



Choosing a healthy and sustainable diet: A three-level approach for understanding the drivers of the Italians' dietary regime over time

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ABSTRACT

Dietary patterns play key roles in health promotion and in preserving the environment. A growing number of studies show the importance of individual factors on food consumption choices, such as socio-economic status, lifestyle variables and contextual and social factors that characterize the geographical area in which individuals reside. The Mediterranean Diet is a sustainable diet that respects the environment, thus reducing per capita emissions from food production in respect to less sustainable diet. The aim of this paper is to determine the Italians' prevailing food patterns using a composite indicator and to identify which factors determine a higher adherence to the Mediterranean Diet in Italy. By using 15 waves of the ISTAT "Aspect of Daily Life" survey, we constructed an original data set and referred to the multilevel approach which enabled us to distinguish between temporal and cross-sectional effects thus providing valuable insights to policy makers and stakeholders in order to promote the Mediterranean Diet and reap environmental and public health. The results show that education plays an important role in determining food consumption behavior while the tendency to practice sports on a regular basis and to have breakfast and lunch at home positively influence people's adherence to this diet.

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1. Introduction

Over the last decades, the environmental consequences of food patterns have become a major issue for policy makers, especially in developed countries where government, non-government and charitable organizations as well as civil society movements have developed sustainable dietary recommendations which safeguard human health and the environment (Barilla Center for Food and Nutrition, 2011; Health Council of the Netherlands, 2011, 2015; Inran, 2003; Swedish National Food Agency, 2015).

Indeed, food consumption and dietary patterns have proved to be strongly associated with individuals' health-related quality of life and with environmental impacts on ecosystems (Donati et al., 2016; Duchin, 2005; Goodland, 1997; Sáez-Almendros, Obrador, Bach-Faig, & Serra-Majem, 2013; Weber & Matthews, 2008; WHO, 2008). The food sector is responsible for between 15% and 31% of total greenhouse gas emissions (GHGE) (Garnett, 2008;

Tilman & Clark, 2014) even if the environmental impact depends on the types of food produced and consumed (Vieux, Darmon, Touazi, & Soler, 2013). Meat products proved to have a higher environmental impact than cereal products, fruit and vegetables as demonstrated in numerous studies (White, 2000; Tilman & Clark, 2014; Tukker et al., 2006, 2011; Westhoek et al., 2014; Gerber et al., 2013; Reijnders & Soret, 2003; Ness & Powles, 1997; Joshipura et al., 2001).

Many studies have analysed the factors influencing individuals' food choice patterns in order to determine the requirements for an environmentally sustainable food system, more eco-friendly food patterns and to help policy makers to design healthy dietary guidelines (Aranceta and Perez-Rodrigo, 2012; Hadjikakou, 2017; Verzeletti, Maes, Santinello, Baldassari, & Vereecken, 2010).

Individual food choices are influenced by a wide variety of individual and environmental (contextual) variables. French (2003, p.842S) emphasized that "three main dimensions related to food choices are taste, perceived value (which includes price and portion size) and perceived nutrition". The importance placed on each dimension vary among different individuals.

In this stream of literature, the influence of socio-economic

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status – measured using various indicators such as level of education, income, employment status, type of employment as well as composite indicators of individual or household wealth – has proved to play an important role in determining individuals' food choice patterns (Dernini & Berry, 2015; Lopez et al., 2009; Moreno et al., 2005; Scali, Richard, & Gerber, 2001). Several studies have highlighted that “people belonging to the lower socio-economic groups are more likely to follow less nutritious diets” (Benedetti, Biggeri, Laureti, & Secondi, 2016) characterized by a high consumption of refined grains and added fats (Darmon & Drewnowski, 2008; Katsarou, Bountziouka, & Panagiotakos, 2010). By referring to the three dimensions identified by French (2003, p.842S) “individuals of lower socioeconomic status may place greater importance on perceived value, whereas those more concerned about health and nutrition may attach more importance on the nutritional quality of foods”. Therefore, even if people are aware of the beneficial effects of healthy food when they are faced with dimensions of price and taste, they may choose tastier, cheaper, but less nutritious food. Pechey, Monsivais, Ng, and Marteau (2015) studied the differences in food patterns among the various socio-economic groups and showed that individuals with low socio-economic status have a dietary pattern mainly composed of less healthy foods and beverages while people belonging to high socio-economic groups tend to follow a healthier diet.

As regards to European countries, De Irala-Estevez et al. (2000) found a positive association between socio-economic status and fruit and vegetable consumption, while in Spain, Aranceta, Perez-Rodrigo, Ribas, and Serra-Majem (2003) showed that children and young people with a low socioeconomic background and those with undereducated mothers consume high quantities of sweets, high-fat bakery products and sugary and salted snacks, but they consume fewer vegetables. Del Mar Bibiloni et al. (2011) analysed a sample of Balearic Islands' adolescents and found that “low parental socio-economic status, much leisure-time spent in sedentary behaviours such as media screen time and body image” are factors associated with the “Western” dietary pattern and therefore with a low level of adherence to the Mediterranean dietary regime.

Despite the increase in studies concerning the relationship between socio-economic and lifestyle factors and the adherence to a sustainable diet, few studies have been carried out on this issue in Italy therefore further research is required to improve policy-making.

