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ADHERENCE TO THE MEDITERRANEAN DIETARY PATTERN IN NORTHERN ITALY: DETERMINANTS AND TRENDS OF FOOD CONSUMPTION FROM 2010 TO 2015

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RIASSUNTO

Introduzione: Nonostante i suoi documentati effetti sulla salute, l'aderenza alla dieta Mediterranea (MDP) è rapidamente diminuita durante le ultime decadi, specialmente nei paesi dal bacino Mediterraneo. Tuttavia, le informazioni circa la prevalenza di aderenza alla MDP nel Nord Italia sono scarse. Inoltre, dal 2010 nessuno studio ha riportato dati riguardanti i trends di aderenza alla MDP.

Scopo: Questo studio aveva lo scopo di: i) identificare I fattori associati all'aderenza alla MDP e ii) valutare I trends di consumo degli alimenti dal 2010 al 2015 in una ampia coorte di soggetti viventi nel Nord Italia.

Metodi: Conducemmo uno studio cross-sectional su 7430 soggetti reclutati dal 2010 al 2015 presso l'International Center for the Assessment of Nutritional Status (ICANS), Università degli Studi di Milano. Un intervistatore addestrato collezionò i dati riguardanti le caratteristiche socio-anagrafiche e lo stile di vita dei soggetti reclutati. Una dietista professionista prese le misure antropometriche. Un questionario da 14 domande fu utilizzato per valutare l'aderenza alla MDP. La regressione di Poisson è stata utilizzata per stimare le prevalenze di aderenza alla MDP e ai singoli componenti.

Resultati: La prevalenza complessiva di aderenza alla MDP nel Nord Italia era del 14%. Essere più anziani, sposati, ex fumatori e fisicamente attivi aumentava la probabilità di aderenza alla MDP. Al contrario, essere obesi diminuiva la probabilità. Il trend di aderenza alla MDP non cambiò durante i 5 anni. Tuttavia, osservammo un intenso aumento del consumo di frutta secca e un leggero incremento del consumo di carne bianca. Dall'altra parte, osservammo una diminuzione del consumo di frutta, dolci e bevande gassate e nell'uso del soffritto.

Conclusioni: I fattori socio anagrafici, di stato nutrizionale e di stile di vita sono associati all'aderenza alla MDP. Negli ultimi 5 anni, nel Nord Italia, alcuni cambianti alimentari suggerivano un miglioramento della qualità dietetica, ma altri cambiamenti suggerivano l'opposto. Tant'è vero che l'aderenza alla MDP rimase costante. Ulteriori strategie saranno necessarie per promuovere le buone abitudini alimentari, specialmente tra i soggetti a rischio per una bassa qualità dietetica.

ABSTRACT

Background: Despite its widely documented health benefits, the adherence to the traditional Mediterranean Dietary Pattern (MDP) has been rapidly declining over the last decades, especially in Mediterranean countries. However, the information on the prevalence of adherence to the MDP in Northern Italy is scarce. In addition, since 2010 no study has reported data concerning trend of adherence to the MDP.

Aim: The present study aimed i) to identify the factors associated to the adherence to the MDP and ii) to investigate the trends of food consumption from 2010 to 2015 in large cohort of subjects living in Northern Italy.

Methods: A cross-sectional study on 7430 subjects enrolled from 2010 to 2015 at International Center for the Assessment of Nutritional Status (ICANS), University of Milan, was conducted. A trained interviewer collected data on socio-demographic characteristics and lifestyle habits. Anthropometrical measurements were taken by a trained dietitian. A 14-item questionnaire was used to evaluate the adherence to the MDP. Poisson regression was used to estimate prevalence and prevalence ratios of adherence to the MDP and to its individual components

Results: The overall prevalence of adherence to the MDP in Northern Italy was 14%. Being older, married, ex-smoker and physically active increased the probability of accordance of the own dietary pattern to the MDP. On the contrary, being obese decreased the probability. The trend of adherence to the MDP did not change during the last five years. However, we observed an intensive increment of the consumption of nuts and a slight increment of white meat consumption. On the other hand, we observed a decrement in the consumption of fruit, sweets and carbonated beverages and in the use of soffritto.

Conclusion: Socio-demographic factors, nutritional status and lifestyle are associated with adherence to the MDP. In the last five years, in Northern Italy, some food food changes suggested an improvement of diet quality, but other changes suggested the opposite. So much so that the prevalence of adherence to the MDP did not change. Additional strategies will be need to promote healthy dietary habits, especially among subjects at risk for poor-diet quality.

1. BACKGROUND

1.1. The Mediterranean dietary pattern

The traditional Mediterranean diet (MD) is the heritage of millennia of exchanges of people, cultures and foods of all countries around the Mediterranean basin. It has been the basis of food habits during the twentieth century in all countries of the region, originally based on Mediterranean agricultural and rural models [1]. However, the traditional MD is now progressively eroding due to the widespread dissemination of the Western-type economy, urban and technology-driven culture, as well as the globalisation of food production and consumption, related to the homogenisation of food behaviours in the modern era. Since the Seven Countries Study in the 1950s, we know which foods were more or less frequently consumed in the Mediterranean area [2], a pattern followed mainly by poor rural societies [3]. This led to defining the MD as dietary pattern rich in plant foods (cereals, fruits, vegetables, legumes, tree nuts, seeds and olives), with olive oil as the principal source of added fat, along with high to moderate intakes of fish and seafood, moderate consumption of eggs, poultry and dairy products (cheese and yogurt), low consumption of red meat and a moderate intake of alcohol (mainly wine during meals).

The pioneer Seven Countries Study and numerous and increasing recent epidemiological studies have established the health benefits associated with the adherence to the Mediterranean diet pattern (MDP), mainly in relation to reducing the risk of developing the metabolic syndrome, type 2 diabetes, CVD and some neurodegenerative diseases and cancers [4,5]. This healthy, traditional MDP has been popularised since 1995 using the world famous pyramid representation that graphically highlights the food groups to be consumed daily, weekly or less frequently [1]. In addition, in 1995, an index or score was introduced to evaluate the adherence to the MDP, allowing the study of its associated health effects [6].

After the recognition of the MD as an Intangible Cultural Heritage of Humanity by UNESCO in 2010, considering the worldwide interest in the MDP and taking as a framework all the mentioned aspects, scientists presented a new Mediterranean diet pyramid (**Figure 1.1**) in order to contribute to a much better adherence to this healthy dietary pattern and its way of life in the Mediterranean area and other countries in the near future [7].

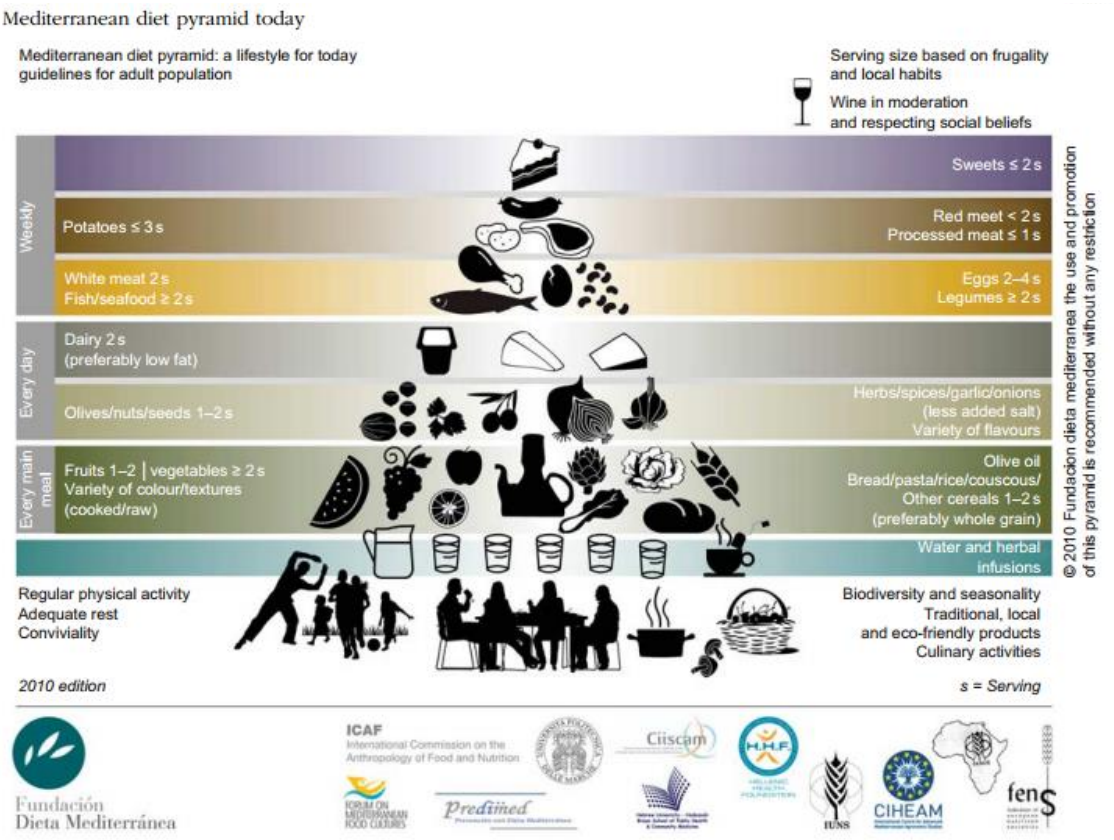


Figure 1.1: Mediterranean diet pyramid: a lifestyle for today [7]

The new MD pyramid provides key elements for the selection of foods, both quantitative and qualitative, indicating the relative proportions and consumption frequency of servings of the main food groups that constitute the MDP. The pattern includes all food groups, and it is just a question of variety of food and culinary techniques, along with adequate frequencies and quantities in the daily diet that make it healthy or unhealthy. A wide variety of foods in the diet minimises the possibility of deficiencies of a particular nutrient. In fact, a

higher adherence to the MDP has been associated with a better nutrient profile, with a lower prevalence of individuals showing inadequate intakes of micronutrients in comparison to other patterns such as the Western pattern [8]. Plant-origin foods are situated at the base of the pyramid. They provide key nutrients, fibre and protective substances that contribute to general well-being, satiety and the maintenance of a balanced diet, and thus should be consumed in high proportions and frequency. This MD core, based on plant-origin foods, is responsible for the prevention of many chronic diseases and for weight control [5,8]. The graphic representation follows the previous pattern: at the base, food items that should sustain the diet and provide the highest energy intake, and at the upper levels, foods to be eaten in moderate amounts such as those of animal origin and/or rich in sugars and fats that should be eaten in moderation and some of them left for special occasions. Meals have an essential role in the MD, and thus the importance of the meal and its composition is emphasized in the new representation. A balanced composition of the main meals should include fruits, vegetables and cereals, complemented in a lower contribution to daily energy intake with other plant foods, dairy products and protein sources. The pyramid establishes dietary daily, weekly and occasional guidelines in order to follow a healthy and balanced diet [7].

Every day

1) The **three main meals** should contain three basic elements, which can also be found throughout the day:
    - Cereals. One or two servings per meal in the form of bread, pasta, rice, couscous and others. Preferably whole grain, since some valuable nutrients (magnesium, phosphorus, etc.) and fibre can be lost during processing.
    - Vegetables. Present at lunch and dinner; or more than two servings per meal, at least one of the serving should be raw.

- Fruit. One or two servings per meal. Should be chosen as the most frequent dessert.

