Adhering to a Mediterranean diet in a Mediterranean country: an excess cost for families?

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Abstract

Adherence to the Mediterranean diet (MD) has been decreasing in southern Europe, which could be linked to several cultural or educational factors. Our aim is to evaluate the extent to which economic aspects may also play a role, exploring the relationship between food prices in Portugal and adherence to the MD. We evaluated data from the Portuguese National Food, Nutrition, and Physical Activity Survey (IAN-AF 2015–2016) (*n* 3591). Diet expenditures were estimated by attributing a retail price to each food group, and the diet was transposed into the Mediterranean Diet Score used in the literature. Prices were gathered from five supermarket chains (65 % of the Portuguese market share). Linear regression models were used to assess the association between different adherence levels to the MD levels and dietary costs. Greater adherence to the MD was associated with a 21·2 % ($P < 0.05$) rise in total dietary cost, which accounts for more 0·59€ in mean daily costs when compared with low adherence. High adherence individuals (*v.* low adherence) had higher absolute mean daily costs with fish (0·62€/+285·8 %; $P < 0.05$), fruits (0·26€/+115·8 %; $P < 0.05$) and vegetables (0·10€/+100·9 %; $P < 0.05$). The analysis stratified by education and income level showed significantly higher mean daily diet cost only amongst higher income groups. Our findings suggest that greater adherence to the MD was positively and significantly associated with higher total dietary cost. Policies to improve population's diet should take into consideration the cost of healthy foods, especially for large low- and middle-income families.

Key words: Mediterranean diet: Food prices: Fiscal policies: Health inequalities

The Mediterranean diet (MD) is associated with better health outcomes and a lower risk of several non-communicable diseases[1,2]. Yet, there is evidence that adherence to the MD has been decreasing in Portugal[3,4]. The current shift away from foods commonly linked to the MD to less nutritious dietary patterns may lead to an increase in the burden of non-communicable diseases in the long term[5,6]. This trend may be linked not only to several cultural or educational factors[7,8] but also to economic ones. Indeed, we recently observed that the adherence to foods associated with the MD in Portugal was greater among the better-off[9,10]. Hence, our purpose is to evaluate the extent to which economic aspects may also play a role, if non-adherence to this diet is associated with lower costs.

Recent studies in Europe and the USA have shown that less healthy and processed foods tend to be cheaper than nutritionally rich alternatives[11,12]. These less healthy products are more often high-energy-density foods with lower nutritional value. This could be seen as a barrier to a healthy diet, especially among lower-income groups[13–15].

Still, Portugal is a southern European country with mild weather and all-year access to local seafood, vegetables and fruits common in the MD. The overall prices of fruit and vegetables are below the European average, even after adjusting for purchasing power parities[16]. Some studies in Mediterranean countries associate a higher cost with this dietary pattern[17,18]. In Portugal, there is some evidence showing a higher cost to the adherence of the MD in children[19,20]. However, these were

small local studies without a representative sample of the Portuguese population.

Moreover, Portugal is a low-income country compared with its European counterparts, marked by a high-income inequality[21]. Knowing the economic environment of food is relevant in this context because affordability may represent a relevant issue for a substantial part of the population. This may be a key issue since southern European countries were particularly hit by the Great Recession and did not fully recover to pre-recession economic levels. Although recent evidence suggested a link between the Great Recession and decreased adherence to the MD in the south of Europe[22,23], it is not clear that food prices may help explain this trend. To our best knowledge, no studies have explored the link between food prices and MD in southern Europe after the Great recession.

Using a representative sample of the Portuguese population, we seek to understand the relationship between food prices in Portugal and whether they might represent an obstacle to adherence to the MD, explaining the income gradient.

Methods

Study design and population

The Portuguese National Food, Nutrition, and Physical Activity Survey (IAN-AF) is based on a representative sample of the non-institutionalised population resident in Portugal[24]. It includes individuals between 3 months and 84 years old, randomly selected by a stepwise sampling process from the National Register of Users of the Portuguese National Service of health. The multistage sampling was implemented by stratification of the seven Statistical Geographic Units – NUTS II (North, Centre, Lisbon Metropolitan Area, Alentejo, Algarve, Madeira, and Azores) – followed by a random selection of Primary Health Care Units in each region. Subsequently, a random selection of registered individuals in each Primary Health Care Unit was made considering sex and age groups.