The aim of this paper is to contribute to this literature by exploring the main socio-economic factors influencing people's food habits in Italy which is historically identified as a country with a high adherence to Mediterranean dietary patterns (Trichopoulos & Pagona Lagiou, 1997).

Among the various nutritional patterns, the traditional Mediterranean Diet (MD) appears to be the healthiest and most well-balanced diet due to environmental and human health benefits: healthy foods which should be frequently consumed – such as fruits, vegetables, cereals, legumes and fish (Trichopoulou et al., 2003; Bach-Faig et al., 2011) – are also foods with a low environmental impact.

In fact nowadays, the MD is appreciated for its low environmental impact, mainly due to the large amount of plant-derived products and reduced consumption of animal products compared to other dietary patterns (De Boer, Helms, & Aiking, 2006; De Boer, 2009; Tilman & Clark, 2014). Due to its nutritional characteristics as well as its economic, environmental and socio-cultural impacts, the MD has been recognized by Unesco as an intangible cultural heritage of humanity (Germani et al., 2014). The MD is a sustainable diet which, according to the recent definition of the FAO, has low environmental impacts, contributes to food and nutrition security

and promote healthy lifestyles for present and future generations. Moreover, sustainable diets safeguard biodiversity and ecosystems, are economically fair and affordable and optimize natural and human resources (FAO, 2010).

UNESCO considers the MD as a “Mediterranean way of living”, which means eating healthy food but also adopting a specific way of life consisting in conviviality, traditions and a moderate amount of daily physical activity (Bonaccio, Iacoviello, & De Gaetano, 2012). In the most recent versions of the well-known “Mediterranean Diet Pyramid”, there are further recommendations for a correct lifestyle, such as how much water and wine should be drunk, how much time should be dedicated to physical activity, the importance of consuming local produced food and the safeguarding of the environment with the aim of promoting a “healthier food-lifestyle” thus reducing the incidence of chronic diseases (Bach-Faig et al., 2011).

Some lifestyle factors are of particular interest in the context of the “Mediterranean Way”: the social support and sense of community that accompanies sharing food with family and friends; lengthy meals that provide relief from stress and afternoon naps which give individuals the opportunity for rest and relaxation (Willett, 1995).

Bearing in mind these special characteristics of the MD, some studies have investigated the effects of the timing of eating events throughout the day (Ma et al., 2003) as well as daily food habits, such as dining with family members and having stricter dietary rules (Verzeletti et al., 2010). Moreover, Mancini, Marchini, and Simeone (2016) found that psychological stress is a potential risk factor for an incorrect dietary pattern and proved the existence of a cyclical and reciprocal interaction between stress, inadequate diet and socio-relational environment.

Most of the studies carried out in Italy evaluated citizens' adherence to the MD and the health benefits obtained (Sofi et al., 2010; Leclercq et al., 2009; Germani et al., 2014) while few studies have examined the role of socio-economic and lifestyle factors in creating differences among dietary patterns (Bonaccio et al., 2012; 2013; 2014) and refer to specific Italian regions or sub-groups of inhabitants. Grosso et al. (2013), in their study on Italian residents in Sicily, showed that adolescents living in the urban areas of the island were more likely to adopt different dietary habits from the traditional MD. Physically active adolescents showed higher adherence and higher odds of adherence to the MD than low active and sedentary adolescents. As regards to the Molise region, Iacoviello et al. (2012) found that the MD is widely followed by the elderly who are fond of local agricultural traditions.

By using 15 waves of the Istat “Aspect of Daily Life” (ADL) survey we constructed an original data set which include temporal (from 1997 to 2012), geographical (19 regions) and individual dimensions (more than 690,000 individuals) concerning food consumption habits in terms of frequency of intake of various types of food per day, week or less often. Although the ISTAT survey does not collect data regarding the quantities and quality of food, its representativeness at national and regional levels makes this survey an important official source of data for exploring the evolution of the Italians' dietary pattern.

In accordance with the Food-Frequency-Questionnaire approach, the degree of adherence to the MD in the Italian adult population for the period 1997–2012 was assessed by constructing a composite indicator. Focusing on the role lifestyle and socio-economic variables play in influencing citizens' adherence to the MD, we analysed individual food consumption patterns across the Italian geographical areas bearing in mind their evolution over time.

Using multiple waves of data taken from cross-national surveys within the multilevel framework enabled us to distinguish

between temporal and cross-sectional effects, thus providing policy makers and stakeholders with useful suggestions for promoting the MD and reaping benefits in terms of both environmental impact and public health. With the aim of selecting the nesting structure, we adopted the procedure proposed by Fairbrother (2013) for introducing covariates which vary both within regions and across years.

The remainder of the paper is structured as follows. Section 2 provides a description of the dataset and methodological approach used. In the same section the specification of the three-level logistic random-intercept model is provided. After illustrating temporal and territorial heterogeneity of lifestyle and food consumption patterns, Section 3 presents and discusses the main findings obtained from the multilevel model. In section 4 some concluding remarks and policy implications are drawn.

2. Materials and methods

2.1. Data

Bearing in mind the rationale of the MD and the components of the Mediterranean pyramid, we constructed a data set by considering 15 repeated cross-sections of the annual ADL survey carried out by the Italian Institute of Statistics (ISTAT) for the period 1997–2012.