2) A daily intake of 1.5–2.0 litre of water should be guaranteed. A good hydration is essential to maintain the corporal water equilibrium, although needs may vary among people because of age, physical activity, personal circumstances and weather conditions. As well as water, non-sugar rich herbal infusions and broths (with low fat and salt content) may complete the requirements.
3) Dairy products. Prefer it in the form of low fat yoghurt, cheese and other fermented dairy products. They contribute to bone health, but can also be an important source of saturated fat.
4) Olive oil is located at the centre of the pyramid; should be the principal source of dietary lipids because of its high nutritional quality (especially extra virgin). Its unique composition gives it a high resistance to cooking temperatures and should be used for cooking as well as dressings (one tablespoon per person).
5) Spices, herbs, garlic and onions are a good way to introduce a variety of flavours and palatability to dishes and contribute to the reduction of salt addition. Olives, nuts and seeds are good sources of healthy lipids, proteins, vitamins, minerals and fibre. A reasonable consumption of olives, nuts and seeds (such as a handful) make for a healthy snack choice.
6) Respecting religious and social beliefs, a moderate consumption of wine and other fermented beverages (one glass per day for women and two glasses per day for men, as a generic reference) during meals is recommended.

Weekly

1) A variety of plant and animal origin proteins should be consumed. Mediterranean traditional dishes do not usually have animal origin protein foods as the main ingredient but as a tasty source.
2) Fish (two or more servings), white meat (two servings) and eggs (two to four servings) are good sources of animal protein. Fish and shellfish are also a good source of healthy proteins and lipids.
3) Consumption of red meat (less than two servings, preferably lean cuts) and processed meats (less than one serving) should be in smaller quantity and frequency.
4) The combination of legumes (more than two servings) and cereals are a healthy protein and lipid source. Potatoes are also included in this group, as they are a part of many traditional recipes with meat and fish (three or less servings per week, preferably fresh potatoes).

Occasionally

In the vertex of the pyramid are represented the sugary and unhealthy fats rich foods (the sweets). Sugar, candies, pastries and beverages such as sweetened fruit juices and soft drinks, should be consumed in small amounts and left for special occasions.

Cultural and lifestyle elements

Together with the proportion and frequency recommendations of consumption, the incorporation of **lifestyle and cultural elements** is one of the innovations of the pyramid. Adopting a healthy lifestyle and preserving the cultural elements should also be considered in order to acquire all the benefits from the Mediterranean diet. These elements are:

- ***Moderation:*** Portion sizes should be based on frugality, adapting energy needs to urban and modern sedentary lifestyles.

- ***Socialisation:*** The aspect of conviviality is important for the social and cultural value of the meal, beyond nutritional aspects. Cooking, sitting around the table and sharing food in company of family and friends is a social support and gives a sense of community.
- ***Cooking:*** Make cooking an important activity taking the proper time and space. Cooking can be relaxing, fun and can be done with family, friends and the loved ones.
- ***Seasonality, biodiversity, eco-friendliness, traditional and local food products*** are presented at the bottom of the pyramid to highlight how the new revised modern Mediterranean diet is compatible with the development of a sustainable diet model for the present and future Mediterranean generations. The preference for seasonal, fresh and minimally processed foods maximises the content of protective nutrients and substances in the diet.
- ***Activity:*** Regular practice of moderate physical activity (at least 30 min throughout the day) as a basic complement to the diet for balancing energy intake, for healthy body weight maintenance and for many other health benefits. Walking, taking the stairs v. the lift, housework, etc., are simple and easy ways of doing exercise. Practising leisure activities outdoors and preferably with others makes it more enjoyable and strengthens the sense of community.
- ***Rest:*** Resting is also part of a healthy and balanced lifestyle.

1.2. Mediterranean diet and risk of disease

1.2.1. Mediterranean diet and cardiovascular disease

Randomized trials of dietary intervention are the best method for the acquisition of causal knowledge in nutritional epidemiology. The Lyon Diet Heart Study [9] was a secondary prevention trial including survivors of a myocardial infarction. This study firstly showed a

protective effect of MDP on recurrence of any type of new heart attack or CVD complication. In detail, the authors observed a 47-72% reduction of the risk of secondary cardiovascular event in subjects following a MDP compared to subjects following a prudent Western diet.

The results of the Lyon trial were subsequently confirmed also for primary prevention by the recent PREvención con DIeta MEDiterránea (PREDIMED) trial conducted in 7447 initially healthy participants, without any previous history of CVD [10,11]. Participants of the PREDIMED trial were men and women from 55 to 80 years at high cardiovascular risk because they were diabetics or had at least three major vascular risk factors. They were randomly allocated to one of three diets: a MD rich in nuts, a MD rich in extra-virgin olive oil, and a control group receiving advice to reduce the intake of fat. A significant reduction in the risk of a combined cardiovascular end-point (myocardial infarction, stroke or cardiovascular death) was observed for both groups allocated to MD. The trial was stopped after a median follow-up of 4.8 years because of the early evidence of benefit. The hazard ratio was 0.70 (95% CI: 0.54–0.92) for the MD with extra-virgin olive oil and 0.72 (95% CI: 0.54–0.96) for the MD with nuts. Both Mediterranean diet interventions were associated with a lower risk of peripheral artery disease compared with the control group. In the model adjusted for classic atherosclerotic risk factors, the hazard ratio was 0.34 (95% CI, 0.20-0.58) for participants in the MD plus extra-virgin olive oil group and 0.50 (95% CI, 0.30-0.81) for the MD plus nuts group vs control group [12]. The random effect meta-analysis combining these two trials showed a relative 38% reduction in the risk of CVD after intervention with a MD with pooled risk ratio 0.62 (95% CI: 0.45–0.85) [13].

The association between adherence to the MDP and the incident risk of cardiovascular disease has been also studied by several prospective cohort studies. A recent meta-analysis [5], published in 2013 and including 13 studies [6,14-25] presenting incidence

and/or mortality from cardio- and cerebrovascular diseases, reported that a 2-point increase of adherence to the MDP was associated with a reduced risk of mortality from and incidence of cardiovascular disease (RR: 0.90, 95% CI: 0.87 – 0.92; $p < 0.001$). Since 2013, 5 new prospective observational studies [26-30] have been published.

The Danish multinational MONItoring of trends and determinants in CArdiovascular disease (MONICA) cohort [26] assessed 1849 men and women, and found a significant 8% relative reduction in the risk of CVD for each 1-unit increase in adherence to an 8-point scale.

MONICA study conducted in the Netherlands included 8128 men and 9759 women aged 20–65 years and assessed a MDP operationalized according to eight of the nine items of the MDS proposed by Trichopoulou et al. [31] (moderate alcohol consumption was excluded). They found a non-significant inverse association with a combined CVD end-point (fatal CVD, nonfatal myocardial infarction and stroke). These results were partly included in the EPIC-Netherlands study [20].

The Swedish Mammography Cohort-study [27], which included 32 921 women aged 48-83 years, observed a lower risk of myocardial infarction (RR: 0.74, 95% CI: 0.61 - 0.90; $p = 0.003$), heart failure (RR: 0.79, 95% CI: 0.68 - 0.93; $p = 0.004$) and ischemic stroke (RR: 0.78, 95% CI: 0.65 - 0.93; $p = 0.007$), but not haemorrhagic stroke (RR: 0.88, 95% CI: 0.61 - 1.29; $p = 0.53$) in subjects with a high adherence to the MDP, compared to low, during 10 y of follow-up.

The same authors, explored the association between adherence to the MDP and risk of heart failure also in men using data from the population-based Cohort of Swedish Men (COSM) [29]. 37 308 men aged 45-79 years were included in the study. The authors found that 2-point increment in the modified Mediterranean dietary score, a variant of original 8-

items score proposed by Trichopoulou et al. [31], was associated with a 12% reduction in the risk of heart failure mortality.

The Health Alcohol and Psychosocial Factors in Eastern Europe (HAPIEE) project [28], a cohort of 28 945 middle-aged man and women recruited in Poland, Russia and Czech Republic, found that a high adherence to the MDP, assessed by Trichopoulou score [31], was associated with a 15% reduction of the risk of death for all causes. Moreover, they found a 10% reduction in the relative risk of CVD for each 1 SD (which equals to 2.2 points) increase in the Mediterranean dietary score. However, the association with coronary heart disease and stroke mortality was also inverse, but statistically non-significant.

Recently, the Norfolk cohort of the EPIC study [30] evaluated the association between four different Mediterranean diet scores and the incidence of and death for cardiovascular disease, ischaemic heart disease and stroke in 23 902 men and women aged 40 – 79 years, and found that all indexes were inversely associated with the outcomes of interest, although the association with stroke was not completely significant.

1.2.2. Mediterranean diet and diabetes

Several studies support a protective role of the MDP against the development of type 2 diabetes [32]. Furthermore, studies in diabetic patients, suggest that the MDP was a suitable dietary pattern for the management of type 2 diabetes [33].

Currently, the PREDIMED study is the lonely available randomized clinical trial which investigated the association between adherence to the MDP and the risk for future type 2 diabetes [34,35]. In a first study, in a small group of 418 non-diabetic subjects, the authors observed that the multivariable adjusted hazard ratios of diabetes were 0.49 (95% CI: 0.25-0.97) and 0.48 (95% CI: 0.24-0.96) in the MD supplemented with olive oil and nuts

groups, respectively, compared with the control group. When the two MD groups were pooled and compared with the control group, diabetes incidence was reduced by 52% (95% CI: 27-86). Authors concluded that Mediterranean diet without calorie restriction could be effective in the prevention of diabetes in subjects at high cardiovascular risk [34]. Subsequently, authors carried out a study including all subjects enrolled in the PREDIMED study and found that the multivariate-adjusted hazard ratios for developing diabetes were 0.60 (95% CI: 0.43 - 0.85) for the MD supplemented with olive oil and 0.82 (95% CI: 0.61 - 1.10) for the MD supplemented with nuts compared with the control diet [35]. Therefore, a MD enriched with olive oil but without energy restrictions reduced diabetes risk among persons with high cardiovascular risk.

The association between adherence to the MDP and incidence of diabetes has also been investigated by 8 prospective cohort studies [36-43], all included in a recent meta-analysis [32], that reports a 15% reduction in the risk of incident type 2 diabetes in subjects with a higher adherence to the MDP compared to the lower.

A further meta-analysis [33] including long-term clinical trials investigating the association between adherence to the MDP and glycaemic control in type 2 diabetes found an overall effect estimate for HbA1c of -0.47% (95% CI: -0.56 to -0.38) favouring the MDP, as compared with the usual care or low-fat diet.

1.2.3. Mediterranean diet and cancer

Several lines of evidence suggest an inverse association between adherence to the MDP and risk of cancer. A recent meta-analysis [44] including cohort [18,45-59] and case-control [60-68] studies worldwide with an overall population of 1,784,404 subjects, showed that the highest adherence score to an MDP was significantly associated with a lower risk of all-cause cancer mortality (RR: 0.87, 95% CI: 0.81–0.93, I^2 = 84%), colorectal cancer (RR: 0.83, 95% CI: 0.76–0.89, I^2 = 56%), breast cancer (RR: 0.93, 95% CI: 0.87–0.99,

I^2=15%), gastric cancer (RR: 0.73, 95% CI: 0.55–0.97, I^2 = 66%), prostate cancer (RR: 0.96, 95% CI: 0.92–1.00, I^2 = 0%), liver cancer (RR: 0.58, 95% CI: 0.46–0.73, I^2 = 0%), head and neck cancer (RR: 0.40, 95% CI: 0.24–0.66, I^2 = 90%), pancreatic cancer (RR: 0.48, 95% CI: 0.35–0.66), and respiratory cancer (RR: 0.10, 95% CI: 0.01–0.70). No significant association could be observed for esophageal / ovarian / endometrial / and bladder cancer, respectively [44]. Among cancer survivors, the association between the adherence to the highest MDP category and risk of cancer mortality, and cancer recurrence was not statistically significant. The updated meta-analyses confirm a prominent and consistent inverse association provided by adherence to an MDP in relation to cancer mortality and risk of several cancer types.

