

# Public health implications of the Mediterranean Diet : its interaction with active and passive smoking

Citation for published version (APA):

Vardavas, C. I. (2010). *Public health implications of the Mediterranean Diet : its interaction with active and passive smoking*. [Doctoral Thesis, Maastricht University]. Datawyse / Universitaire Pers Maastricht. <https://doi.org/10.26481/dis.20100527cv>

## Document status and date:

Published: 01/01/2010

## DOI:

[10.26481/dis.20100527cv](https://doi.org/10.26481/dis.20100527cv)

## Document Version:

Publisher's PDF, also known as Version of record

## Please check the document version of this publication:

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## Summary

This thesis describes the public health implications of adherence to the Mediterranean diet among farmers from the island of Crete, Greece and secondly indicates how adherence to the Mediterranean diet could have a protective role against the ramifications of active and passive smoking.

The main core of research was provided through the context of the MESSARA study, which was a cross sectional study of 500 farmers randomly selected from villages of the Valley of Messara, not far from the villages from which participants of the historical Seven Countries Study (SCS) were recruited from almost 50 years ago. In addition to the MESSARA study, data from the cross sectional MEDIS study (data courteously provided by Prof Panagiotakos of the Harokopio University of Athens), was analysed so as to investigate the interaction between diabetes, secondhand smoke and adherence to the Mediterranean diet among a cohort of 1190 elderly (aged 65 to 100 years) men and women from the Republic of Cyprus, and the Greek islands of Mitilini, Samothrace, Cephalonia, Crete, Limnos, Corfu and Zakynthos.

As described in **chapter 2**, we compared the risk factors for the development of CVD between farmers from Crete in the 1960's and farmers from Crete in 2005. Our results were compared with both findings from the initial SCS, led by Prof Ancel Keys in 1960 and from a regional study led by Prof Christakis a few years later. According to these findings, although smoking status and diastolic blood pressure was not found to differ between the two cohorts, the majority of other indexes were found to be significantly different. Total serum cholesterol was found to have increased by 16% from  $206.9 \pm 41.4$  mg/dl to  $239.6 \pm 45.8$ mg/dl and this difference was statistically significant ( $p < 0.001$ ), while the percentage of the population with total serum cholesterol  $> 200$  rose by 22%, from 51.5% in the SCS to 73.6% in 2005. From a public health perspective this increase in serum cholesterol levels would have a significant impact on the development of CVD. One consoling finding was that systolic blood pressure was found to have dropped by 8%, as also the percentage of the population with high blood pressure (by -26%) a fact which we attribute to the improvement in hypertensive treatment and primary care prevention of hypertension.

Although the energy intake among participants of the SCS was higher than those of the MESSARA study a significant increase in the daily intake of PUFA and SFA from 13.4g to 14.7g and from 28g to 30.4g was noted, and these differences were statistically significant ( $p = 0.035$  and  $p = 0.031$  respectively). The daily intake of MUFA has

on the other hand decreased over the past 45 years from 84.1 g to 63.4 g ( $p < 0.001$ ). The above dietary fat and energy intake have also affected the BMI among farmers in Crete and the mean BMI was found to have increased by almost 7 kg/m<sup>2</sup> over the past 45 years from 23 kg/m<sup>2</sup> to almost 30 kg/m<sup>2</sup> ( $p < 0.001$ ). This surprisingly large increase in BMI among farmers of Crete is a direct indicator of their increased risk for the development of CVD. Puzzled by these scientific findings we investigated into the possible dietary intakes of farmers from Crete then and now by comparing food groups initially and secondly by comparing the fatty acid composition of gluteal adipose tissue. Indeed the daily intake of fruit alone in the 1960's SCS cohort was 464gr in comparison to today's 118gr (-75%,  $p < 0.001$ ) of the MESSARA cohort, while combined consumption of fruit and vegetables dropped 39% (655 to 401gr,  $p < 0.001$ ).

