

# Assessment of the Cost of the Mediterranean Diet in a Low-Income Region: Adherence and Relationship with Available Incomes

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## Research article

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# Abstract

## Background

The Mediterranean Diet (MD) is recognized as heart-healthy, but the economic cost associated with this type of diet has scarcely been studied.

## Aim

The objective of the present study was to explore the cost and adherence of the low-income region population to the MD and its relationship with available incomes.

## Methods

A population-based study was carried out on 2,833 subjects between 25 and 79 years of age, 54% women, selected at random from the communities of Vegas Altas, La Siberia and La Serena in the province of Badajoz, Extremadura, Spain.

The average cost of each product included in the MD and monthly expenditure were calculated. The expenditure was related to the degree of adherence to the MD (the Panagiotakos Index) and to the incomes of the participants.

## Results

The monthly median cost was 203.6 euros (IQR 154.04-265.37). Food-related expenditure was higher among the male population ( $p < 0.001$ ) of between 45 and 54 years of age ( $p < 0.013$ ) and living in urban areas ( $p < 0.001$ ). A positive correlation between food-related expenditure and the MD adherence was found. Expenditure represents 15% of total incomes, ranging from 11% for the group with a low MD adherence to 17% for the group with a high MD adherence.

## Conclusions

The monthly cost of the MD was positively correlated with the degree of adherence to this dietary pattern, and is similar to that of other regions of Spain with higher per capita income, which entails a greater expenditure for equal adherence to the MD.

## Introduction And Objectives

Cardiovascular disease (CVD) is the primary cause of death in developed countries. Leading a healthy lifestyle (a proper diet, suitable levels of physical activity, and the reduction of toxic habits) is essential to prevent it [1,2]. The Mediterranean Diet (MD) is widely recognised as being cardiovascular-healthy [3,4,5] although few studies have been carried out on the associated cost of this type of food and is rarely used as an argument for debate on following it by the population as part of health policies.

The MD concentrates on the consumption of olive oil as the main source of fat; a high consumption of fruit, vegetables, nuts and dried fruit, and whole grains; a moderate consumption of wine, meat, fish, eggs, and dairy products; and a low consumption of red meat, processed foods, and sugary drinks [1]. Several studies have found that those populations with a high adherence to MD patterns show a lower rate of CVD [3-6]. In 2010 the UNESCO declared the MD to be an Intangible Cultural Heritage of Humanity and the World Health Organisation classed it as a diet giving protection against CVD [7].

The cost of food plays an important role in determining decisions related to the purchase and consumption of food [8]. The first tests regarding the monetary cost of food products were first carried in the late 1990 [9]. Since then, several studies have provided reports on economic aspects of eating patterns [10,11,14-17].

It has been pointed out that healthy diets cost more than unhealthy diets [10]. A recent review showed that a diet rich in fruit, vegetables, and walnuts was on average 1.5 dollars more expensive per day than a diet of processed foods, meat, and refined cereals [11].

Following a cheaper diet may give rise to health problems for consumers owing to a reduction in nutritional quality. The cost of the diet may therefore constitute an obstacle to the adopting of a healthy diet, in particular among people with a lower socioeconomic level [12,13].

This socioeconomic gradient in the quality of their diet is thus capable of contributing to the disparity of health among the various socioeconomic groups [14], which ultimately leads to an increase in overall social costs [15,16]. Estimates for Spain have also corroborated the higher associated cost of higher adherence to the MD, but noteworthy differences can be found between studies with the cost of high adherence being between 18% and 28% higher than that of low adherence [17,18]. However, none of these studies have related the cost of the MD to the disposable income, which is highly relevant if we are to assess the level of attainability of the MD for families.

Our objective was to study the cost and level of adherence to the MD of the population of a low-income region together with its relationship to the level of disposable income.

## **Materials And Methods**

### *Study sample*

A cohort study consisting of a population sample of 2.833 subjects selected at random to represent the population between 25 and 79 years of age of the communities of Vegas Altas, La Siberia, and La Serena in the province of Badajoz (Extremadura), the population of which corresponding to this age group is 75.455 inhabitants. The characteristics of the sample, the participation rate, and the methodology have previously been published [19].