A total of 19 635 persons were considered eligible for participation, and 5811 completed the two planned interviews with information for dietary intake (from 2×24 h recall or diaries). Fieldwork took place between October 2015 and September 2016. To minimise seasonal variability in eating behaviours, the interviews were conducted within the 12 months of the year and the days were randomised to have a proportional interview distribution on all days of the week.

The two face-to-face interviews were conducted at the Local Health Unit or at home by interviewers trained in Nutrition Science or Dietetics and using computer-assisted interviews (CAPI). Information on dietary intake was collected using the module eAT24 from the software You eat&move[25], and for quantification of food portions, a photographic manual with 1048 food photos was purposely developed[26].

As this survey did not include institutionalised persons, we excluded people older than 79 years to avoid a potential bias in this population group. Individuals aged under 18 years were also not included (no household income data available for participants aged < 18 years old).

Mediterranean diet adherence

The MD was assessed by the Mediterranean Diet Score proposed by Trichopoulou *et al.*[27,28], which includes nine key components: MUFA:SFA ratio, vegetables, fruit, legumes, cereals, fish, dairy products (milk, cheese and yogurt), red meats and processed meat, and alcohol. For fruit, vegetables, legumes, cereals and fish (more common in the MD), individuals with consumption above the median (calculated by sex) were scored 1 and those with consumptions equal to or below were scored with 0; for the remainder, except alcohol, the score was reversed. For alcohol, moderate intakes (10 to <50 g/d in men and 5 to <25 g/d in women) were scored with one and consumption below or above these values with 0. The final score ranges from 0 to 9. Three levels of adherence to the MD were established with the following cut-off points: low adherence (≤3 points), moderate adherence (>3/<6 points) and high adherence (≥6 points).

The specific foods included in each of the nine food categories are available in the Portuguese National Food, Nutrition, and Physical Activity Survey (IAN-AF) website and can be consulted in the Codebook, IAN-AF 2015–2016 data sets (https://ian-af.up.pt/sites/default/files/IAN-AF%20Codebook_0.pdf)[29].

Dietary cost

To estimate the participants' expenditures with diet, a price was attributed to each food group included in the index of adherence to the MD, and to the rest of the diet. All food prices were collected in July 2019 from five supermarket chains, which together account for 65 % of the Portuguese market share (Continente, Pingo Doce, Lidl, Intermaché and Auchan)[30]. When available, the prices were collected online using official retail websites. For the retailers that did not display prices online, the data were gathered in supermarkets in the Lisbon Metropolitan Area. Although there is some evidence of lower prices in more populated areas in Portugal, the prices are mostly homogenous throughout the country[31]. A total of 654 prices were collected.

The lowest price per gram was attributed to each selected item, discarding any potential sale prices. That is, if a similar food was sold in packages of different sizes and prices, we calculated the price per gram of each package and selected the lowest one. For example, considering meat and fish prices, we selected the lowest price of every type of meat (pork, beef, turkey and so on) and fish (sea bass, swordfish, tuna and so on) consumed. The mean prices gathered from the supermarkets were adjusted for 100 g of the edible portion[32]. By doing so, we thus controlled for quantities and nutritional composition, so that we were able to evaluate the differences in the costs of dietary patterns.

The data on dietary cost were only collected after the study hypotheses were identified and the analytic plan was pre-specified in detail.

Explanatory variables and covariates

Adherence to the MD was the explanatory variable.

Covariates included income and education level. Income was stratified into three categories: <970€; 971–1940€ and >1941€. The household income referred to monthly values and included salaries, pensions, allowances and other regular benefits after

deductions for taxes and social security. Due to a large percentage of missing values in the household income variable (9·7 %) and their uneven distribution across groups (40·4 % among low-educated people, for 12·3 % among high-educated ones), a multiple-imputation (five imputations) method was used to replace the missing values and avoid a potential bias. A multiple set of simulated values were imputed according to the socio-demographic characteristics of the participants (sex, educational level and age).

Education level was stratified into three different income categories: (1) no education (0–3 years of education) and primary education (9 years of education); (2) secondary education (12 years of education) and (3) tertiary education (>12 years of education).