Moreover farmers of the MESSARA study were found to consume 254% more meat per day, a very strong indicator of their non adherence to the Mediterranean diet. These dietary preferences were also corroborated by the adipose tissue composition which indicated an increase in the percentage of saturated fats and a decrease in the percentage of monounsaturated fats located within gluteal adipose tissue. In summary it has become clear that from the world famous mediterranean diet originated in Crete, little is left nowadays which certainly will have its public health implication in the near and far future for the population in Crete.

In **chapter 3**, we investigated into the obesity indexes of both men and women of the MESSARA study and found that 86% of the population was either overweight or obese. Specifically 42.9 % had a BMI of 25.1 –30 kg/m<sup>2</sup> and were overweight and 43.2 % were obese with a BMI > 30 kg/m<sup>2</sup>. The percentage of body fat was estimated at 27.3 % of total body weight among males and 39.3 % among females. Moreover for all indexes, women were found to be of a higher risk for the development of chronic disease as both BMI and waist circumference were statistically related to gender with a p-value of 0.007 and <0.001 respectively. Similar findings were also found regarding WC (males 100.4 cm, females 102.7 cm,  $p = 0.037$ ), W/Hip ratio (males 0.99, females 0.96,  $p = 0.001$ ) and W/Height ratio (males 0.60, females 0.66,  $p < 0.001$ ). Additionally the participants conicity index was found to be affected by gender ( $p < 0.001$ ), daily energy intake ( $p = 0.019$ ) and fasting days that the participant adheres to per year ( $p = 0.010$ ), leading us to investigate into the role of the fasting rituals of the Mediterranean diet, and we did so in the study presented in **chapter 4**.

In **chapter 4** we showed that nutrient and food intake profiles of Greek Orthodox monks were favourable in the fasting weeks in comparison to non fasting weeks. Lower intakes of total, saturated and trans fatty acids were noted, while on the contrary the participants were noted to have a higher intake of dietary fibre, folate

legumes and seafood. This important compound of the Mediterranean diet should be widely recognised for its ability to lower serum cholesterol lipid levels, as noted within the context of this study. Furthermore, the ratio of total:HDL-cholesterol, a better predictor of coronary heart disease risk status than total cholesterol levels, was also significantly lower during the fasting week, suggesting the potential contribution of the Greek Orthodox fasting rituals in favourable blood lipid profiles. It is possible at a population based level that public health could be effectively influenced by such a lipid profile. A further indication of the healthy dietary habits associated with the Greek Orthodox Church's fasting rituals is the increased mean daily fruit and vegetable intake observed during the fasting weeks, which would act protectively against the development of chronic diseases such as cancer and CVD, which could thus have an impact on mortality and public health.

In **chapter 5**, an overview is given about the possible role of the Mediterranean diet as an effect modifier of the role active and passive smoking can have on ones health and a number of mechanisms and possible role of micronutrients and antioxidants is discussed. One important point raised by this review is that smokers often have a different dietary profile when compared to non smokers and thus the epidemiological noted differences could be attributed to a "smoker diet" and not solely to cigarette smokes role on circulating lipids, antioxidants and atherosclerotic mechanisms in the human body.

Taking the above into account we deemed it of interest to investigate into the dietary intakes of both smokers and non-smokers and how they have an effect on selected serum micronutrients. Thus we investigated into this hypothesis through the MESSARA study participants for whom analytical dietary data was available and the results of this investigation are presented in **chapter 6**. According to the collected information and after controlling for possible confounding factors such as age, gender and Christian Orthodox fasting rituals current smokers were found to have a lower dietary intake of vitamin C (112.1mg vs. 136.4mg,  $p=0.03$ ), fibre (16.6g vs. 19.1g,  $p=0.006$ ) and fruits and vegetables (339g vs. 412g,  $p=0.014$ ), while dietary vitamin B<sub>1</sub> intake was found to be higher (1.7mg vs. 1.4 mg,  $p=0.02$ ) in comparison to non/ex smokers. This different dietary pattern has an impact on their intake of essential micronutrients and antioxidants. This in coherence with their increased oxidative stress that they are exposed to could further predispose smokers to chronic disease development.

