding was observed for all versions of NRF/serving and NRF/100 kcal. NRF index is a valid tool which scores foods on the basis of their healthy and unhealthy nutrients content (Table 1).²⁶ It is a useful scoring system to identify affordable foods.²⁸ NRF index can be calculated for individual foods and food groups.²⁹ A previous study reported that food groups with higher NRF (i.e. vegetables and fruits) were more expensive in the US.²⁸ We could not find any study regarding the association between food price and NRFs of individual foods. Therefore, it seems that this is the first study which assessed foresaid relationship.

A significant direct association between food price and several important nutrients was observed in the present study. Direct association between food price and NRF was expected because NRF was calculated based on nutrient content of foods. Townsend et al. reported that energy adjusted diet cost was directly related to intake of potassium, vitamin A, vitamin C and dietary fiber in the US.¹⁴ Evidence from a non-developed country revealed that there was a positive association between per capita expenditure and intake of iron, zinc, vitamin A, vitamin B12 and folate.¹⁰ Therefore, results of previous studies confirmed our findings. Also, we found that there was no association between food price and cholesterol and saturated fatty acid content of foods. It means that unhealthy foods for cardiovascular system rich in cholesterol and saturated fatty acids are not more expensive than healthy foods. Therefore, higher consumption of unhealthy foods for cardiovascular system rich in cholesterol and saturated fatty acids is not due to lower price of these foods and education has an important role in choosing a cardioprotective food.

It was observed that more expensive foods had higher energy density. The study by Monsivais et al. conducted in the US reported similar result.³⁰ Previous study showed that the cost of low-energy density diet was high in a developed country.¹² Low energy density diet was associated with several cardiometabolic risk factors and disorders such as obesity,³¹ dyslipidemia³² and metabolic syndrome.³³

We found that the kcal/price of "oils", the main source of dietary fat, was less than the main carbohydrate rich food groups, i.e. "whole grains" and "refined grains". It shows that in Iran,

carbohydrate, as a source of energy, is more affordable than fat. Evidence from the US showed that grain products had lower kcal/dollar than fats.²⁸ Also, it was observed that "sugar, sweets and beverages" and "beans and legumes" food groups had equal kcal/price median. Therefore, we can educate Iranians to provide their required energy from "beans and legumes" rather than "sugar, sweets and beverages" without any economic pressure. In contrast, it was reported that the kcal/price median of sugars food groups was greater than beans and legumes in a developed country.²⁸ "Dairy products" food group has lower kcal/price than other sources of animal protein because it is the only source of animal protein to receive a government subsidy in Iran. The price of other sources (i.e. "red meats", "white meats" and "processed meats") is determined by supply and demand system. Observed equal kcal/price medians for "nuts" and "vegetables" food groups in our study is due to lower caloric content of "vegetables". According to the results from the US, the kcal/price median of fruits and vegetables was higher than different types of meat in this country.²⁸ Nevertheless, the findings of present study showed that the kcal/price median of meats were higher than fruits and vegetables in Iran.

As shown in the results, "whole grains" and "refined grains" had the lowest price/serving. The "whole grains" food group consists of two types of bread available in all provinces of Iran. Nevertheless, there are several whole grain products only available in affluent areas of metropolises of Iran. These products are more expensive than frequently consumed whole grain products included in our analysis.

Our results revealed that "whole grains" and "refined grains" had lower price/serving than "oils". In contrast with this finding, Drewnowski et al. reported that the price/serving median of oils was greater than grain products in the US.³⁴ According to the findings of the current study, the price/serving of healthy food groups such as "vegetables" and "beans and legumes" were less or equal to price/serving of unhealthy food group i.e. "sugar, sweets and beverages". This finding is in contrast with reported results from the US.³⁴ We could not find any evidence regarding price/serving of food groups from developing countries. Nevertheless, the comparison between findings of the present study and reported results from the developed countries disclose the importance of nutritional education in Iran because Iranians can

replace several unhealthy foods with healthy ones without any economic pressure.

We found that the price/serving of healthy foods for cardiovascular system was similar to unhealthy foods. This finding shows that education of healthy nutrition has important role in dietary pattern of Iranian population and individuals can consume a healthy diet for cardiovascular system without economic pressure.

The limited number of food items included in the current study may be considered as a limitation because we did not include local foods consumed in an ethnic group. This study focused on the frequently consumed foods and therefore food items only available in metropolises were not assessed. Also, the differences in the price of several foods in areas with thriving agriculture and livestock were not considered. We could not find evidence from different countries. Therefore, we did not compare our findings with reports from several countries.

There are scarce data regarding food cost in different food groups in developing countries. Therefore, the main strength of the present research is study location. Moreover, the association between food price and nutritional quality of foods was presented by several indices.

Conclusion

Our findings revealed that the pattern of food price in Iran is different from developed countries. Also, we found that Iranians can consume a cardioprotective diet without any economic pressure.

Acknowledgments

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Conflict of Interests

Authors have no conflict of interests.

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