Although the ADL is not a food consumption survey, a specific section is devoted to the exploration of individuals' dietary patterns where participants are asked to self-report the frequency of intake of various types of food in terms of times per day (more than once a day; one a day), per week (a few times per week) or less often (less than once a week; never).

For the construction of the Mediterranean Diet Index - from now on MDI or MD index - we considered the frequencies of consumption of 14 types of food (12 food groups plus 2 types of oils and/or fats) as described by Benedetti et al. (2016).

In accordance with the Food-Frequency-Questionnaire approach (Trichopoulou, 2003; Goulet, Nadeau, & Lemieux, 2003; Panagiotakos & Stefanadis, 2006; Agnoli et al., 2011) we assigned to each food a score assuming values from 0 to 4 according to the frequency of consumption in the MD pyramid. Therefore, the MDI ranges between 0 (minimum level of adherence to the MD) and 56 (maximum level of adherence to the MD).

In constructing our database, we considered several variables describing socio-demographic and economic characteristics, such as gender, age, Italian regions¹ in which the respondents reside, level of education, marital status, occupational status, wealth status.

After having computed for each individual the numbers of years of education completed (which ranges from 0 to 20) we constructed a categorical variable by distinguishing two categories: a low level of education if the years of education are lower or equal to 8 (corresponding to the mandatory period of education in Italy) and a medium-high level of education if the number of years is greater than 8. Occupational status is classified into three categories: employed individuals, job seekers and individuals not in labour force. Moreover, we assessed the individuals' socioeconomic status by constructing the composite relative Wealth status Index (WI) by means of a Multiple Correspondence Analysis by using proxy indicators of individuals' economic well-being obtained by referring

to the respondents' self-assessment, including the ownership of dwelling, having a holiday period, cars owned and evaluation of household economic resources.

The WI was divided into three categories: individuals with a low level of wealth with values of WI lower or equal to the first observed quartile (0.68); ii) individuals with a medium level of wealth with values of WI up to the third quartile (0.83); iii) individuals with a high level of wealth with values of the WI greater than the third quartile.

Regarding life-style variables, we included smoking habits divided into three categories (current smoker, ex-smoker, never smoked) as well as physical exercise habits. We also considered people's habits regarding breakfast (divided into four categories: drink only, eat and drink, "special breakfast" with yogurt, cereals and orange juice and not having breakfast), Italians' declared main meal (breakfast, lunch or dinner), the habitual place where lunch is consumed (home, canteen, office or not having lunch) and lastly how much water and alcohol the respondents drink each day. Moreover, we considered the respondents' satisfaction with family and friends relationships as proxies of community and conviviality (Willett, 1995).

2.2. The multilevel approach

In order to account for the complex hierarchical structure of our multiple wave ADL data – which include temporal, geographical and individual dimensions – we referred to the multilevel approach. Indeed, each wave (cross-sectional data) includes a new sample of respondents drawn from a set of higher-level units (i.e. regions).

The use of multiple waves of data from cross-national surveys within the multilevel framework enabled us to extract "insights about the correlates of change over time" (Fairbrother, 2013). However, the selection of the nesting structure is not obvious and has important and relevant consequences when each higher-level unit (in our study, the region) is observed multiple times (Schmidt-Catran & Fairbrother, 2015).

With the aim of obtaining simultaneous but separate analysis of cross-sectional and longitudinal relationships, we adopted the procedure suggested by Fairbrother (2013) for the introduction of covariates that vary both within regions and across years.

We specified a three-level hierarchical model that considers individuals (first level units) nested in regions-years (second level units) and regions (third level units). We considered over 690,000 individuals aged 14 or over nested in 285 region-years (19 regions*15 years) which in turn are nested in 19 regions.

The observed response variable Y_{ijk} is a binary variable describing the food consumption pattern of individual i observed in region-year j and living in region k , which is equal to 0 if the level of adherence to MD is lower than the pooled median value (equal to 42) while it is equal to 1 if the level of adherence is greater than (or equal to) the median. This threshold and the use of a binary variable enabled us to distinguish individuals in two groups and therefore to adopt a segmentation approach for the identification of the factors determining sustainable food consumption patterns².

The three-level logistic random-intercept model can be

¹ It is worth noting that in the ADL survey 19 regions are considered: Piemonte and Valle d'Aosta as a unique region; Lombardia; Veneto; Trentino Alto Adige; Friuli Venezia Giulia; Emilia Romagna; Liguria; Toscana; Marche; Lazio; Umbria; Abruzzo; Campania; Basilicata; Molise; Calabria; Puglia; Sicilia; Sardegna.

² It is worth noting that various cut-off points have been tested with the aim of verifying if different specifications produce different results. Since from the various models (not reported here but available on request by the authors) we obtained similar results, we selected the median value of the empirical distribution as cut-off point in accordance with similar studies which assess the adherence towards MD (Monteagudo et al., 2015; Sánchez et al., 2012; Talegawkar et al., 2012).

specified as:

$$\text{logit}\left\{\Pr\left(Y_{ijk} = 1 \mid \mathbf{x}_{ijk}, \zeta_{jk}^{(2)}, \zeta_k^{(3)}\right)\right\}_{ijk} = \beta_1 + \beta_2 x_{2ijk} + \dots + \beta_m x_{mk} + \zeta_{jk}^{(2)} + \zeta_k^{(3)} \quad (1)$$

where $\mathbf{x}_{ijk} = (x_{2ijk}, \dots, x_{mk})$ is a vector containing all covariates, $\zeta_{jk}^{(2)} \mid \mathbf{x}_{ijk}, \zeta_k^{(3)} \sim N(0, \psi^{(2)})$ is a random intercept varying over region-years (level 2) while $\zeta_k^{(3)} \mid \mathbf{x}_{ijk} \sim N(0, \psi^{(3)})$ is a random intercept over regions (level 3). The same model specification can alternatively be written as a latent-response model (Rabe-Hesketh & Skrondal, 2008).