Statistical analysis

Linear regression models were used to assess the association between different adherence levels to the MD and dietary cost. For the analysis of the total dietary cost and the cost of adherence (exclusively for food items included in the Mediterranean Diet Score index), the models were first presented as unadjusted and then adjusted for age (used as a continuous value), sex, education level (no education, primary, secondary and tertiary education), dietary intake (kcal/d) and region (North, Centre, Lisbon Metropolitan Area, Alentejo, Algarve, and Autonomous Regions of Madeira and the Azores).

The dietary intake (kcal/d) (total intake of energy content from all sources) was included as a covariate to analyse the dietary quality and lessen potential bias for the energy intake (the so-called 'standard multivariate method'). Results were presented as predicted expenditures from the model according to the MD adherence, assuming a 2000 kcal/d intake and putting all other covariates at their mean value[33].

The adjustment was performed to avoid the potential bias of different subpopulations consuming products of different types within the MD (e.g. a person may adhere to the MD while consuming different quantities of fish, to take a costlier food). Finally, we performed a stratified analysis on the link between MD adherence and cost, by education and income level. We used a Poisson regression for some of these analyses considering the positive skewed distribution of the variables. A P-value of 0·05 was considered in this study.

All the analyses were conducted using Stata version 13.

Ethics

The Portuguese National Food, Nutrition, and Physical Activity Survey (IAN-AF) ethical approval was obtained from the National Commission for Data Protection (Reference number: 4940/2015), the Ethical Committee of the Institute of Public Health of the University of Porto (Reference number: CE16053/15–01–2016) and the Ethical Commissions of each one of the Regional Administrations of Health.

Results

The study included a total of 3591 participants. The overall mean MD score was significantly higher for males ($P < 0.05$) and

people over 65 years old ($P < 0.05$). Participants with secondary education ($P < 0.05$) had a significantly lower MD score (Table 1).

Greater adherence to the MD was positively and significantly associated with higher total dietary cost (Table 2). The total mean daily cost of high MD adherence was 0·59€ (+21·2 %; $P < 0.05$) more when compared with the total daily average of low adherence. Identical results were found when the model was adjusted for age, sex, education and location.

Considering the percentage of total dietary cost, the fish (24·8 %) and fruit/nuts (17·1 %) food groups had the highest share of the total cost amongst high adherence participants. On the other hand, for low adherence participants, meat/processed meat (29·4 %) and dairy products (11·3 %) were the food groups with the highest percentage of the total cost within this subcategory.

Comparing the absolute differences on the average daily cost between high and low adherence to the MD, individuals who had high adherence showed a significantly higher mean daily cost on most MD foods (Fig. 1). Of all the foods included in the index to the MD, fish (0·62€/+285·8 %; $P < 0.05$), fruits (0·26€/+115·8 %; $P < 0.05$), vegetables (0·10€/+100·9 %; $P < 0.05$) and nuts (0·04€/+93·6 %; $P < 0.05$) had the largest absolute mean daily cost differences. Pasta and rice were the only MD food items that showed no significant daily cost differences between high and low adherence to the MD. Furthermore, participants with a greater adherence to the MD had a significantly lower mean daily cost regarding the consumption of red meat (0·16€/–88·3 %; $P < 0.05$), white meat (0·13€/–69·7 %; $P < 0.05$), processed meat (0·04€/–104·5 %; $P < 0.05$) and milk (0·07€/+226·4 %; $P < 0.05$).

A higher mean daily dietary cost was associated with higher income groups: comparing the absolute differences between high- and low-income subgroups, people with incomes above 1941€ had a significantly higher mean daily cost than people with

Table 1. Baseline characteristics of participants (aged 18–79 years) from Portuguese National Food, Nutrition, and Physical Activity Survey (IAN-AF 2015–2016) and mean of Mediterranean diet (MD) score
(Mean values and 95 % confidence intervals; numbers and percentages)

Variables	Total		MD score	
	n	%	Mean	95 % CI
Sex				
Female†	1919	53·4	3·82	3·78, 3·87
Male	1672	46·6	4·10*	4·05, 4·15
Age (years)				
18–34†	961	26·8	3·46	3·40, 3·52
35–64	2070	57·6	4·05*	4·01, 4·09
65–79	560	15·6	4·38*	4·30, 4·47
Educational level				
No education/primary education†	1158	32·3	4·09	4·03, 4·15
Secondary education	1574	43·8	3·82*	3·77, 3·87
Tertiary education	859	23·9	4·01	3·94, 4·08
Household income				
<970€†	1439	40·1	3·88	3·82, 3·92
971–1940€	1446	40·3	3·88	3·88, 3·92
>1941	706	19·6	4·01	3·94, 4·08

* Statistically significant MD score difference found in comparison with the reference category ($P < 0.05$).
† Reference category.