### *Nutritional register*

The dietary assessment of the participants was carried out by means of a semi-quantitative questionnaire on the frequency of food consumption with 157 food variables and 7 variables related to the consumption of alcoholic drinks, previously validated [20] (see Table A1 of the Appendix). In all of them we assessed intake on a scale of 0 to 9 in which 0 corresponds to “never or less than once a month” and 9 to “6 or more times a day”.

### Cost assessment

In order to calculate the daily (monthly) cost of the diet the stages mentioned below were followed. Firstly, the answers obtained on consumption frequencies were translated in terms of grams or millilitres (see note to Table A1 of the Appendix). Secondly, taking the year 2019 as a reference the average price was obtained for each of the categories considered, using price comparators of supermarkets located in the same geographical area as that of the population sample, i.e. Carrefour, Mercadona, and Día (see Table A2 of the Appendix for details of the number of references used in each category and the average, minimum, and maximum prices). Thirdly, by using the daily (monthly) amounts consumed and the price of each category the total daily (monthly) cost for each participant was obtained.

The costs of the products are presented with the mean and standard deviation (SD) when they follow a Gaussian distribution and with the median and interquartile range (IQR) when the distribution is not normal.

### Statistical analysis

Once the total cost had been calculated, an analysis was performed segmenting the population by sex, age, educational level and their belonging to the urban or rural sectors to then carry out a lineal regression between the cost and such segmentation variables (p-values are shown by means of the 3000 bootstrap samples).

Finally, costs were correlated to adherence to MD using the Panagiotakos Adherence Index<sup>21</sup> (PAI), the results of which were divided by establishing 3 adherence groups based on the score obtained: low (adherence to MD < 29.99), medium (adherence to MD between 30 and 33.99) and high (adherence >34) [21].

A recent systematic review places this index as one of those that provides the most outstanding amount of information [22] and for that reason, it was selected to assess adherence to MD.

The different cost levels associated to the different degrees of adherence to MD were compared by using the Pearson’s correlation index as a measure of lineal association and the Kruskal-Wallis test as a non-parametric tool to study the significance of the differences between the different levels of adherence. A value of  $p < 0.05$  was considered significant.

In order to compare income, data from the Statistical System of Extremadura [23] were used. The average disposable income (month/year) was calculated as a weighted average among the different municipalities of the of Vegas Alta, La Serena and La Siberia.

Microsoft Excel and statistical package IBM SPSS 21 were used as computer support.

## Results

Table 1 shows that the median of the monthly food cost (MFC) was 203.63 Euros (IQR 154.04-265.37) with this cost being 216.91 Euros (IQR 167.64-280.13) for men and 191.22 Euros (IQR 145.07-248) for women; this means that the MFC of men was 13.43% higher than that of women ( $p < 0.001$ ).

The MFC median by age cohorts ( $p < 0.013$ ) takes the form of an inverted U with a maximum in the cohort of 45-54 years of age (212.11 Euros; IQR 155.47-274.63). The minimum cost corresponds to the cohort of 75-79 years of age (179 Euros; IQR 130.21-224.99), i.e. 15.61% less than the cohort of 45-54 years of age.

With regard to the area of residence, the cost in rural areas was 188.26 Euros (IQR 147.83 -232.93) whereas it was 223.52 Euros (IQR 166.06 -296.91) in urban areas, i.e. 14,64% less among inhabitants of rural areas ( $p < 0.001$ ).

No significant differences were found between different levels of education and the MFC ( $p < 0.701$ ).

The MFC was positively correlated with the level of adherence to the MD as it was observed that higher adherence involves higher costs. According to PAI, the MFC associated with high adherence was 229.38 Euros. Among individuals with a high adherence the MFC is 34.50% higher than that of those of average adherence and 49.37% higher than that of those of low adherence. This relation is reflected in the positive values of Pearson's coefficient and in the significant differences between the different groups of adherence according to the Kruskal-Wallis test (Table 2).