This type of model specification - which represents the most widely used approach in studies dealing with multiple waves of comparative survey data (Fairbrother, 2013) - can include coefficients that capture the effect of covariates that varies across regions and within region over time on the dependent variable Y . With the aim of obtaining a simultaneous yet separate analysis of cross-sectional and longitudinal relationships, we used the procedure suggested by Fairbrother (2013) for introducing covariates that vary both within regions and across years. Firstly, we computed regional-level variables by averaging the available variables over years and region-by-region. Secondly, we computed a region-year level variable by calculating the deviation from the regional-mean for each year and for each region in order to capture the effect of variation over time within each region on Y . The longitudinal component obtained (i.e. the region-year level variable) is group mean-centered and it is orthogonal to the regional mean value so that the two coefficients can be estimated separately. Consequently, the specified model includes each selected variable which varies in region-years twice: in terms of regional mean value ($\bar{x}_k$) and deviation from the mean ($\bar{x}_{jkm}$). This extension, which enabled us to consider both a “between” and “within” effect, represents an important improvement on existing techniques when analysing data from repeated cross-sectional surveys.

It is worth noting that this type of model recognizes that respondents from the same region are more similar than respondents from different regions. In addition, it considers that respondents observed in the same region in the same year have more in common than respondents observed in the same region in a different year.

Lastly, by focusing on the random part of the models and

specifically on the estimated variance of the region level random intercept, $\psi^{(2)}$, and the estimated variance of the region-year level random intercept, $\psi^{(3)}$, we obtained valuable insights concerning the “contextual” variability of individual behavior towards food consumption. In fact, in a three-level model it is possible to estimate different types of Intraclass Correlation Coefficient (ICC) for pairs of responses (Rabe-Hesketh & Skrondal, 2008). Specifically, we computed the ICC for individuals living in the same region k but with a different region-year j and j' thus obtaining $\rho(\text{region})$ as:

$$\rho(\text{region}) = \frac{\psi^{(3)}}{\psi^{(2)} + \psi^{(3)} + \pi^2/3} \quad (2)$$

Moreover, we also computed the ICC for individuals living in the same region k and observed within the same region-year cluster j thus obtaining $\rho(\text{region} - \text{year} - \text{region})$ as:

$$\rho(\text{region} - \text{year} - \text{region}) = \frac{\psi^{(2)} + \psi^{(3)}}{\psi^{(2)} + \psi^{(3)} + \pi^2/3} \quad (3)$$

3. Results

3.1. Lifestyle and food consumption patterns: evolution over time and across geographical areas

Table 1 shows how Italians' food patterns changed across geographical macro-areas from 1997 to 2012 and underlines the differences concerning frequency of consumption of the various food groups. The percentage of individuals eating pasta, rice and bread more than once a day has decreased continuously from 42.28% in 1997 to 29.37% in 2012.

During the period 1997–2012, the consumption of red meat fluctuated and then dropped slightly while the consumption of pork meat increased contrary to the MD recommendations. Eggs and dairy product consumption increased slightly during the period in question even if consumption in Southern Italy was above the national average.

Contrastingly, a high percentage of Italians has continued to consume unhealthy food on a frequent basis, such as red and processed meat which should only be consumed a few times per

Table 1
Frequency of consumption of selected food groups: years 1997–2012.^a

Years	Fruit	Leafy vegetables	Pasta, rice and bread	Milk	Fish	Poultry	Red meat	Pork	Processed meat	Eggs	Dairy products and cheese
	More than once a day	more than once a day	more than once a day	once a day	a few times per week	sometimes a week	a few times per week	a few times per week	a few times per week	a few times per week	a few times per week
1997	43.41	15.67	42.28	48.43	50.39	70.73	65.92	37.65	51.28	52.45	54.17
1998	42.71	15.71	41.10	48.45	50.44	71.21	67.18	37.83	53.20	51.90	53.76
1999	40.37	15.35	40.41	48.07	50.12	70.91	68.22	40.11	53.57	52.99	53.61
2000	39.89	13.73	37.05	47.91	53.46	70.90	64.28	40.54	53.07	54.00	55.33
2001	40.00	13.64	37.32	49.41	54.34	72.06	66.56	46.76	54.44	54.92	56.35
2002	40.43	14.57	36.08	47.95	53.82	71.58	66.46	44.63	53.09	54.17	56.17
2003	42.70	14.81	35.58	47.82	55.05	70.79	66.54	43.51	53.40	55.03	56.50
2005	44.53	15.57	35.19	48.39	57.57	71.02	67.70	45.02	53.31	55.83	57.20
2006	44.69	15.12	35.48	47.94	56.77	66.60	68.99	46.74	53.33	52.67	57.21
2007	44.38	16.93	33.75	47.08	58.04	70.22	66.76	44.79	51.97	52.97	57.57
2008	44.06	17.29	32.26	47.23	55.22	70.70	65.96	44.59	53.47	54.03	57.62
2009	42.15	16.72	31.79	48.02	56.32	70.99	66.22	46.11	53.33	54.71	58.07
2010	43.72	17.16	31.51	47.44	57.22	71.28	65.50	45.49	53.79	53.74	57.17
2011	42.03	16.79	30.97	47.36	57.09	71.80	64.49	44.57	53.42	54.42	57.97
2012	40.94	17.36	29.37	46.79	55.34	72.38	63.45	44.68	53.28	55.57	58.37

^a Percentage of individuals are reported.