Table 2. Mean dietary cost (€/d) by Mediterranean diet (MD) adherence
(Odds ratio and 95 % confidence intervals)

	Low adherence		Moderate adherence		High adherence		Absolute differences†
	OR	95 % CI	OR	95 % CI	OR	95 % CI	
Cost adjusted 2000 kcal/d							
Total dietary cost	2·78€	2·74, 2·84	3·14€*	3·11, 3·19	3·37€*	3·30, 3·43	0·59€/+21·2 %
Adjusted total dietary cost‡	2·79€	2·74, 2·83	3·14€*	3·10, 3·17	3·35€*	3·29, 3·41	0·56€/+20·0 %
Percentage of total dietary cost (main food categories)§							
Vegetables/legumes	4·5 %		5·5 %		6·5 %		–
Fruits/nuts	10·5 %		14·4 %		17·1 %		–
Fish	8·4 %		16·5 %		24·8 %		–
Cereals	9·3 %		9·1 %		9·2 %		–
Dairy products	11·3 %		8·4 %		6·1 %		–
Sweets/pastry	5·9 %		4·6 %		3·7 %		–
Meat/processed meat	29·4 %		19·6 %		12·3 %		–

* Statistically significant cost difference found ($P < 0.05$).
† High adherence v. low adherence.
‡ Adjusted for age, sex, education and location using a generalised linear model.
§ Not all food groups were included in the Table, in order to ease the reading. Food groups not included in this list: alcoholic drinks, fruit juices and other beverages, salty snacks, process fish and fruits, meat and dairy replacements, eggs, breakfast cereals. Results are available upon request.
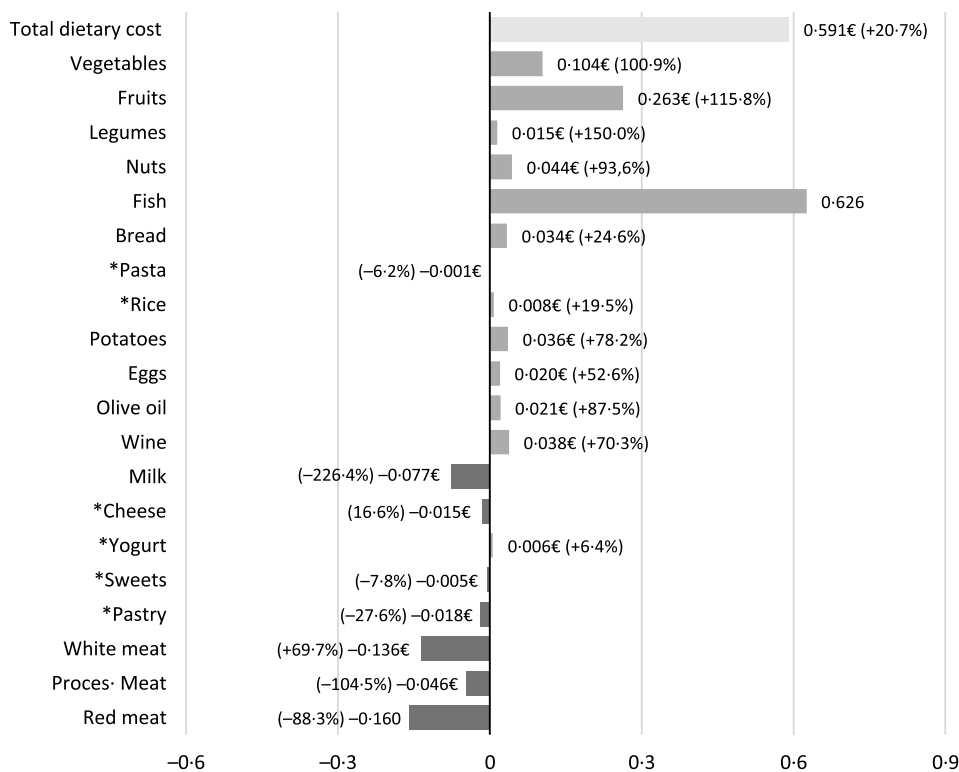
Fig. 1. Absolute differences between high adherence and low adherence to the Mediterranean diet (mean dietary cost €/d).

incomes below 970€ for both low adherence (0·27€/+10·1 %; $P < 0.05$) and high adherence (0·36€/+11·2 %; $P < 0.05$) participants (Table 3). Conversely, the observed differences in mean daily dietary cost were not significant between education subgroups. Yet, higher adherence to MD was associated with similar greater costs in all income and education groups.