Moreover, almost 40% of the participants of the MESSARA study were found to consume less than 67% of the RDA for fruit and vegetables. A fact that is indicative that the population of the Messara valley, or a subgroup of it, may not adhere to the traditional Mediterranean diet of Crete.

In **Chapter 7**, we investigated into the factors that influence the development of diabetes mellitus among the elderly and found that hypertension (OR 2.07), family history of diabetes (OR 4.46) and body mass increase (OR 1.05 per 1 kg/m<sup>2</sup> increase) were risk factors for the development of diabetes mellitus. Taking these factors into account we must stress that adherence to the Mediterranean diet has been shown to effectively reduce these factors independently and thus subsequently could reduce the prevalence of diabetes mellitus and thus have an additional role in public health measures. Furthermore, chronic exposure to second hand smoke was independently related to the development of type II diabetes mellitus (OR 1.60), while on the other hand adherence to the Mediterranean diet (assessed with a 55 point dietary scale) was independently found to act protectively against the development of type II diabetes mellitus (OR 0.97 per 1/55 units).

In summary, from the series of studies described in this thesis the main conclusions are that:

- The potential risk for the development of CVD among farmers from Crete has significantly changed over the past 45 years with current farmers found to have a by 7kg/m<sup>3</sup> higher BMI, higher cholesterol levels and lower levels of physical activity albeit lower mean systolic blood pressure in comparison to the initial participants of the SCS.
- The above changes in the prevalence of the above CVD risk factors are attributable to the population's non adherence to the Mediterranean diet as indicated through both the decrease in consumption of fruit and vegetables and the increase in consumption of meat. These above dietary differences have lead to an alteration of the fatty acid composition of gluteal adipose tissue over the past 45 years with a noted increase in the percentage of saturated fats and a decrease with the percentage of monounsaturated fats within gluteal adipose tissue.
- The majority of farmers from Messara in Crete were overweight and obese while their farmers' concity index was found to be related to energy intake and the number of fasting days per week.
- Adherence to the Mediterranean diet and specifically to the fasting rituals of the Mediterranean diet can increase the intake of fibre, folate, antioxidants vitamins and reduce fat intake. The latter has an impact on total serum cholesterol levels.
- Smoking status has a significant impact on dietary preferences as smokers were found to have a lower dietary intake of antioxidants, fruit and vegetables while a higher intake of meat. These dietary preferences of smokers increase the percentage of the population that receives less than the recommended daily allowance in essential micronutrients and vitamins.

- Chronic exposure to second hand smoke is related to the development of type II diabetes mellitus, while adherence to the Mediterranean diet is independently found to act protectively against the development of type II diabetes mellitus at a population based level.

Further research is necessary to investigate into the public health implications of the interaction between active/passive smoking and adherence to the Mediterranean diet through prospective cohort studies or dietary/exposure control trials.

The farming population of Crete would benefit from population based and school based educational interventions. Having identified the problem within the context of the MESSARA study, a campaign aimed on educating the young population of the Messara valley in regards to the beneficial effects of a healthy lifestyle, that would include smoking prevention, physical activity and adherence to the traditional Mediterranean diet, is essential.

Smoking and exposure to secondhand smoke must be recognised as two significant factors that may play a role in the development of chronic disease among populations that adhere to the Mediterranean diet, and efforts should be made so as to both “denormalise” smoking and eliminate exposure to secondhand smoke in public places, such as the traditional “kafenia”.

Health practitioners, school teachers and the local authorities should unify their efforts so as to promote good health and protect public health in both rural areas as also urban areas of Crete.