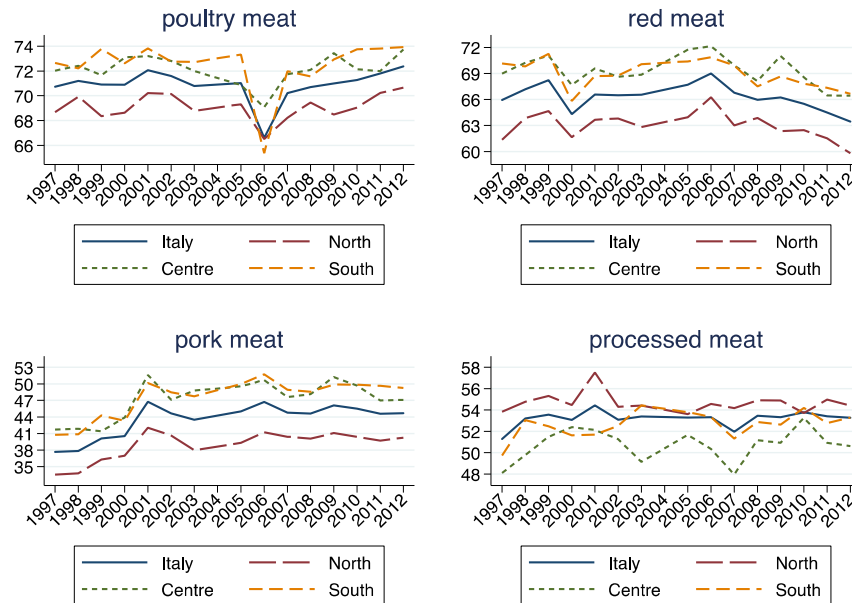


Fig. 1. Meat consumption by geographical areas.

month. Focusing on meat consumption (Fig. 1), we can see that the virtuous regions for red meat and pork are in Northern Italy, where the average consumption is almost 10 points below the national average consumption while an opposite trend was observed for processed meat: Central regions show the lowest values while the highest values of processed meat consumption were observed in the North. During the studied period, there was a slight increase in the consumption of poultry which significantly decreased in 2006 especially in the Southern regions probably due to the spread of avian influenza.

During the studied period a slight increase in the consumption of fruits, vegetables and dairy products was observed (Fig. 2) even if values of the Northern regions were below the national average.

Regarding Mediterranean lifestyle habits Fig. 3 shows which

meal is considered to be the most important meal by Italian citizens across different areas and throughout the studied period. The percentage of individuals that consider lunch as the main meal decreased continuously from 75% in 1997 to 68% in 2012. This trend was observed especially in the Southern regions. Contrastingly the citizens who considered breakfast as the main meal increased significantly especially in the Central regions while an upward trend was observed for dinner with the highest values observed for the Central regions.

Preferences regarding the place where Italians usually have lunch changed considerably from 1997 to 2012. As we can see from Fig. 4, the percentage of Italians who preferred having lunch at home or at the office decreased significantly while preferences for consuming canteen lunches rose (from 14.95% in 1997 to 19.65% in

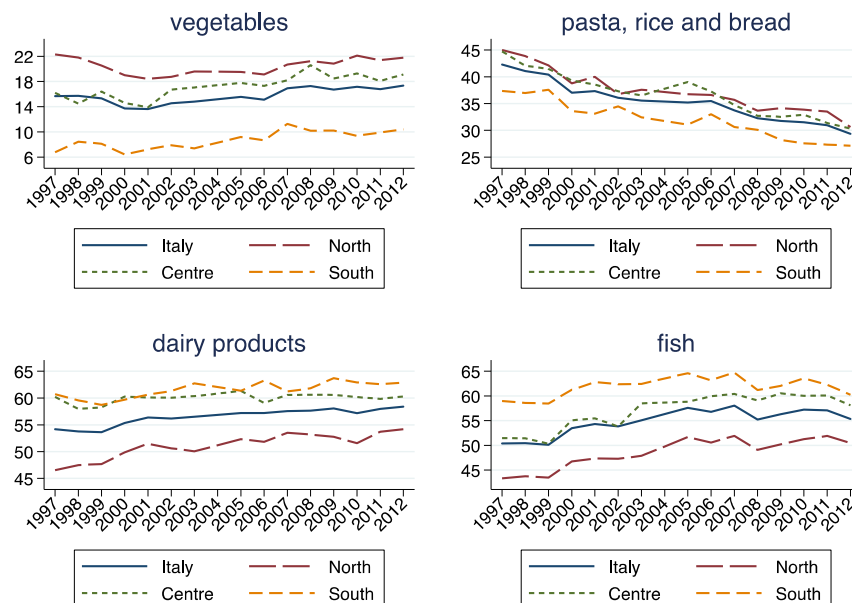


Fig. 2. Other product consumption and temporal evolution by geographical areas.