Amongst participants with high adherence to the MD, when comparing the absolute mean daily cost differences of food components between >1941€ and <970€ income groups (Fig. 2), high-income persons showed a significantly higher mean daily cost in relation to the consumption of nuts (0·08€/+150·1 %; $P < 0.05$), fruits (0·06€/+14·4 %; $P < 0.05$), vegetables (0·03€/+22·1 %; $P < 0.05$), cheese (+0·04€/+78·0 %; $P < 0.05$) and yogurt (0·04€/+58·3 %; $P < 0.05$). The largest mean daily cost difference was with regard to the consumption of fish (+0·09€/+11·4 %). However, the observed difference was not found to be statistically

Table 3. Mean dietary cost (adjusted 2000 kcal/d) by Mediterranean diet (MD) adherence amongst different socio-economic groups
(Odds ratio and 95 % confidence intervals)

	Low adherence		High adherence		Absolute differences
	OR	95 % CI	OR	95 % CI	
Educational level					
No education/primary education	2·71€	2·63, 2·79	3·20€	3·09, 3·30	0·49€/+18·0 %
Secondary education	2·78€	2·72, 2·84	3·46€	3·36, 3·56	0·68€/+24·4 %
Tertiary education	2·84€	2·76, 2·93	3·43€	3·31, 3·55	0·59€/+20·7 %
Absolute differences (high v. low education)	0·13€/+4·7 %		0·23€/+7·1 %		
Household income					
<970€	2·65€	2·59, 2·72	3·20€	3·10, 3·30	0·57€/+21·5 %
971–1940€	2·83€	2·76, 2·89	3·40€	3·30, 3·50	0·56€/+19·7 %
>1941	2·92€*	2·82, 3·01	3·56€*	3·43, 3·69	0·63€/+21·6 %
Absolute differences (high v. low income)	0·27€/+10·1 %		0·36€/+11·2 %		

* Statistically significant cost difference found between socio-economic groups (*P* < 0·05).
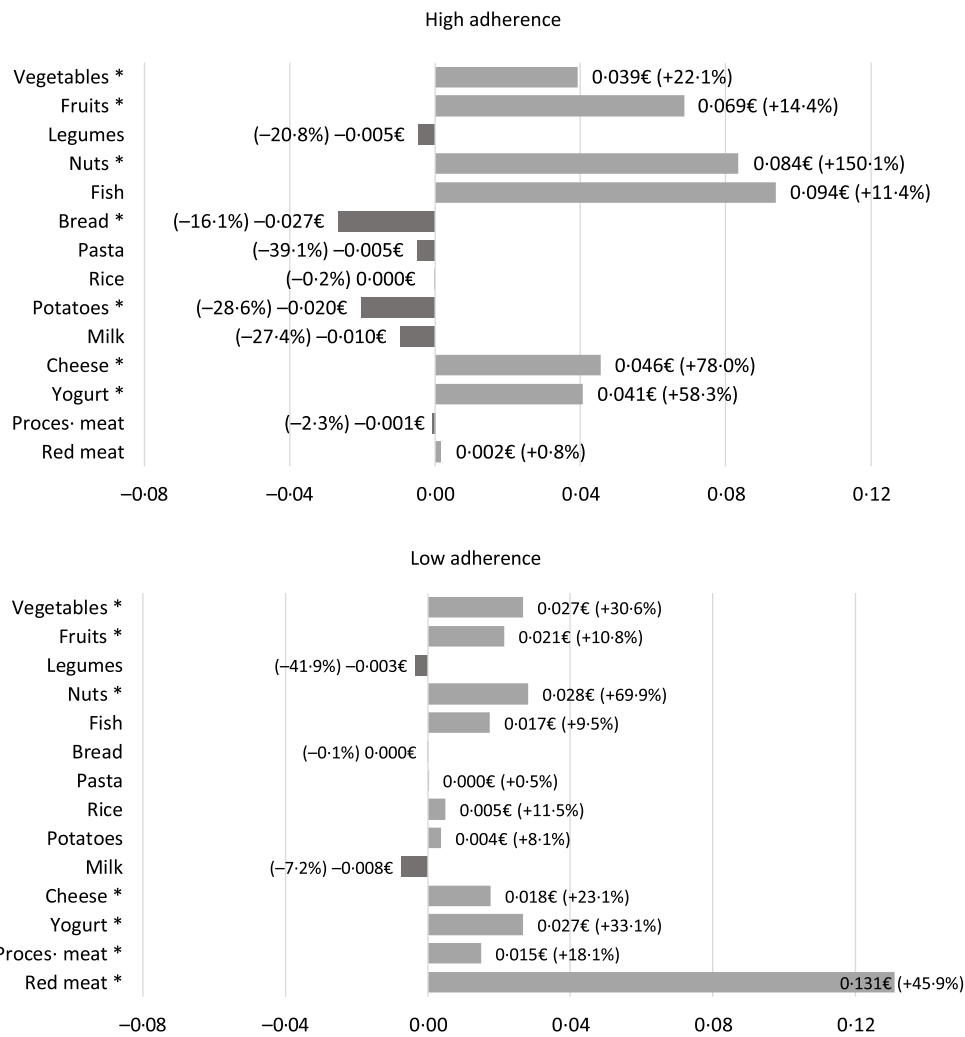
* Statistically significant cost difference found between income groups (*p* < 0·05)