A further prospective study, not included in the meta-analysis mentioned above, and carried out on 35 303 men and women aged 40-69 years of the Melbourne Collaborative Cohort Study (MCCS), reports a 36% reduction of the risk of lung cancer in subjects with the highest adherence to the MDP compared to the lowest [69].

Even in this case, the PREDIMED study is the lonely available randomized trial, which reports a reduction in the risk of breast cancer in women following a Mediterranean diet. In detail, after a median follow-up of 4.8 years, the multivariable-adjusted hazard ratios vs the control group were 0.32 (95% CI, 0.13-0.79) for the MD with extra-virgin olive oil group and 0.59 (95% CI, 0.26-1.35) for the MD with nuts group [70].

1.2.4. Mediterranean diet and mental health

An emerging field of research in nutritional epidemiology is the relationship between dietary pattern and mental health. Several lines of evidence suggest a relationship between MDP and depression, cognitive impairment and eating behaviour.

Concerning depression, some studies have pointed out that several food patterns could be associated with the risk of depression among adults. This association seems to be consistent across countries, cultures and populations according to several systematic reviews and meta-analyses [71-73], which report a 32% reduction in the risk of depression [74]. These systematic reviews included not only adults but also other populations, included retrospective or cross-sectional studies without longitudinal data and finally, occasionally included studies that really did not assess the effect of an overall food pattern, but only of food items or food groups. Only one large randomised trial (the PREDIMED study) has tested the effects of MDP on the incident risk of clinical depression during 5.4-years follow-up [75]. The point estimates for the relative risks associated with the intervention using a MD supplemented with extravirgin olive oil (RR = 0.91) or a MD supplemented with mixed tree nuts (RR = 0.78) in the PREDIMED trial suggested an inverse association. However, the CI for both estimates were wide and they showed that the results were compatible with a null result. Even when both MD were merged together and analysed as a single group, the multivariable-adjusted RR was 0.85 (95% CI: 0.64, 1.13). Only when the analysis was limited to participants with type 2 diabetes (approximately 50% of the sample), a significantly reduced risk of depression was observed and only for participants assigned to the MD + nuts (RR = 0.59; 95% CI: 0.36, 0.98; P = 0.04) but not for participants randomly allocated to MD + extra-virgin olive oil. Among observational studies, an inverse association between a priori defined Mediterranean-type diets and the incidence of depression has been found in two large cohorts [76,77]. In the largest of them (the SUN study) a reduced risk of depression associated with adherence to the MDP, operationally defined using the score proposed by Trichopoulou et al.[31], was found (31). Adherence to the MDS was categorised into five categories: low (score 0–2), low–moderate (score 3), moderate–high (score 4), high (score 5) and very high (6–9). The RR of incident clinical depression (480 new diagnoses during

4.4-years follow-up) were 0.74, 0.66, 0.49 and 0.58 for low-moderate, moderate-high, high and very high conformity vs low conformity, respectively, all of them statistically significant in fully adjusted models and with a significant linear trend (P = 0.002). Nevertheless, it should be pointed out that a smaller cohort study in Greece, did not find any significant advantage of the MDP [78]. However, it is necessary to highlight that the present study was based on a sample of only 732 elders. The point estimate for the RR associated with the MD was protective although not significant probably due to a lack of statistical power [79].

Several studies suggested a relationship between adherence to the MDP and a lower rates of cognitive decline, however the results are still inconsistent [80]. A recent meta-analysis [81], including all the available prospective studies [82-86] investigating the association between the adherence to the MDP and the risk of mild cognitive impairment (MCI) and Alzheimer disease (AD), found that when restricting the analyses to incident mild cognitive impairment (MCI), MDP score, as a continuous variable, was not associated with incident MCI (adjusted HR = 0.95, 95% CI: 0.84–1.08; p = 0.45). When examining tertiles, the highest MDP tertile (adjusted HR = 0.73, 95% CI: 0.56–0.96; p = 0.02) was associated with a reduced risk of MCI compared to the lowest. Among studies examining AD, each one-point increase in the MDP score in cognitively normal individuals was associated with an 8% reduced risk of developing AD (adjusted HR = 0.92, 95% CI: 0.85–0.99, p = 0.03). Examining the MDP in tertiles, subjects in the middle MDP tertile had 13% (not significant) reduced risk (adjusted HR = 0. 87, 95% CI: 0.66–1.14, p = 0.31), while the subjects in the higher tertile had 36% risk reduction (adjusted HR = 0.64, 95% CI: 0.46–0.89, p = 0.007) as compared to the lowest. Findings from this study suggested the need for further prospective longitudinal studies with longer follow-up and randomized controlled trials to determine whether adherence to the Mediterranean diet could reduce the risk of MCI and AD.

A still largely unexplored field of research is the relation between the adherence to the MDP and the risk of eating disorders. A recent cross-sectional study [87] shows that, after adjustments for age, gender, nutritional status, education, smoking status and physical activity level, high adherence to the MDP was associated with lower odds for binge eating behaviour. Odds ratios and 95% confidence intervals of binge eating for successive levels of adherence to the MDP were: 1 (reference), 0.77 (0.44, 1.36), 0.66 (0.37, 1.15), 0.50 (0.26, 0.96), and 0.45 (0.22, 0.55) (P for trend: <0.01). Moreover, olive oil and nut consumption were associated with lower risk of binge eating, whereas butter, cream, sweets and commercial bakery/sweets/cakes consumption increased the risk. Even though the cross-sectional design did not allow to establish a cause-effect relationship, these findings encourage future studies to investigate the possible protective effect of MDP against eating disorders.

1.3. Indexes of adherence to the Mediterranean dietary pattern

Based on the features of the MDP, many food indexes have been developed to evaluate the accordance of dietary pattern to the MDP. A recent review retrieved in literature 22 indexes of adherence to the MDP [88].

The first index of adherence to the MDP was developed by Trichopoulou et al. [6], in 1995 among an elderly population (182 participants). In this study, a 1-unit increase in the score was associated with a 17% reduction of overall mortality (95% CI: 0.69-0.99). The same authors modified this index in 2003 [31] within the 22 043, participants of the EPIC-Greek Cohort. A higher adherence to this new index was associated with a reduction of mortality in adults and elderly people. Moreover, 2-units increment in this score was inversely associated with mortality (RR=0.75, 95% CI: 0.74-0.87), as well as with cause-specific mortality of coronary heart disease (RR= 0.67: 95% CI: 0.47-0.94) and cancer (RR=0.66,

95% CI: 0.59-0.98). In detail, the score ranges from 0 to 9 and includes nine characteristics of the traditional Mediterranean diet; that is, high monounsaturated / saturated fat ratio, moderate alcohol intake, high consumption of cereals, legumes, fruit, vegetables and fish, and low consumption of meat and meat products, and milk and dairy products. The cutpoints for the items considered are set to the sex-specific median values.

A further score of adherence to the MDP, often used in literature, was developed by Martínez-González et al [89] in 2004. The original 9-items score was, subsequently, modified in 2011 [90] and used in the PREDIMED study. The score consists of 12 questions on food consumption frequency and 2 questions on food intake habits considered characteristic of the Mediterranean diet. Each question was scored 0 or 1. One point was given for using olive oil as the principal source of fat for cooking, preferring white meat over red meat, or for consuming: 1) 4 or more tablespoons (1 tablespoon = 13.5 g) of olive oil/d (including that used in frying, salads, meals eaten away from home, etc.); 2) 2 or more servings of vegetables/d; 3) 3 or more pieces of fruit/d; 4) <1 serving of red meat or sausages/d; 5) <1 serving of animal fat/d; 6) <1 cup (1 cup = 100 mL) of sugar-sweetened beverages/d; 7) 7 or more servings of red wine/wk; 8) 3 or more servings of pulses/wk; 9) 3 or more servings of fish/wk; 10) fewer than 2 commercial pastries/wk; 11) 3 or more servings of nuts/wk; or 12) 2 or more servings/wk of a dish with a traditional sauce of tomatoes, garlic, onion, or leeks sautéed in olive oil. If the condition was not met, 0 points were recorded for the category. The final PREDIMED score ranged from 0 to 14.

1.4. Trends of adherence to the Mediterranean dietary pattern

Despite its widely documented health benefits, adherence to the traditional MDP has been rapidly declining over the last decades [91,92]. Data from Central-Southern Italy showed that the percentage of people following a MDP in 2009 was equal to lowest rates of

adherence recorded in Nicotera and Pollica studies during the 60s [93]. Ecological studies reported a substantial shifting from this eating pattern all over Europe but more evident in countries of the Mediterranean area that have experienced a “westernisation” process of food habits, and sharing increasingly similar patterns of food availability, especially of non-Mediterranean food groups [94]. Among possible causes, the increasing cost of many key-foods of the Mediterranean diet has been proposed as a major factor driving people to give up this eating pattern in favour of less expensive, energy-dense foods that typically have lower nutritional quality [95]. In addition, recent evidence has discussed a possible involvement of the economic crisis in the decline of the MD by showing how material resources have become strong determinants of the adherence to the MD just after the recession started in 2007-2008 [96]. This study, conducted in Southern Italy, highlighted that a large number of subjects left the MDP during the period 2005-2010, with a dramatic drop in 2007. In detail, the prevalence of high adherence to the MDP fell from over 30% in 2005 to 18% in 2010. A further study, conducted in Spain in 2009-2010, recorded that only 12% of subjects had dietary habits in accordance with MDP [92].

2. AIM

However, the information on prevalence of adherence to the MDP and its determinants in Northern Italy is scarce. Moreover, since 2010, no study has investigated the trend of adherence to the MDP. Therefore, the aims of the present study were i) to identify the factors associated to the adherence to the MDP and ii) to investigate the trends of food consumption from 2010 to 2015 in large cohort of subjects living in Northern Italy.

3. MATERIALS AND METHODS

3.1. Study design

We performed a cross-sectional study on 7480 consecutive adults who self-referred to International Center for the Assessment of Nutritional Status (ICANS, University of Milan) from January 2010 to December 2015, in order to participate to a structured weight loss or weight maintenance program. On the same day, they underwent a clinical examination, an anthropometric assessment and a structured interview by trained dietician, in order to obtain information about marital status, educational level, smoking and structured physical activity. This latter was investigated asking to subjects the following questions: “Do you practice any structured physical activity?” and “How many hours per week do you spend on this activity?”. Subjects who spent ≥2 hours per week to any structured physical activity were considered as active [97]. Moreover, all patients filled in a questionnaire to evaluate adherence to the MDP [89,90]. From the initial number of subjects recruited for the study, 50 subjects were excluded because diagnosed as having acute infective, neurological, gastrointestinal, cardiac, renal and pulmonary failure, or were unable to understand and fill in questionnaires. The study was carried out according to the Declaration of Helsinki and each participant gave written informed consent to participate. The institutional review board approved the study procedures.