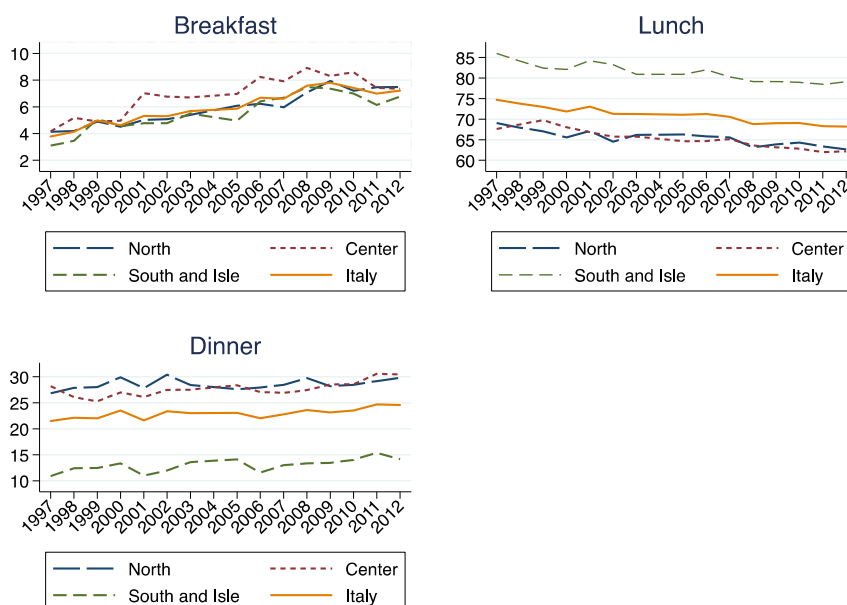


Fig. 3. Italians' declared main meal: temporal evolution distinguished by geographical areas.

2012) and the percentage of people who did not have lunch almost doubled.

Fig. 5 shows how the Italians' MD adherence changed from 1997 to 2012 across geographical areas (North, Center, South and Islands) with the highest value of adherence observed for the Central regions and the lowest levels observed in the North.

Bearing in mind the MDI calculated for each individual, we carried out several ANOVAs and t-tests with the aim of evaluating if and to what extent differences across groups, defined using selected socio-economic characteristics, can be considered statistically significant or not. For most of the above-mentioned variables (i.e. wealth status, education, socio-demographics, lifestyle factors) the average values differed significantly among the various groups. Moreover, the multiple-comparison tests carried out using the

Bonferroni specification showed that each group was different to the others (p -values < 0.01) thus supporting the existence of an association between these variables and the adherence to MD.

3.2. The multilevel model: estimation results

Table 2 shows the results obtained with the three-level logistic random intercept model described by equation (1). The estimates, obtained by using STATA 13.0 software, are presented in terms of Odds Ratios (ORs).

Demographic, socio-economic and individual life-style variables, proved to be strictly related to a food consumption pattern closer to MD. Indeed, the effect of these individual-level variables is also confirmed by introducing regional and region-year variables

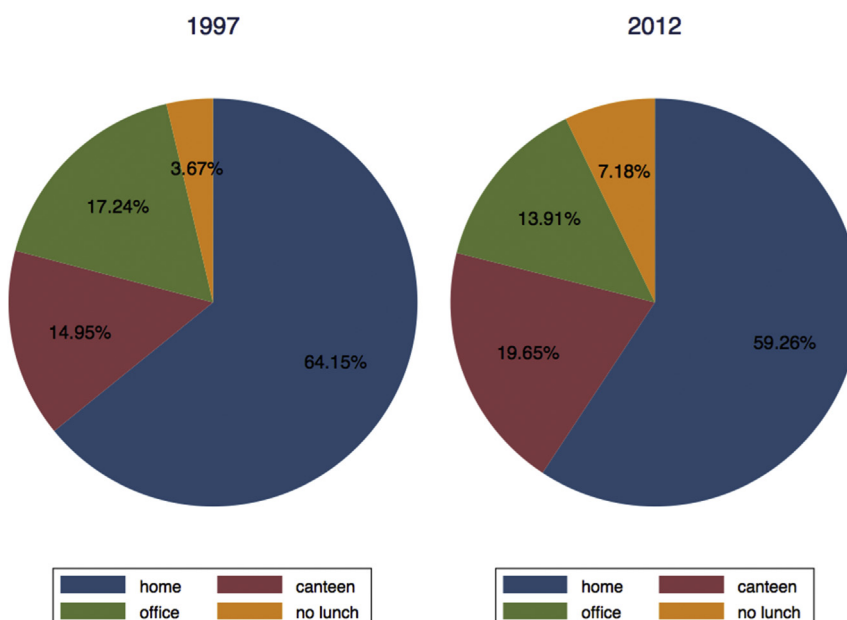


Fig. 4. Italians' habitual place for eating lunch.