Table 3 shows the MFC and the PAI as percentages of various income indicators. The median of the MFC represents 22.60% of the official minimum wage, 37.81% of the IPREM (the indicator used to calculate the minimum guaranteed income), 44.02% of the minimum living income support, and 51.88% of the non-contributory pension. Even when adherence to the MD is low, this cost is close to 30% for the IPREM and above this threshold for minimum living income support and non-contributory pensions.

Table 3 also shows the MFC and PAI in relation with the average disposable income for Spain, Extremadura, Badajoz and in the communities of Vegas Altas, La Siberia and La Serena. The MFC in the communities represents 14.98% of the average disposable income, ranging between 11.31% for the group with low adherence and 16.90% for the group with high adherence, according to the PAI. These values are similar for Badajoz and Extremadura. It is observed that the MFC associated to the MD represents 10.78% of the national average disposable income, ranging from 8.14% for the group with low adherence and 12.16% for the group with high adherence.

## Discussion

In a low-income region of Spain, the median of the MFC was 203.63 Euros. The MFC was higher in the masculine population, in that of between 45 and 54 years of age, and in the urban population. It had a positive correlation with the level of adherence to the MD.

This study is the first to relate the cost, level of adherence, and level of income to the MD in the population of Extremadura, which is that of the lowest per capita income in Spain [24].

### Costs, economic resources, and adherence to the MD

Despite the significant differences in income between regions such as Navarra, Cataluña, and Extremadura [24], the MFC recorded is along the lines of that of the studies of Fresán et al. [25] and Schröder et al [18]. In the former study, which uses data from a university population between 27 and 45 years of age, the estimated MFC was 226 Euros. In the study of Schröder et al [18], which took into account a population between 25 and 74 years of age, the MFC was 220 Euros. Considering that the average levels of income of the regions are very different, it is clear that the importance will differ in accordance with the income of each region.

The relationship between economic resources and the level of adherence to a healthy diet is a factor which is not usually considered in daily welfare clinical practice. Various studies [10,15,16] have described a higher level of adherence to the healthy pattern of the MD in a population with higher income. Schröder et al. [18] observed that the MFC associated with high adherence was 237.60 Euros while that associated with low adherence was 202.20 Euros.

For their part, López et al. [26] stressed that good adherence to the MD involves a higher cost than good adherence to other dietary patterns. In their study they describe the eating behaviour of 11,195 participants and affirm that the expenditure of subjects with good adherence to the MD was higher (0.64 Euros more for each 1000 kcal) than that of those with the same level of adherence to the “Western food pattern”.

According to a study of 2014 of the Harvard School of Public Health [27], which analysed consumer choices in recent decades, differences in the choice of food between individuals with a higher and lower level of income are becoming more relevant every year. The economic crisis contributed towards the increasingly unhealthy eating habits of the population with lower economic resources. In contrast to our study, which found no differences owing to the level of education, these authors also highlight this second factor as another determinant.

In the Moli-Sani study [28], which related following a healthy diet to economic variables of the adult population of the Italian region of Molise, the higher income groups showed a positive difference of two points in adherence to the MD, which was also associated with a 15% reduction of the risk of CVD.

As for our findings on lower expenses in the case of women, as far as we are aware there has so far been no research which has studied this aspect in depth. Nevertheless, our hypothesis would be that the lower expenses of women could be due to their better use of resources, as traditionally women earn less than men [29,30] and their socio-cultural pattern is characterised by a greater involvement in household tasks. Future studies should also explore the possibility that there are differences between the dietary habits of both sexes.

Neither have we found any information on lower expenses in rural areas; this may be due to the lower cost of foods in this milieu together with the greater direct availability of foods of higher nutritional value (i.e. fruit and greens from vegetable gardens).

Finally, age as a determinant of the choice of diet may be influenced by the lower level of income and the different food habits of the two extremes of life, i.e. young people and pensioners. A closer look should be taken at all this in suitably designed studies.