3.2. Anthropometric measurements

Anthropometric measurements were collected, according the to the conventional criteria and measuring procedures proposed by Lohmann et al. [98]. Body Weight (BW, kg) were measured by Column scale (Seca 700 balance, Seca Corporation, Hanover, MD, USA) to 100 g with subjects wearing only light underwear and after bladder emptying, Body Height (BH, cm) was measured to the nearest 0.1 cm using a vertical stadiometer. Body mass

index (BMI) was calculated using the formula: BMI (kg/m^2) = BW (kg)/BH^2 (m^2). BMI was classified into four categories: Underweight (BMI < 18.5 kg/m^2), Normal weight (BMI 18.5–24.9 kg/m^2), Overweight (BMI 25.0–29.9 kg/m^2) and Obese (BMI > 30.0 kg/m^2). Waist circumference was measured midway between the lower rib 105 margin and the superior anterior iliac spine taken to the nearest 0.5 cm and measured with a non-stretch tape applied horizontally.

3.3. Adherence to the Mediterranean dietary pattern

Adherence to the Mediterranean diet was evaluated using a validated 14-item questionnaire [90], which is the extension of an original 9-item questionnaire [89]. A 14-item Mediterranean score (Medscore) was obtained from this questionnaire following the guidelines of the PREDIMED group (www.predimed.es) and a specific validation study by Schröder et al. [90] with some adaptations already used in previous studies [87,99-101]. Briefly, one point was attributed for each of the following: 1) olive oil as main cooking fat, 2) olive oil ≥4 tablespoons/day, 3) vegetables ≥2 servings/day (≥1 portion raw or on salad), 4) fruits ≥3 servings/day, 5) red or processed meat <1 serving/day, 6) butter or cream or margarine <1/day, 7) soda drinks <1/day, 8) wine ≥3 glasses/week, 9) legumes ≥3 servings/week, 10) fish/seafood ≥3 servings/week, 11) commercial sweets and confectionery <3/week, 12) nuts ≥1/week, 13) white more than red meats (yes) and, 14) use of sofrito sauce ≥ 2/week. Subjects with a MEDscore ≥9 points have been considered to have a high adherence to the MDP [87,99-101].

3.4. Statistical analysis

Most continuous variables had non-Gaussian distributions and all are reported as 25^{th}, 50^{th} and 75^{th} percentiles. Discrete variables are reported as counts and percentages. A

Poisson working regression model (PWRM) with robust 95 % confidence interval was used to estimate prevalence and prevalence ratios (PR) of adherence to the MDP and to its individual components [102,103]. A PWRM was used because a binomial regression model (BRM) failed to converge for some of the regressions of interest. Expectedly, the PR estimated by the PWRM and by the BRM were similar in all cases where both could computed [102,103]. Uni- and multivariable PWRM were also used to evaluate the associations of the adherence to the MDP and individual components with sex, age, BMI, educational level, occupation, marital status, smoking status and physical activity. The outcome variables of all models (adherence to the MDP and to its individual components) were discrete (0=no; 1=yes). The covariates were coded as follows: (i) sex (discrete, 0=female; 1=male); (ii) age (continuous, years); (iii) BMI (continuous, kg/m^2); (iv) educational level (discrete, 0=≤high school; 1=>high school); (v) occupation (discrete, 0=unemployed / student / retired / housewife, 1=worker); (vi) marital status (discrete, 0=single or widower; 1=married or cohabitants), (vii) smoking status (discrete, 0=no smoker; 1=smoker; 2=ex-smoker); (viii) physical activity (discrete, 0=no; 1=yes) and (ix) year of recruitment (ordinal, 0=2010; 1=2011; 2=2012; 3=2013; 4=2014; 5=2015). Prevalence ratios and marginal probabilities were calculated from PWRM [104,105]. Tests of linear trend across increasing year of recruitment were conducted treating the variable as a continuous variable. Univariable and multivariable fractional polynomials were used to test whether the relationships of continuous predictors with the outcomes were non-linear [106]. As there was a statistically significant but practically irrelevant improvement in model fit following an inverse transformation of BMI in the multivariable PWRM having the adherence to the MDP as outcome, BMI was kept linear with the benefit of making the relationships more understandable to a clinical audience [107].

4. RESULTS

Overall characteristics of the recruited sample are reported in **Table 1**.

Table 1: Anthropometric measurements and Mediterranean score of the studied sample according to year of recruitment

	2010 (n = 1259)			**2011 (n = 1220)**			**2012 (n = 1224)**			**2013 (n = 1259)**			**2014 (n = 1205)**			**2015 (n = 1263)**			**Total (n = 7430)**		
	P25	P50	P75	P25	P50	P75	P25	P50	P75	P25	P50	P75	P25	P50	P75	P25	P50	P75	P25	P50	P75
Age (years)	37	45	55	38	46	56	38	47	56	37	45	55	38	47	55	37	47	54	37	46	55
BMI (kg/m^2)	25.7	29	32	25.5	29	33	25.5	29	32.7	25.3	28	33	25.6	29	32.4	25.1	28	32.6	25.4	29	32.5
WC (cm)	85.3	95	106	85.7	95	106	86.7	96	107	86.1	96	107	88	98	107	87	97	108	86.5	96	107
Medscore	5	7	8	6	7	8	5	7	8	5	7	8	6	7	8	6	7	8	6	7	8

Socio-anagraphic, nutritional status and lifestyle characteristics of the sample are reported in **Table 2**.

Table 2: Socio-anagraphic, nutritional status and lifestyle characteristics of the sample according to the year of recruitment

	2010		2011		2012		2013		2014		2015		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Sex														
Women	883	70.1	862	70.7	868	70.9	923	73.3	857	71.1	891	70.5	5284	71.1
Men	376	29.9	358	29.3	356	29.1	336	26.7	348	28.9	372	29.5	2146	28.9
Age decades														
18-19 years	16	1.3	13	1.1	17	1.4	18	1.4	14	1.2	21	1.7	99	1.3
20-29 years	116	9.2	106	8.7	112	9.2	124	9.8	103	8.5	110	8.7	671	9
30-39 years	285	22.6	251	20.6	226	18.5	266	21.1	233	19.3	245	19.4	1506	20.3
40-49 years	354	28.1	362	29.7	376	30.7	377	29.9	354	29.4	385	30.5	2208	29.7
50-59 years	274	21.8	275	22.5	290	23.7	271	21.5	290	24.1	314	24.9	1714	23.1
60-69 years	166	13.2	174	14.3	159	13	158	12.5	160	13.3	136	10.8	953	12.8
≥70 years	48	3.8	39	3.2	44	3.6	45	3.6	51	4.2	52	4.1	279	3.8
BMI classes														
Normal weight	256	20.3	267	21.9	262	21.4	291	23.1	248	20.6	307	24.3	1631	22
Overweight	496	39.4	467	38.3	471	38.5	458	36.4	476	39.5	459	36.3	2827	38
Obesity 1class	341	27.1	306	25.1	304	24.8	328	26.1	311	25.8	309	24.5	1899	25.6
Obesity 2class	113	9.0	124	10.2	141	11.5	134	10.6	112	9.3	121	9.6	745	10
Obesity 3class	53	4.2	56	4.6	46	3.8	48	3.8	58	4.8	67	5.3	328	4.4
Education														
Low degree	766	60.8	801	65.7	768	62.7	743	59	689	57.2	687	54.4	4454	59.9
High degree	493	39.2	419	34.3	456	37.3	516	41	516	42.8	576	45.6	2976	40.1
Occupation														
Unworker	259	20.6	290	23.8	277	22.6	299	23.7	241	20	247	19.6	1613	21.7
Worker	1000	79.4	930	76.2	947	77.4	960	76.3	964	80	1016	80.4	5817	78.3
Marital status														
Single	551	43.8	535	43.9	572	46.7	605	48.1	557	46.2	602	47.7	3422	46.1
Married	708	56.2	685	56.1	652	53.3	654	51.9	648	53.8	661	52.3	4008	53.9
Smoking														
No-smoker	670	53.2	642	52.6	665	54.3	690	54.8	623	51.7	641	50.8	3931	52.9
Smoker	255	20.3	259	21.2	262	21.4	239	19	249	20.7	363	28.7	1627	21.9
Ex-smoker	334	26.5	319	26.1	297	24.3	330	26.2	333	27.6	259	20.5	1872	25.2
Physical activity														
No	721	57.3	766	62.8	772	63.1	727	57.7	649	53.9	624	49.4	4259	57.3
Yes	538	42.7	454	37.2	452	36.9	532	42.3	556	46.1	639	50.6	3171	42.7
Mediterranean diet														
Yes	158	12.6	180	14.8	176	14.4	164	13.0	172	14.3	189	15.0	1039	14.0
No	1101	87.4	1040	85.2	1048	85.6	1095	87.0	1033	85.7	1074	85.0	6391	86.0

Firstly, we investigated the factors associated with the adherence to the MDP and individual components. The prevalence of adherence to the MDP in the pool sample was 14%. **Table 3** reports the PRs obtained from the multivariable PWRM. In **Table 4** we report the corresponding marginal probabilities for each factor obtained from the PWRM. Age (PR=1.03, 95% CI: 1.03 - 1.04; for each 1-year increase), being married (PR=1.16, 95% CI: 1.03 - 1.31), ex-smoker (PR=1.21, 95% CI: 1.06 - 1.38) and physically active (PR=1.40, 95% CI: 1.25 - 1.57) were directly associated with the prevalence of adherence to the MDP. On the contrary, BMI (PR=0.99, 95% CI: 0.97 - 1.00; for each 1-kg/m^2 increase) was inversely associated with the prevalence of adherence to the MDP. Sex, education and being a worker were not associated with the prevalence of adherence to the MDP.

Being men was associated with higher consumption of carbonated beverages, wine and legumes and greater use of soffritto. On the contrary, it was associated with a lower consumption of olive oil, vegetables, fish and white meat. Being graduated was associated with a greater use of olive oil as main culinary fat and with higher consumption of vegetables, wine, legumes, fish and lower consumption of carbonated beverages and white meat. Being a worker was associated with a greater use of olive oil as main culinary fat and lower consumption of vegetables, fruit and sweets. Being married was associated with a higher consumption of olive oil, red meat and use of soffritto and lower consumption of carbonated beverages and legumes. Ex-smokers had higher consumption of olive oil, wine and nuts, and lower consumption of fruit, sweets and white meat compared to non-smokers. To spend at least 2 hours/week for physical activity was associated with higher consumption of vegetables, fruit, fish, nuts and white meat and lower consumption of olive oil, red meat, carbonated beverages, sweets and use of soffritto.

Age and BMI were associated with almost all components of Mediterranean diet. **Figure 1** plots the prevalence of adherence to the MDP and individual components estimated from the PWRM as a function of age and BMI.

It can be seen that the adherence to the MDP increased with increasing age and decreased with increasing BMI levels. Moreover, almost all criteria of adherence to the Mediterranean diet were more followed by older than younger. Only the consumption of olive oil and use of soffritto decreased with age. Finally, a lower BMI was associated with a higher consumption of wine and nuts and lower consumption of olive oil, red meat, carbonated beverages and use of soffritto.