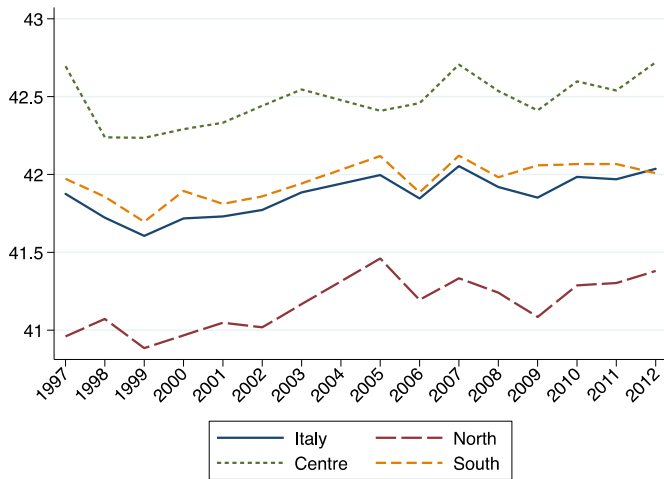


Fig. 5. MD adherence by geographical areas.

into the models as we can see in Table 2 which reports the estimates of the models with individual-level variables (left-hand side of Table 2) only and the estimates of the full model (right-hand side of Table 2).

The coefficients of individual characteristics are similar for both models. The analysis and discussion of the results refer to the magnitude and sign of the ORs obtained for the full model.

Regarding demographic characteristics, gender and age significantly affect individuals' adherence to MD. Indeed, females tend to follow MD more than males ($OR = 1.402$) while an increase in age leads to a higher probability of adhering to MD ($OR = 1.014$). The presence of children in the family has a slightly negative effect on the probability of adhering to MD ($OR = 0.961$).

Concerning lifestyle variables, not smoking was found to be related to healthier food habits: people who never smoked or stopped smoking are 25% more likely to adhere to the MD. Moreover, people who practice sports (at least occasionally) are 10% more likely to follow MD compared to people who do not practice sport.

Interesting relationships were observed for individuals' food-related habits. Not having lunch or having lunch in the office or in a canteen negatively influence the probability of adhering to the MD ($OR = 0.820$, $OR = 0.847$ and $OR = 0.933$, respectively) than people who have lunch at home. Moreover, breakfast habits were found to be strongly related with adherence to MD: individuals who "eat and drink something" for breakfast are more than two times likely to adhere to MD ($OR = 2.57$), compared to individuals who do not generally have breakfast. Drinking up to one or two glasses of water per day negatively affects the probability of adhering to the MD ($OR = 0.928$ and $OR = 0.811$, respectively). On the other hand, according to our expectations, individuals who drink two glasses or less of wine (1–2 glasses or <1 glass) per day are more likely to adhere to the MD ($OR = 1.360$ and $OR = 1.341$, respectively) than individuals who drink more than two glasses per day.

Moreover, it was observed that people who are "not at all" satisfied with family relationships and friendships are less likely to adhere to the MD than those who are very satisfied ($OR = 0.839$ and $OR = 0.882$, respectively).

Concerning socio-economic characteristics, the level of education proved to be a strong predictor of MD adherence: the higher the number of years of education completed, the higher the probability of adhering to MD ($OR = 1.269$), compared to individuals who completed less than 8 years of education. People seeking employment are less likely to adhere to the MD ($OR = 0.948$),

compared to people in employment. Regarding family status, couples without children tend to follow MD more than single parents without children ($OR = 1.227$).

Regional context played an important role and contributed to the reduction of unobserved heterogeneity. Indeed, regions with higher levels of GDP are characterized by a lower likelihood of adhering to the MD while changes over time in GDP are positively associated with the adherence to MD within regions. A similar effect was observed for the level of public expenditure for education: both within and between effects are statistically significant.

Concerning the higher-level variability, the estimated ICC at regional level - $\rho(\text{region})$ - was equal to 1.5% when only individual-level variables were considered and it dropped to 0.63% when higher-level covariates were introduced. On the other hand, the estimated ICC - $\rho(\text{region-year}, \text{region})$ - was equal to 1.9% when only individual level variables were considered while it decreased to 0.9% in the full model.

4. Conclusions

In recent years, environmental problems related to food emissions have become one of the main concerns of policy makers. Therefore, the assessment of the population's adherence to sustainable dietary patterns and the identification of food choice drivers is an important research topic.

The aim of this study was to identify the factors influencing the Italians' adherence to MD, which is recognized as being a sustainable diet by UNESCO due to its positive effects on human health and the environment. We estimated a random-intercept three-level logistic model which enabled us to investigate the effects of the citizens' lifestyles, socio-economic characteristics and regional variables as well as their changes over the 1997–2012 period.

Concerning individual covariates, our results show that education proved to have an important role in determining food consumption patterns. Moreover, a healthy lifestyle is a strong factor influencing one's adherence to the MD: tendency to practice sports on a regular basis, having breakfast and lunch at home positively influence the adherence to MD. Unfortunately, people with a low socio-economic status do not tend to follow MD which appears to confirm that the cost of MD could be an economic barrier thus hindering the diffusion of this sustainable diet. Moreover, the regional context in which people reside play a significant role, as a negative relationship between GDP and MD adherence. These findings could also indicate that economic growth may act as a proxy of environmental degradation (Givens & Jorgenson, 2011).