Fig. 2. Absolute differences between high income (>1941€) and low income (<970€) by adherence to the Mediterranean diet (mean dietary cost €/d).

significantly. On the other hand, low-income persons had a significantly higher mean daily cost attributed to the consumption of bread (+0·09€/+16·1 %) and potatoes (+0·09€/+28·6 %).

For low adherence to the MD participants, high-income persons had a significantly higher dietary cost associated with the consumption of red meat (0·13€/+45·9 %), processed meat

(0·01€/+18·1 %), yogurt (0·02€/+33·1 %), cheese (0·01 €/+32·1 %), nuts (0·02€/+69·9 %), fruits (0·02€/+10·8 %) and vegetables (0·02€/+30·6 %).

Discussion

Greater adherence to the MD was associated with a 21·2 % (0·59 €) increase in total dietary cost. These results are in line with similar studies from Europe, which found that the MD patterns are generally more expensive when compared with other western diets[11,13,17,18,34]. The observed differences in total dietary cost between high and low adherence participants were similar to those found in population-based studies from Spain (17·5 and 28·0 %)[17,18], and higher than those in a cohort study from the UK (5·4 %)[13]. The more substantial difference when compared with the UK may be partly explained by the higher consumption of more expensive MD foods like fish in high adherence subgroups from Spain and Portugal. Considering the absolute differences in the mean daily cost between high and low adherence subgroups, while our results showed a + 285·8 % (0·62€/d) difference in mean daily cost related to the consumption of fish, in the UK, the difference in average daily cost was +77·2 % (0·15 £/d). Nevertheless, the dissimilar methods used to assess the adherence and total diet cost of these studies may also contribute to these differing results.

Fish and fruit were the main contributors to the total dietary cost amongst MD high adherents. The greatest gap in total dietary cost was also found in those groups between high and low adherence individuals. In contrast, amongst low adherence participants, the highest dietary cost was related to the intake of meat. Although dietary costs in regard to vegetables were greater among high adherence participants, the total share of cost from this food group in Portugal was lower than those in other countries. For instance, evidence from Spain indicates that vegetables and legumes represented about 1/5 of total dietary cost[17], whereas in Portugal, it was <7 % of total dietary cost. The fact that the price of vegetables in Portugal is lower than the European average may have contributed to this result. Additionally, while our survey accounts for the edible portion of vegetables after being cooked (as consumed), other surveys might have assumed the gross amount at point of purchase, which would lead to higher quantities and greater costs. Finally, food prices were collected in July when most vegetables are in season and thus more abundant and potentially cheaper[35,36]. This could have also underestimated the all-year cost of this food group.