Table 3: Factors associated with adherence to the Mediterranean dietary pattern and its individual food-items

	MDP (Yes)	Olive oil (Yes)	Olive oil (≥4 sp/d)	Vegetable (≥2 s/d)	Fruits (≥3 units/d)	Red meat (<1 s/d)	Animal fats (<1 s/d)	Carbonated beverages (<1 gl/d)	Wine (≥3 gl/w)	Legumes (≥3 s/w)	Fish (≥3 s/w)	Sweets (<3 t/w)	Nuts (≥1 s/w)	White meat (Yes)	Soffrito (≥2 t/w)
Sex (Men)	1.00 [0.88,1.14]	0.99 [0.99,1.00]	0.84*** [0.78,0.90]	0.85*** [0.81,0.89]	0.90 [0.78,1.04]	0.97 [0.94,1.01]	1.00 [0.99,1.01]	0.95*** [0.92,0.97]	1.90*** [1.77,2.03]	1.70*** [1.36,2.12]	0.77** [0.65,0.93]	1.04 [0.99,1.09]	0.97 [0.87,1.10]	0.84*** [0.80,0.87]	1.14*** [1.08,1.21]
Age (years)	1.03*** [1.03,1.04]	1.00*** [1.00,1.00]	1.00* [0.99,1.00]	1.01*** [1.01,1.01]	1.03*** [1.03,1.04]	1.01*** [1.01,1.01]	1.00 [1.00,1.00]	1.00*** [1.00,1.00]	1.02*** [1.02,1.02]	1.02*** [1.01,1.02]	1.01*** [1.01,1.02]	1.01*** [1.00,1.01]	1.03*** [1.02,1.03]	1.00*** [1.00,1.01]	1.00** [0.99,1.00]
BMI (kg/m^2)	0.99* [0.97,1.00]	1.00 [1.00,1.00]	1.01*** [1.01,1.02]	1.00 [0.99,1.00]	1.01 [1.00,1.02]	0.99*** [0.98,0.99]	1.00 [1.00,1.00]	1.00** [1.00,1.00]	0.98*** [0.97,0.98]	0.98 [0.96,1.01]	1.00 [0.98,1.01]	1.00 [0.99,1.00]	0.97*** [0.96,0.98]	1.00 [1.00,1.01]	1.01*** [1.01,1.02]
Education (High degree)	1.11 [0.99,1.25]	1.01* [1.00,1.02]	0.99 [0.93,1.06]	1.09*** [1.04,1.14]	1.02 [0.90,1.16]	1.01 [0.98,1.05]	1.01 [1.00,1.01]	1.05*** [1.03,1.07]	1.18*** [1.10,1.26]	1.58*** [1.27,1.96]	1.38*** [1.19,1.61]	0.99 [0.95,1.03]	1.09 [0.98,1.21]	0.86*** [0.83,0.90]	0.98 [0.93,1.04]
Occupation (Worker)	0.90 [0.78,1.03]	1.02*** [1.01,1.03]	1.01 [0.94,1.09]	0.91*** [0.87,0.96]	0.75*** [0.64,0.87]	0.99 [0.96,1.03]	1.00 [0.99,1.01]	0.98 [0.95,1.00]	1.03 [0.95,1.12]	0.81 [0.61,1.06]	1.04 [0.85,1.26]	0.84*** [0.80,0.88]	1.08 [0.94,1.23]	0.96 [0.92,1.00]	0.95 [0.88,1.01]
Marital status (Married)	1.16* [1.03,1.30]	1.00 [1.00,1.01]	1.11** [1.04,1.19]	1.03 [0.99,1.08]	0.97 [0.86,1.10]	0.93*** [0.90,0.96]	0.99 [0.99,1.00]	1.02* [1.00,1.04]	1.01 [0.94,1.08]	0.77* [0.62,0.95]	0.88 [0.76,1.02]	1.02 [0.98,1.07]	0.94 [0.84,1.04]	1.01 [0.97,1.05]	1.24*** [1.17,1.32]
Smoking															
(Smoker)	1.09 [0.94,1.26]	1.00 [0.99,1.01]	1.14*** [1.06,1.23]	0.97 [0.92,1.03]	0.76** [0.64,0.90]	0.96* [0.92,1.00]	1.00 [0.99,1.01]	0.99 [0.96,1.01]	1.46*** [1.35,1.59]	1.00 [0.77,1.31]	0.86 [0.71,1.05]	1.09*** [1.04,1.15]	1.03 [0.90,1.18]	0.91*** [0.87,0.96]	1.04 [0.97,1.11]
(Ex-smoker)	1.20** [1.06,1.37]	1.01 [1.00,1.02]	1.16*** [1.07,1.25]	1.03 [0.98,1.08]	0.85* [0.74,0.98]	1.00 [0.97,1.04]	1.00 [0.99,1.01]	1.00 [0.98,1.03]	1.36*** [1.26,1.47]	0.93 [0.72,1.21]	1.02 [0.86,1.22]	1.09*** [1.04,1.15]	1.20** [1.07,1.36]	0.93** [0.89,0.97]	1.04 [0.97,1.11]
Physical activity (Yes)	1.40*** [1.25,1.56]	1.00 [0.99,1.01]	0.90** [0.85,0.96]	1.20*** [1.15,1.25]	1.12 [1.00,1.27]	1.06*** [1.03,1.09]	1.01 [1.00,1.01]	1.06*** [1.04,1.08]	1.04 [0.97,1.11]	1.10 [0.89,1.36]	1.52*** [1.31,1.77]	1.11*** [1.07,1.16]	1.43*** [1.29,1.59]	1.10*** [1.06,1.15]	0.91*** [0.86,0.96]
Observations	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430

Values are prevalence ratios (PR) with robust 95% confidence intervals obtained from a multivariable PWRM.

Abbreviations: sp = spoons; d = day; s = servings; gl = glass; w = week; t = times.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

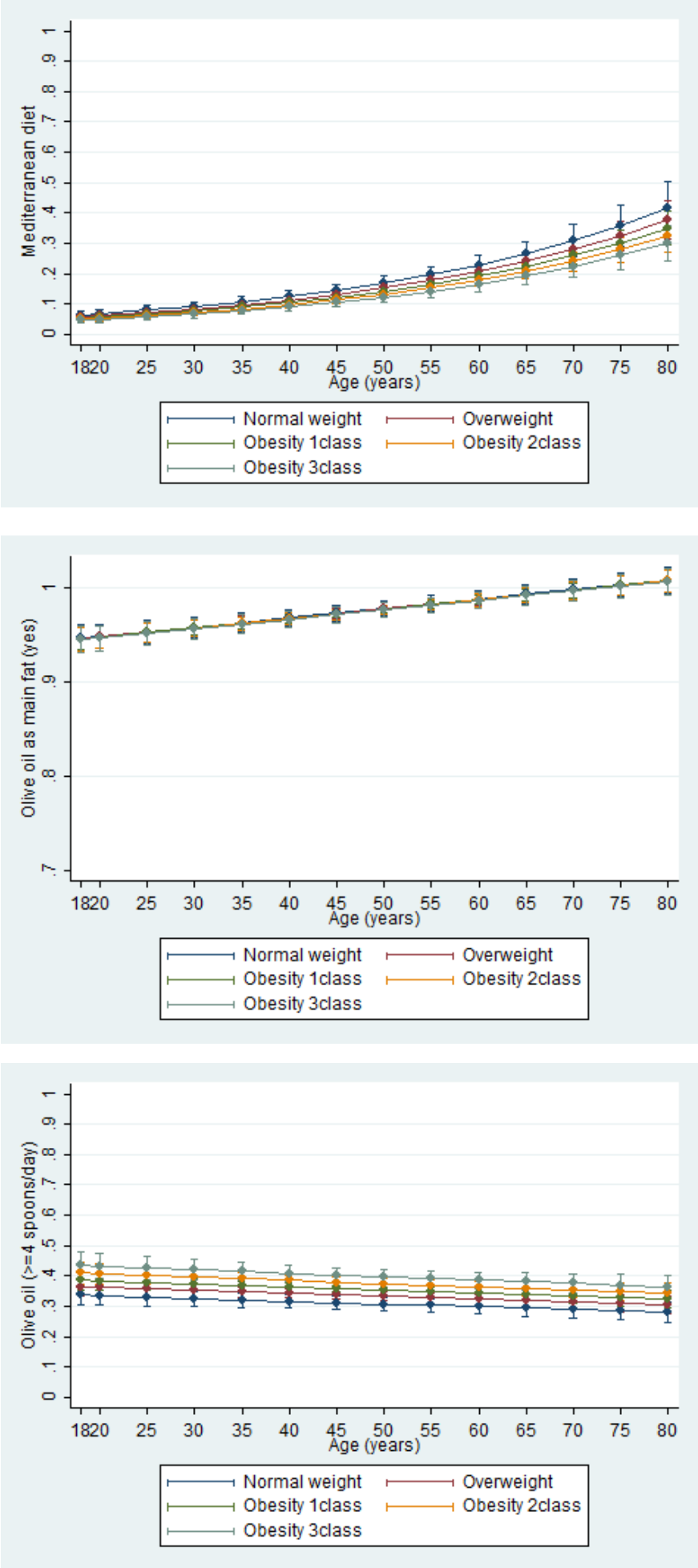
Table 4: Estimated probabilities of adherence to the Mediterranean dietary pattern and individual components for each factor