### Choices in the management of public health

If we analyse these data from the perspective of public health policies, those strategies to improve the quality of diet should be emphasised, in particular for people with a relatively low socioeconomic level [31]. These actions can be carried out in two complementary ways. Firstly consumers should be educated on the nutritional value and cost of food. In this sense the studies of Drewnowski et al. [32] and Goulet et al. [33] confirm the fact that Mediterranean-style foods can be obtained at all price ranges whether they are calculated in grams or calories. The only condition is to include more cereals, vegetables, and seasonal fruit; this allows the reproduction of the Mediterranean diet at a reasonable price. As far as food education for citizens is concerned a possibility would be to go more deeply into how healthy foods can be selectively acquired in the form of products of different economic value, thus lowering the total cost of the diet.

Secondly, the possibility of reducing taxes on food consumption (VAT) that favours the choice of healthy diet patterns (e.g. MD) [34,35], or to increase taxes on unhealthy food (e.g. sugary drinks) [36,37,38] is being discussed. In this sense, Andreyeva et al [39], highlight the difficulty to carry out a proper analysis due to the price elasticity and consumption collected in “normal market” conditions that may vary should the economic scenario change (for instance, an increase on VAT).

Given the consensus of the scientific community about the importance of the elasticity of the variables and subsequent gaps observed in this field, future research should focus on the prediction of the impact of those public health policies and for this reason, the analysis of the effect and implications of those measures becomes a field of research for future projects. Interdisciplinary consensus work is essential.

## **LIMITATIONS**

The main limitations which this study has faced are two in number. On the one hand we have the fact of using consumption data from 2007-2009 and information on prices from 2019, and on the other the

possibility of extrapolating the results obtained for this region at a national level.

In relation to the first limitation, Table A3 of the Appendix shows the average accumulated annual rate of the Spanish Consumer Price Index (CPI) for foods, non alcoholic drinks, and alcoholic drinks together with the average available income for 2008-2019. It can be observed that the accumulated annual average growth rate in Badajoz is slightly higher than the growth rate of the CPI components mentioned. Consequently, there has been no loss in purchasing power in said components during the period considered, and it can be taken into account that the data on diet collected in 2007-2009 are also representative of diet in 2019.

As far as the second limitation is concerned, the extrapolation of the average cost of the MD in the communities of Vegas Altas, La Serena, and La Siberia to the Spanish total shows some restrictions. Firstly, the average available income in Spain was 37.67% (29.79%) higher than that of Badajoz in 2008 (2019). Secondly, the percentage of the family budget devoted to food is higher in Badajoz (39.20 percentage points in 2008 and 42.27 percentage points in 2019) (see Table A4 of the Appendix). Nevertheless, for both the average for Spain and for Badajoz, there has been a decrease of the percentage represented by food in the shopping basket (-13.96 points for Spain and -17.03 points for Badajoz). On the other hand, the accumulate average annual growth of the average disposable income has been higher in Badajoz (1.376% compared to 0.834%) and also higher than the growth of the three groups of goods considered (food, non-alcoholic drinks and alcoholic drinks) (see Table A4 of the Appendix). These data suggest a process of convergence of the average disposable income in Badajoz in comparison to the average Spanish income and also a greater similarity with the consumption patterns at a national level.

## Conclusion

The MFC in a low-income region was positively correlated with the level of adherence to the MD and is similar to that of other Spanish regions with a higher per capita income, which relates higher expenditure to equality of adherence to the MD.

Our results should have a particular political and sanitary impact regarding the management of areas with lower economic resources. Knowledge of and handling of this information by healthcare personnel should be useful if they consider in their dietary indications the economic factors having a positive or negative effect on their compliance.

## Declarations

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**Conflict of interest/competing interests:** None.