Noticeably, although a slightly higher dietary cost was observed in higher educated people, the differences between education groups were not significant. This finding contradicts those observed in other European countries, where education level was a clear determinant on dietary patterns and spending habits[13,37]. This could result from the largest percentage of low-educated people in Portugal being over 65 years old[38], among whom we found a significantly higher adherence to the MD. Indeed, there is evidence that younger generations in Portugal are shifting away from the MD more quickly than older age groups, which seem less resistant to food-related behaviour changes[9,39]. Hence, education level is less likely to be a significant factor in spending habits, due to the different dietary patterns between older and younger generations.

On the contrary, we observed a sharp gradient in dietary cost between household income groups. First, higher-income participants had significantly higher dietary cost in both low and high adherence groups. It thus seems that the household income has a transversal weight in people's dietary spending habits and dietary behaviour. That high-income persons spend a lower share of their total income on food[14] may allow greater spending on more expensive foods. Also, within the same adherence to the MD groups, the participants' household income led to different mean costs with regard to the intake of food components. For instance, among the high adherence subgroup, participants with higher income had higher daily costs in more expensive MD foods like fish, fruits and nuts. Conversely, lower-income persons had higher daily costs in less expensive MD foods such as cereals. This disparity could mean that some vital nutrient-dense foods are less affordable to lower-income people, including amongst individuals with healthier dietary patterns.

Still, it is worth pointing out that even with lower costs relative to more expensive MD foods, the total dietary cost of lowest-income high adherence to the MD participants (3·20€/d) was higher than the dietary cost of highest-income low adherence ones (2·92€/d). Hence, and unlike what the data from the UK cohort study suggest[13], it is unclear that the population's adherence to the MD could be significantly improved without increasing dietary cost.

In Portugal, considering the average of 23 % of the total family's expenditure spent on food[40], a median equivalised net income of 779€ per month[41] and a household savings rate of 7·1 %[42], the 21·2 % gap in dietary cost could represent an additional real-world 1·12€ per d, or 34€ per month. This discrepancy amounts to roughly 4 % of the individual median earning and implies an even greater excess cost for families with children. Taking into account the equivalence scale for food expenditure[43], a household of two adults and two children, with a net income of 1558€, would spend on average an additional 7 % (102€) of their monthly income to change from a low adherence MD to a high adherence one. Thus, the cost of adhering to the MD can be presented as a substantial barrier, especially for larger households with dependent members.

Limitations

The method of estimating dietary costs by retail prices assumes that foods are purchased, prepared and eaten at home. This methodology neglects the prices of foods consumed away from home or self-produced foods and may underestimate the variability of food prices. This limitation is especially meaningful for the variability of prices within different income groups, whereby high-income persons could purchase more expensive alternatives within the same food group.

Our study does not consider the variability of food prices within different regions in Portugal. There is some evidence of lower prices in more populated areas in which there is access to more retail options; nevertheless, the prices are mostly homogenous throughout the country[31].

Finally, prices of food components were gathered in 2019, while food questionnaires were collected between 2015 and 2016. Possible price and dietary changes during this 3-year gap are therefore not accounted for. This can be meaningful if, for example, the price of a particular food rises more quickly or slowly in relation to other foods, which can then lead to different consumption patterns and dietary costs.

Policy implications

Our findings suggest that policies to promote healthier diets should take into consideration the cost disparity between healthy and less healthy food patterns. The recent implementation of fiscal policies towards healthy diet, in various countries including Portugal, is a step in this direction[44–46]. It shows that even in a Mediterranean country with easier access and relatively lower prices of some MD foods, dietary cost increases with greater adherence to the MD. Furthermore, low-income groups that adhere to MD had more associated costs on food than high-income groups that do not, highlighting the need to make the MD adherence less regressive.

Conclusion

Our study shows that greater adherence to the MD was positively and significantly associated with higher total dietary cost. We found that fish and fruit were the food groups with the highest total dietary cost amongst MD high adherents and contributed the most to the observed cost difference between high and low adherence participants.

Noticeably, while household income was a clear determinant of spending habits (higher income was associated with higher dietary cost), the gap in diet price was less evident among different education levels. More expensive foods like fish, fruits and nuts were less common amongst low-income people, even within participants with healthier dietary patterns, which may elucidate the weight of income and food prices in shaping our food choices.

This cost gap could imply a substantial barrier for low- and middle-income families. Hence, policies to improve dietary patterns will likely be less effective if dietary cost is not considered.

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