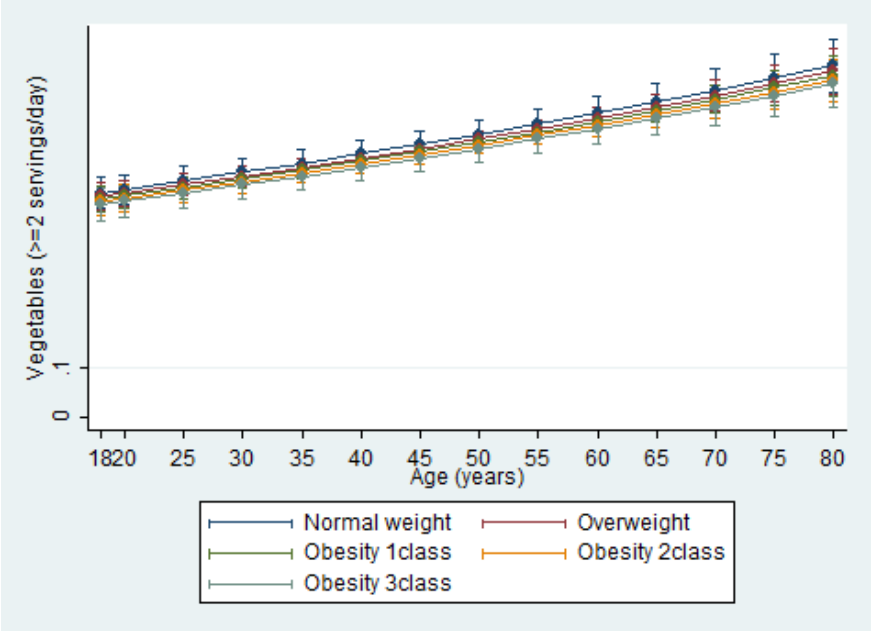
	MDP (Yes)	Olive oil (Yes)	Olive oil (≥4 sp/d)	Vegetable (≥2 s/d)	Fruits (≥3 units/d)	Red meat (<1 s/d)	Animal fats (<1 s/d)	Carbonated beverages (<1 gl/d)	Wine (≥3 gl/w)	Legumes (≥3 s/w)	Fish (≥3 s/w)	Sweets (<3 times/w)	Nuts (≥1 s/w)	White meat (Yes)	Soffritto (≥2 times/w)
Sex															
Women	0.14 [0.13,0.15]	0.98 [0.97,0.98]	0.37 [0.36,0.39]	0.57 [0.56,0.58]	0.13 [0.12,0.14]	0.69 [0.67,0.70]	0.98 [0.97,0.98]	0.85 [0.84,0.86]	0.24 [0.23,0.26]	0.04 [0.03,0.04]	0.09 [0.09,0.10]	0.55 [0.53,0.56]	0.16 [0.15,0.17]	0.63 [0.61,0.64]	0.40 [0.38,0.41]
Men	0.14 [0.13,0.15]	0.97 [0.96,0.98]	0.31 [0.29,0.33]	0.48 [0.46,0.50]	0.11 [0.10,0.13]	0.67 [0.65,0.69]	0.98 [0.97,0.98]	0.81 [0.79,0.82]	0.46 [0.44,0.48]	0.06 [0.05,0.07]	0.07 [0.06,0.08]	0.57 [0.55,0.59]	0.16 [0.14,0.18]	0.52 [0.50,0.55]	0.45 [0.43,0.47]
Education															
Low degree	0.13 [0.12,0.14]	0.97 [0.96,0.97]	0.36 [0.34,0.37]	0.53 [0.51,0.54]	0.12 [0.11,0.13]	0.68 [0.66,0.69]	0.97 [0.97,0.98]	0.82 [0.81,0.84]	0.29 [0.27,0.30]	0.04 [0.03,0.04]	0.08 [0.07,0.08]	0.56 [0.54,0.57]	0.16 [0.15,0.17]	0.63 [0.62,0.65]	0.42 [0.40,0.43]
High degree	0.15 [0.14,0.16]	0.98 [0.97,0.98]	0.35 [0.34,0.37]	0.57 [0.55,0.59]	0.13 [0.11,0.14]	0.69 [0.67,0.70]	0.98 [0.97,0.98]	0.87 [0.85,0.88]	0.34 [0.32,0.36]	0.06 [0.05,0.07]	0.10 [0.09,0.12]	0.55 [0.53,0.57]	0.17 [0.16,0.18]	0.55 [0.53,0.56]	0.41 [0.39,0.43]
Occupation															
Unemployed	0.15 [0.13,0.17]	0.96 [0.95,0.97]	0.35 [0.33,0.37]	0.58 [0.56,0.61]	0.15 [0.13,0.17]	0.68 [0.66,0.71]	0.97 [0.96,0.98]	0.86 [0.84,0.87]	0.30 [0.28,0.32]	0.05 [0.04,0.07]	0.08 [0.07,0.10]	0.63 [0.61,0.66]	0.15 [0.14,0.17]	0.62 [0.59,0.64]	0.43 [0.41,0.46]
Worker	0.14 [0.13,0.15]	0.98 [0.97,0.98]	0.36 [0.34,0.37]	0.53 [0.52,0.55]	0.11 [0.10,0.12]	0.68 [0.67,0.69]	0.98 [0.97,0.98]	0.84 [0.83,0.85]	0.31 [0.30,0.32]	0.04 [0.04,0.05]	0.09 [0.08,0.10]	0.53 [0.52,0.54]	0.17 [0.16,0.18]	0.59 [0.58,0.61]	0.41 [0.39,0.42]
Marital status															
Not married	0.13 [0.12,0.14]	0.97 [0.97,0.98]	0.33 [0.32,0.35]	0.53 [0.52,0.55]	0.13 [0.11,0.14]	0.71 [0.69,0.72]	0.98 [0.97,0.98]	0.83 [0.82,0.84]	0.31 [0.29,0.32]	0.05 [0.04,0.06]	0.09 [0.08,0.10]	0.55 [0.53,0.56]	0.17 [0.15,0.18]	0.59 [0.58,0.61]	0.37 [0.35,0.38]
Married	0.15 [0.14,0.16]	0.98 [0.97,0.98]	0.37 [0.36,0.39]	0.55 [0.54,0.57]	0.12 [0.11,0.13]	0.66 [0.64,0.67]	0.97 [0.97,0.98]	0.85 [0.84,0.86]	0.31 [0.30,0.32]	0.04 [0.03,0.05]	0.08 [0.07,0.09]	0.56 [0.54,0.58]	0.16 [0.15,0.17]	0.6 [0.59,0.62]	0.45 [0.44,0.47]
Smoking															
No-smoker	0.13 [0.12,0.14]	0.97 [0.97,0.98]	0.33 [0.32,0.35]	0.54 [0.53,0.56]	0.14 [0.13,0.15]	0.69 [0.67,0.70]	0.98 [0.97,0.98]	0.84 [0.83,0.85]	0.26 [0.24,0.27]	0.05 [0.04,0.05]	0.09 [0.08,0.10]	0.53 [0.51,0.55]	0.15 [0.14,0.16]	0.62 [0.61,0.64]	0.41 [0.39,0.42]
Smoker	0.14 [0.12,0.16]	0.97 [0.96,0.98]	0.38 [0.35,0.40]	0.53 [0.50,0.55]	0.10 [0.09,0.12]	0.66 [0.63,0.68]	0.98 [0.97,0.98]	0.83 [0.81,0.85]	0.38 [0.35,0.40]	0.05 [0.04,0.06]	0.08 [0.06,0.09]	0.58 [0.56,0.60]	0.16 [0.14,0.18]	0.57 [0.54,0.59]	0.42 [0.40,0.45]
Ex-smoker	0.16 [0.14,0.17]	0.98 [0.97,0.99]	0.38 [0.36,0.41]	0.56 [0.54,0.58]	0.12 [0.10,0.13]	0.69 [0.67,0.71]	0.98 [0.97,0.98]	0.85 [0.83,0.86]	0.35 [0.33,0.37]	0.04 [0.03,0.05]	0.09 [0.08,0.10]	0.58 [0.56,0.60]	0.18 [0.17,0.20]	0.58 [0.55,0.60]	0.42 [0.40,0.44]
Physical activity															
Sedentary	0.12 [0.11,0.13]	0.97 [0.97,0.98]	0.37 [0.35,0.38]	0.50 [0.49,0.52]	0.12 [0.11,0.13]	0.66 [0.65,0.68]	0.97 [0.97,0.98]	0.82 [0.81,0.83]	0.30 [0.29,0.32]	0.04 [0.04,0.05]	0.07 [0.06,0.08]	0.53 [0.51,0.54]	0.14 [0.13,0.15]	0.57 [0.56,0.59]	0.43 [0.41,0.44]
Physically active	0.17 [0.15,0.18]	0.97 [0.97,0.98]	0.33 [0.32,0.35]	0.60 [0.59,0.62]	0.13 [0.12,0.14]	0.70 [0.69,0.72]	0.98 [0.97,0.98]	0.87 [0.86,0.88]	0.31 [0.30,0.33]	0.05 [0.04,0.05]	0.11 [0.10,0.12]	0.59 [0.57,0.60]	0.2 [0.18,0.21]	0.63 [0.62,0.65]	0.39 [0.37,0.41]
Observations	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430

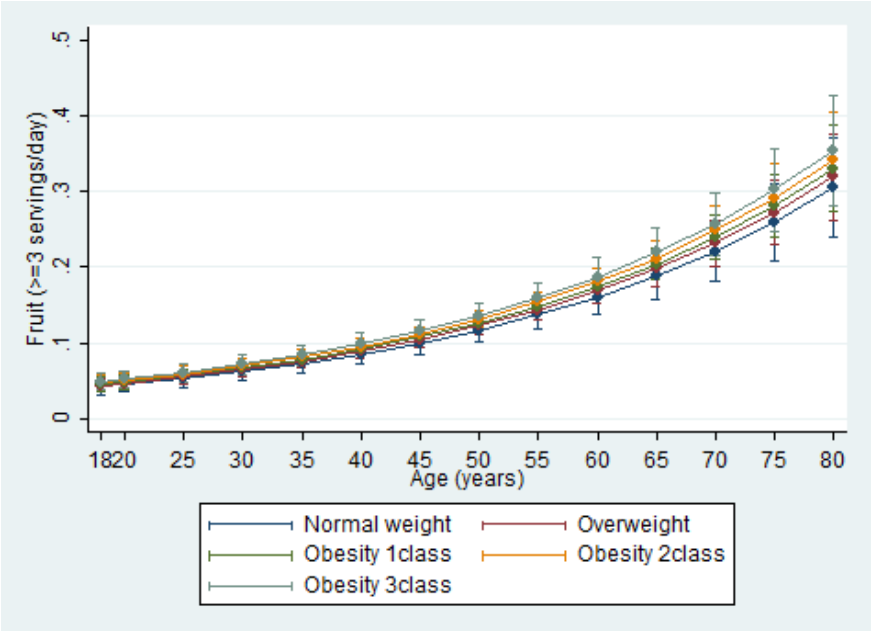
Values are marginal probabilities with 95% confidence intervals estimated for sex, education, occupation, marital status, smoking and physically activity level using the multivariable PWRM.

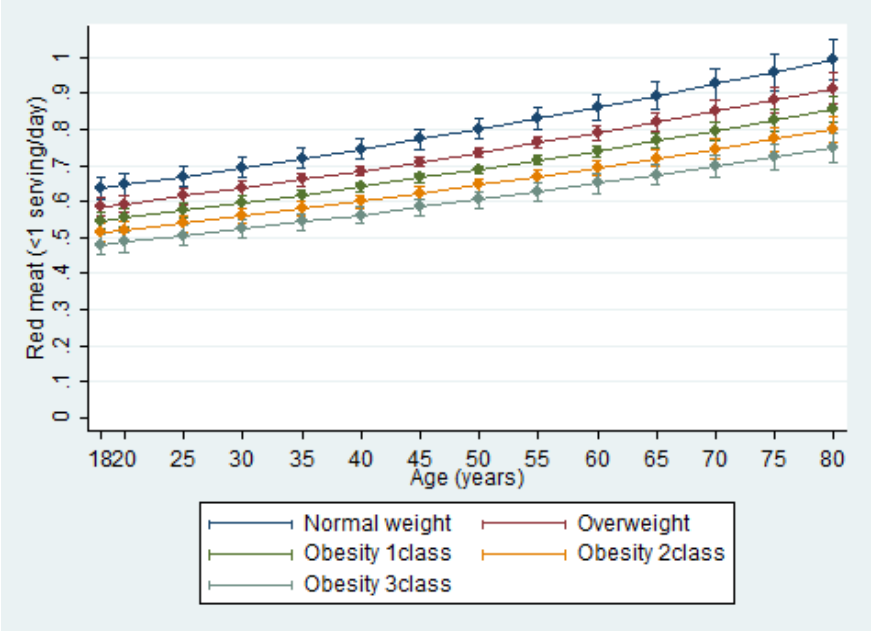
Abbreviations: sp = spoons; d = day; s = servings; gl = glass; w = week; t = times.