The results obtained highlight some interesting aspects for decision makers including government, companies, retailers and households. A successful strategy for creating a more sustainable food system should combine supply-side and demand-side options.

Demand-side solutions should promote behavioural changes through general sustainable environmental beliefs, environmental norms and environmental attitudes. On one hand, nutritional labelling and improved consumer education are important tools for achieving sustainability (Hadjikakou, 2017), on the other hand dietary guidelines should emphasise the importance of preparing, valorising and enjoying meals (Monteiro et al., 2015).

On the supply side, changes must be made to the production and distribution processes of the food chains. Dietary patterns are affected by the information provided by public administration, mass media, ecological associations and shopping sites. In fact, it is essential to educate consumers on sustainable dietary patterns and firms and governments should enhance product information

Table 2

Three level logistic random intercept models: estimation results and ORs.

	Model with individual covariates			Model with individual, Regional and region-year covariates		
	OR	S.E.	Sig.	OR	S.E.	Sig.
Gender (ref. Male)	1.402	0.010	***	1.402	0.010	***
Age	1.014	0.000	***	1.014	0.000	***
Children (ref. No)	0.961	0.005	***	0.961	0.005	***
Sport at least occasionally (ref. No)	1.099	0.010	***	1.099	0.010	***
Smoking status (ref. Current smoker)						
Former smoker	1.249	0.010	***	1.249	0.010	***
Never smoker	1.258	0.011	***	1.257	0.011	***
Education (ref. ≤ 8 years)						
>8 years	1.269	0.009	***	1.269	0.009	***
Occupational status (ref. Employed)						
Job seekers	0.947	0.013	***	0.948	0.013	***
Not in labour force (housewives, retired from work, ...)	1.007	0.008		1.007	0.008	
Kind of family (ref. single parent without children)						
Couple with children	1.169	0.015	***	1.168	0.015	***
Couple without children	1.228	0.013	***	1.227	0.013	***
Single parent with children	1.100	0.016	***	1.099	0.016	***
Habitual place for eating lunch (ref. Home)						
Canteen	0.933	0.010	***	0.933	0.010	***
Office	0.846	0.011	***	0.847	0.011	***
No lunch	0.821	0.020	***	0.820	0.020	***
Kind of breakfast (ref. No)						
Drink only	1.751	0.022	***	1.752	0.022	***
Food and drink	2.570	0.030	***	2.570	0.030	***
Yogurt and cereals	2.062	0.042	***	2.062	0.042	***
Mail meal (ref. Breakfast)						
Lunch	1.054	0.014	***	1.054	0.014	***
Dinner	1.009	0.015		1.009	0.015	
Water drunk per day (ref. > 2 glasses)						
1-2 glasses	0.811	0.009	***	0.811	0.009	***
<1 glass	0.928	0.007	***	0.928	0.007	***
Wine drunk per day (ref. > 2 glasses)						
1-2 glasses	1.361	0.020	***	1.360	0.020	***
<1 glass	1.342	0.019	***	1.341	0.019	***
Satisfaction with family relationships (ref. Very satisfied)						
Fairly satisfied	0.944	0.007	***	0.944	0.007	***
Not very satisfied	0.823	0.012	***	0.823	0.012	***
Not at all satisfied	0.840	0.024	***	0.839	0.024	***
Satisfaction with leisure time (ref. Very satisfied)						
Fairly satisfied	1.069	0.011	***	1.069	0.011	***
Not very satisfied	1.062	0.012	***	1.062	0.012	***
Not at all satisfied	0.986	0.015		0.986	0.015	
Satisfaction with friendships (ref. Very satisfied)						
Fairly satisfied	1.017	0.009	*	1.017	0.009	*
Not very satisfied	0.974	0.012	**	0.974	0.012	**
Not at all satisfied	0.882	0.017	***	0.882	0.017	***
Satisfaction with one's economic situation (ref. Very satisfied)						
Fairly satisfied	1.105	0.020	***	1.104	0.020	***
Not very satisfied	1.138	0.022	***	1.136	0.022	***
Not at all satisfied	1.052	0.022	**	1.051	0.022	**
Wealth status (ref. Low level)						
Medium level	1.113	0.013	***	1.114	0.013	***
High level	1.028	0.008	***	1.028	0.008	***
Year	1.003	0.001	**	0.982	0.005	***
GDP (regional value)			***	0.912	0.020	***
GDP (annual deviation from regional value)				1.005	0.004	
Expenditure for education (regional value)				0.864	0.048	***
Expenditure for education (annual deviation from regional value)				1.096	0.027	***
Number of household components (regional value)				1.120	0.377	
Number of household components (annual deviation from regional value)				0.867	0.158	
Individuals with medium-level education (% regional value)				1.038	0.019	
Individuals with medium-level education (% deviation from regional value)				1.013	0.002	***
Constant	0.086	0.006	***	0.089	0.135	
Random effect estimates						
Region*year						
Intercept (s.d.)	0.099	0.006	***	0.089	0.005	***
Region						
Intercept (s.d.)	0.235	0.039	***	0.152	0.026	**

Notes: * Significant at the 10% level. **Significant at the 5% level. *** Significant at the 1% level.

campaigns to raise awareness in the topic of sustainability.

In conclusion, people will have to change their lifestyles if they want to live in a more sustainable world or accept the fact that their food choices may have large-scale consequences on the environment and human health.

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