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**Authors' contribution:** AR: Conception and design of the work; interpretation of data; analysis of the results; drafting and revision of the manuscript; final approval of version to be published; accountability for all aspects of the work. CVP: Conception and design of the work; interpretation of data; analysis of the results; drafting and revision of the manuscript; final approval of version to be published. MFA: analysis of the results; drafting and revision of the manuscript; final approval of version to be published. LYR: analysis of the results; drafting of the manuscript; final approval of version to be published. MHG: interpretation of data; drafting of the manuscript; final approval of version to be published. FJFG: interpretation of data; drafting of the manuscript; final approval of version to be published. FJFR: Conception and design of the work; interpretation of data; analysis of the results; revision of the manuscript; final approval of version to be published; accountability for all aspects of the work. DFB: Conception and design of the work; interpretation of data; analysis of the results; drafting and revision of the manuscript; final approval of version to be published; accountability for all aspects of the work.

**Ethics approval:** Approved by the Ethics Committee of the University Hospital of Badajoz

**Consent to participate:** Collected all the consents of the 2833 participants in the study. Available on request

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## Tables

**Table 1. Descriptive statistics of costs categorized by sex, age, level of education and place of residence.**

Sex*		Total	Male	Female			
N		2.833	1.317	1.516			
	%	100%	46,49%	53,51%			
Median		203,63	216,91	191,22			
Percentiles	25	154,04	167,64	145,07			
	75	265,37	280,13	248,00			
Age **		25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
N		407	671	616	502	418	219
	%	14,37%	23,69%	21,74%	17,72%	14,75%	7,73%
Median		203,27	206,63	212,11	210,76	193,95	179,00
Percentiles	25	152,48	158,10	155,47	163,44	149,46	130,21
	75	266,73	270,79	274,63	267,36	246,18	224,99
Place of Residence *** and level of education ****		Rural	Urban	Illiterate	Primary studies	Secondary studies	Higher degree, university o similar
N		1.445	1.388	358	1.541	586	348
	%	51,36%	48,64%	12,64%	54,39	20,68%	12,29%
Median		188,26	223,52	177,70	208,18	206,57	205,70
Percentiles	25	147,83	166,06	131,84	156,83	157,75	161,12
	75	232,93	296,91	223,73	269,78	271,28	269,06

Own elaboration with data from HERMEX study. \* p <0,001; \*\* p <0,013; \*\*\* p < 0,001; \*\*\*\*: p < 0,701.

**Table 2. Monthly cost according to the indicator of adherence to the Mediterranean Diet of Panagiotakos**

		Low adherence	Medium adherence	High adherence
N		335	828	1670
	%	11,82	29,23	59,95
Median		153,56	170,54	229,38
Percentiles	25	117,25	138,46	184,35
	75	204,19	213,30	295,64
Pearson's correlation		0,39		
Kruskal-Wallis' test		0,001		

Own elaboration with data from HERMEX study.

**Table 3. Monthly cost and adherence rates for various income indicators**

	Median cost (€/month)	MW * 2019	IPREM** 2019	MVI *** 2020	nCP **** 2019
Income index (€/month) In % respect to the average income	203,36	900 22,60%	537,84 37,81%	462 44,02%	392 51,88%
PAI***** Low adherence	153,56	17,06%	28,55%	33,24%	39,17%
Medium adherence	170,54	18,95%	31,71%	36,91%	43,51%
High adherence	229,38	25,49%	42,65%	49,65%	58,52%
	Median cost (€/month)	Spain	Extremadura	Badajoz	Communities of Vegas Altas, La Siberia and La Serena
Average disposable income (€/year)		22.634	17.361	17.439	16.288
Average disposable income (€/month)		1886,17	1446,75	1453,25	1357,30
In % respect to the average income	203,36	10,78%	14,06%	13,99%	14,98%
PAI***** Low adherence	153,56	8,14%	10,61%	10,57%	11,31%
Medium adherence	170,54	9,04%	11,79%	11,74%	12,56%
High adherence	229,38	12,16%	15,85%	15,78%	16,90%

\* MW: Minimum Wage

\*\* IPREM: Public Indicator of Multiple Effects Income

\*\*\* MVI: Minimum Living Income (single-person household)

\*\*\*\* nCP: Non-Contributory Pension (one-person household)

\*\*\*\*\* PAI: Panagiotakos Adherence Index

Own elaboration based on data from the Statistical System of Extremadura - Citizen Portal (gobex.es)

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryMaterial.pdf](#)