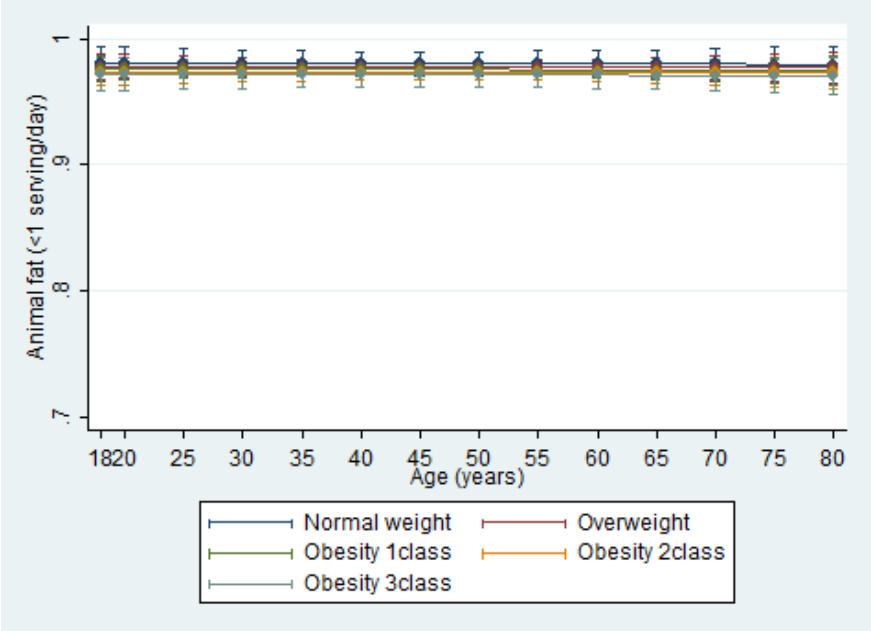
Figure 1. Prevalence of adherence to the MDP and individual components according to age and BMI

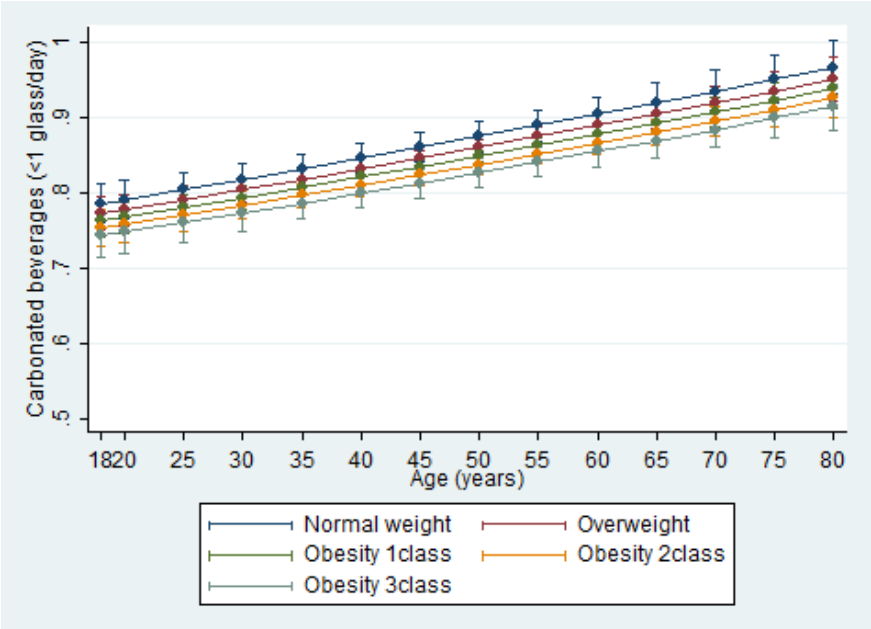


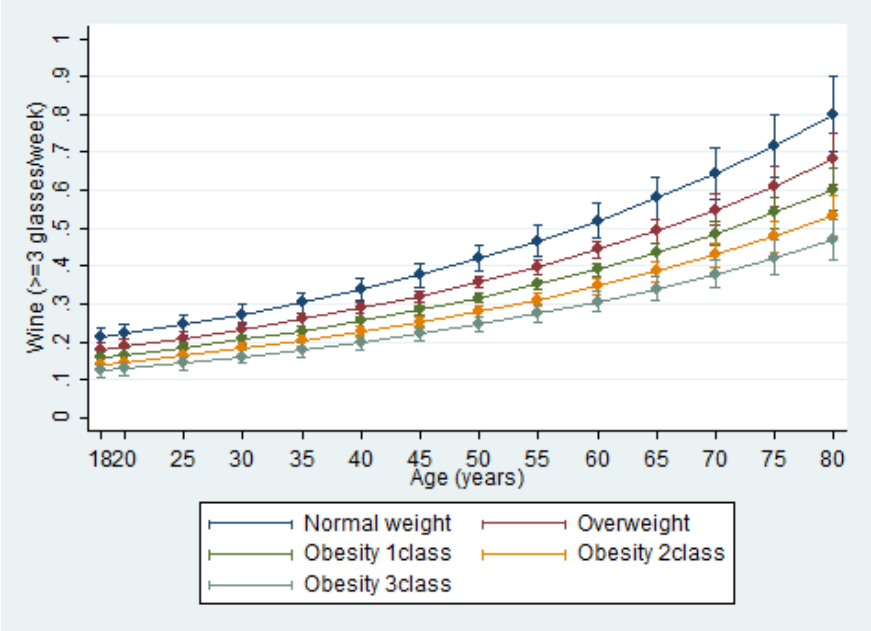

Vegetables (>=2 servings/day)
0
.1
1820
25
30
35
40
45
50
55
60
65
70
75
80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class

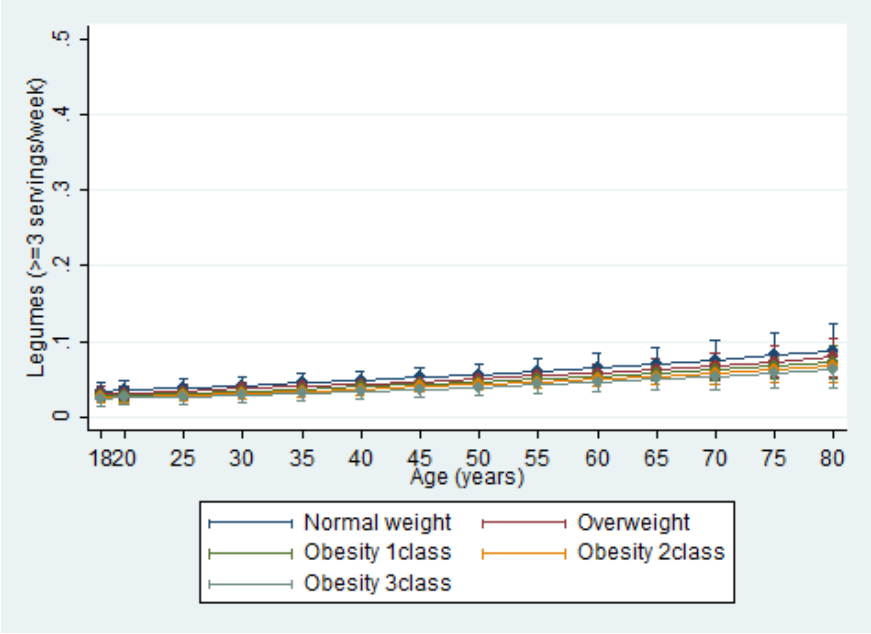

Fruit (>=3 servings/day)
0
.1
.2
.3
.4
.5
1820
25
30
35
40
45
50
55
60
65
70
75
80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class

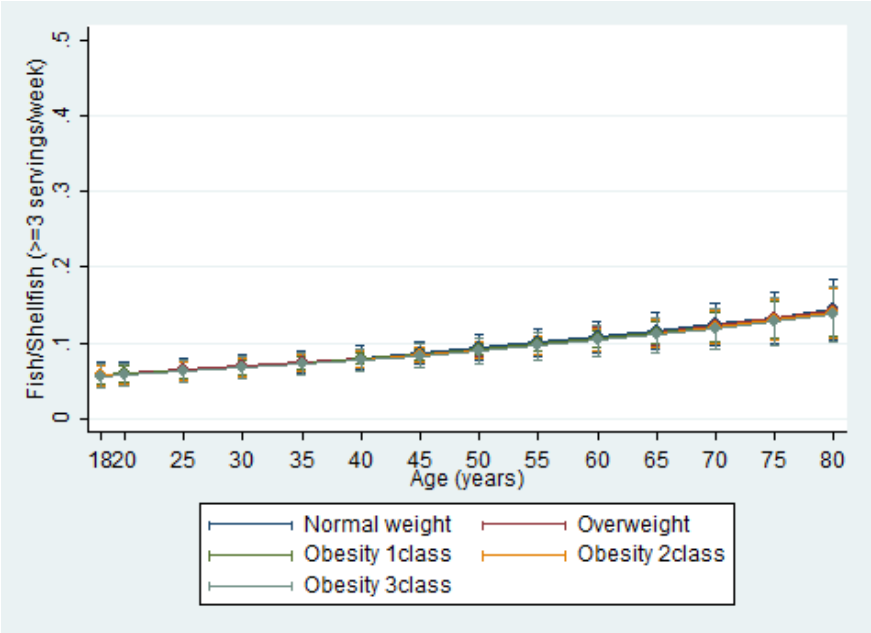

Red meat (<1 serving/day)
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
1820
25
30
35
40
45
50
55
60
65
70
75
80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class

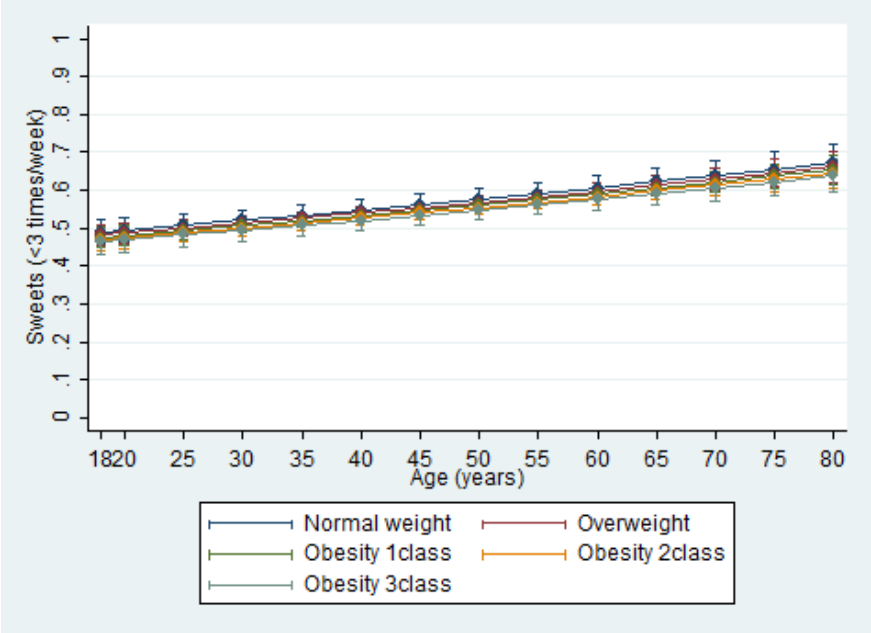

Animal fat (<1 serving/day)
.7
.8
.9
1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class

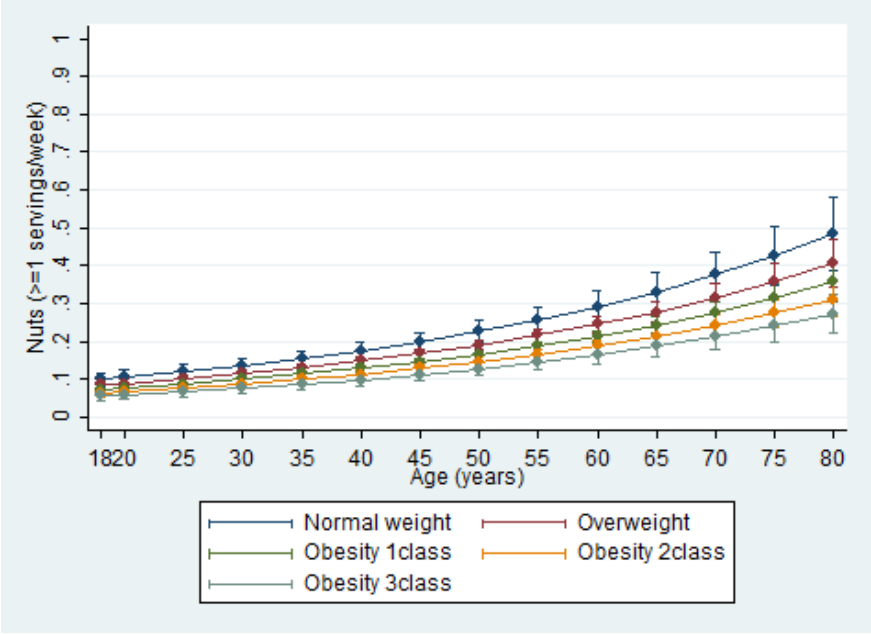

Carbonated beverages (<1 glass/day)
.5
.6
.7
.8
.9
1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class

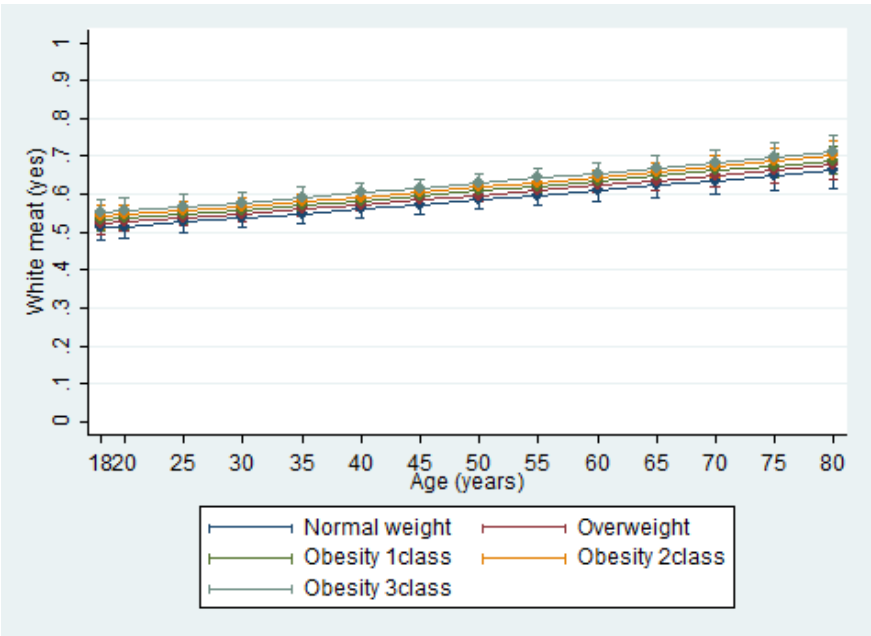

Wine (>=3 glasses/week)
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class

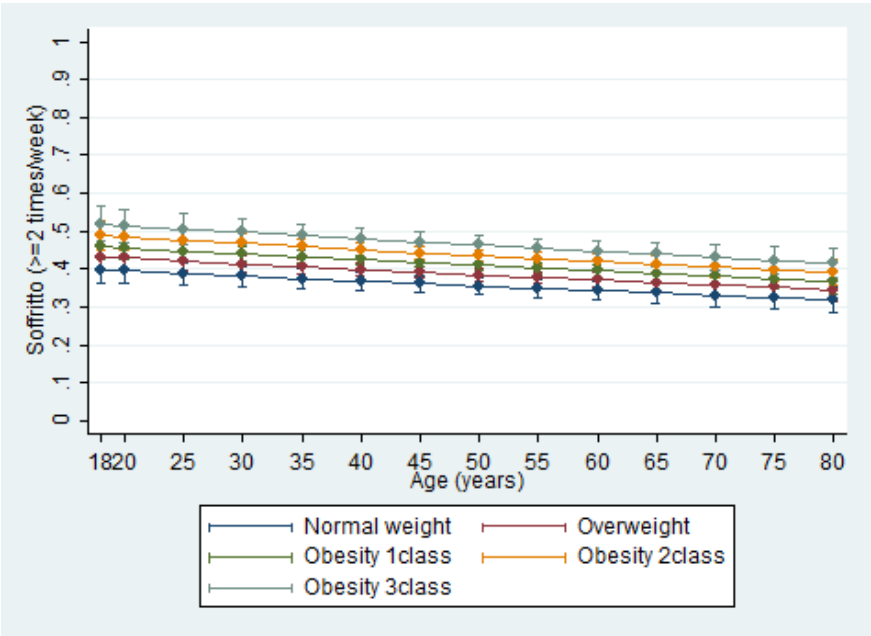

Legumes (>=3 servings/week)
0
.1
.2
.3
.4
.5
1820
25
30
35
40
45
50
55
60
65
70
75
80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class


Fish/Shellfish (>=3 servings/week)
0
.1
.2
.3
.4
.5
1820
25
30
35
40
45
50
55
60
65
70
75
80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class


Sweets (<3 times/week)
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
1820
25
30
35
40
45
50
55
60
65
70
75
80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class


Nuts (>=1 servings/week)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class


White meat (yes)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class


Soffritto (>=2 times/week)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
Normal weight
Overweight
Obesity 1class
Obesity 2class
Obesity 3class

After identifying the factors associated with adherence to the MDP and individual items, we evaluated the trends of food consumption during the period 2010-2015. In **Table 5** we report the PRs of adherence to the MDP and individual components estimated by PWRM for the years 2011-2015 in comparison with 2010, and in **Table 6** the corresponding marginal probabilities. We observed an increment of the consumption of nuts (p for trend < 0.001) and white meat (p for trend = 0.001) and a decrement of the consumption of fruit (p for trend < 0.001), sweets (p for trend = 0.006), carbonated beverages (p for trend = 0.004) and use of soffritto (p for trend < 0.001). The consumption of olive oil was found increased during the period 2011-2015 compared to 2010, but the linear trend was not significant (p for trend = 0.283). The adherence to the MDP did not change during the period of interest.

Figure 2 plots the prevalence of adherence to the Mediterranean diet and the trends of consumption from 2010 to 2015 estimated from the PWRM as a function of age and year of recruitment.

Table 5: Adherence to the Mediterranean dietary pattern and individual components during the period 2010-2015

	MDP (Yes)	Olive oil (Yes)	Olive oil (≥4 sp/d)	Vegetable (≥2 s/d)	Fruits (≥3 units/d)	Red meat (<1 s/d)	Animal fats (<1 s/d)	Carbonated beverages (<1 gl/d)	Wine (≥3 gl/w)	Legumes (≥3 s/w)	Fish (≥3 s/w)	Sweets (<3 t/w)	Nuts (≥1 s/w)	White meat (Yes)	Soffrito (≥2 t/w)
Year															
2011	1.20 [0.99,1.45]	1.00 [0.99,1.02]	1.35*** [1.21,1.52]	1.07 [0.99,1.15]	0.88 [0.73,1.07]	1.01 [0.96,1.07]	1.00 [0.99,1.01]	1.02 [0.99,1.06]	1.09 [0.97,1.23]	1.03 [0.73,1.46]	0.81 [0.63,1.04]	1.05 [0.97,1.13]	1.32* [1.05,1.65]	1.01 [0.95,1.08]	0.95 [0.89,1.02]
2012	1.17 [0.96,1.42]	1.00 [0.99,1.01]	1.47*** [1.32,1.64]	0.95 [0.88,1.03]	0.75** [0.61,0.91]	1.06* [1.00,1.11]	1.00 [0.99,1.02]	1.01 [0.97,1.04]	1.18** [1.06,1.32]	0.84 [0.58,1.21]	0.77* [0.60,0.99]	1.10* [1.02,1.18]	1.54*** [1.24,1.92]	1.03 [0.96,1.10]	0.66*** [0.60,0.72]
2013	1.04 [0.86,1.27]	1.00 [0.99,1.01]	1.42*** [1.27,1.59]	0.98 [0.91,1.05]	0.79* [0.65,0.95]	1.05 [0.99,1.10]	1.00 [0.99,1.02]	1.02 [0.99,1.06]	1.11 [0.98,1.24]	0.72 [0.49,1.05]	0.81 [0.63,1.03]	1.05 [0.98,1.13]	1.79*** [1.45,2.20]	1.10** [1.03,1.17]	0.57*** [0.52,0.63]
2014	1.10 [0.90,1.34]	1.00 [0.99,1.02]	1.18** [1.05,1.33]	1.05 [0.98,1.13]	0.65*** [0.53,0.79]	1.01 [0.95,1.07]	1.01 [0.99,1.02]	1.03 [1.00,1.07]	1.12 [1.00,1.25]	1.03 [0.73,1.45]	0.87 [0.68,1.10]	1.11** [1.03,1.19]	2.16*** [1.76,2.64]	1.10** [1.03,1.17]	0.59*** [0.54,0.65]
2015	1.17 [0.96,1.42]	1.00 [0.99,1.01]	1.19** [1.06,1.34]	1.06 [0.98,1.13]	0.65*** [0.52,0.79]	1.05 [1.00,1.11]	1.00 [0.99,1.01]	1.05** [1.02,1.09]	1.09 [0.97,1.22]	0.89 [0.62,1.26]	0.80 [0.63,1.02]	1.10** [1.02,1.18]	2.50*** [2.06,3.04]	1.07* [1.01,1.15]	0.61*** [0.55,0.66]
p for trend	0.494	0.836	0.283	0.224	**< 0.001**	0.171	0.374	**0.004**	0.234	0.497	0.217	**0.006**	**< 0.001**	**0.001**	**< 0.001**
Observations	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430

Values are prevalence ratios (PR) with robust 95% confidence intervals obtained from a multivariable PWRM, using 2010 as reference year.

Abbreviations: sp = spoons; d = day; s = servings; gl = glass; w = week; t = times.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

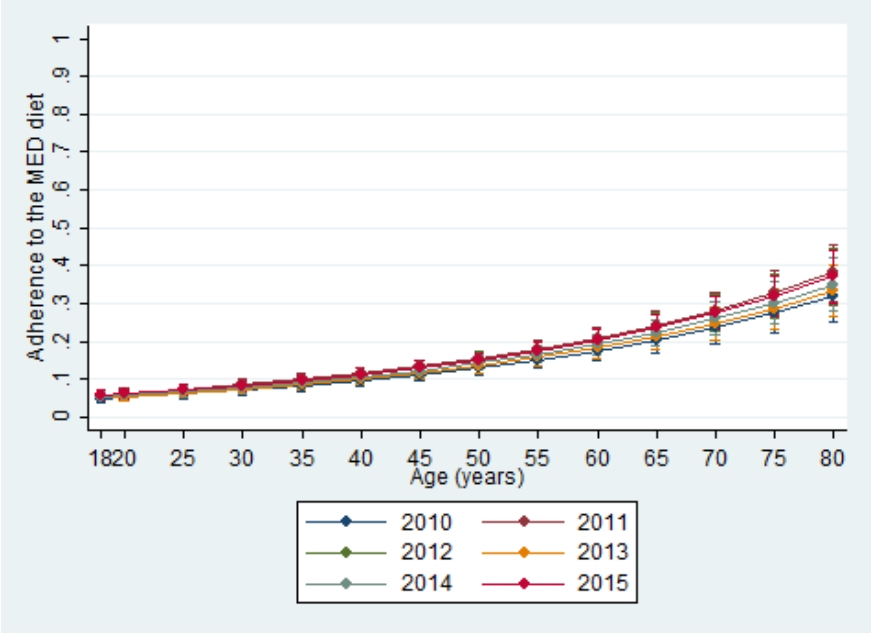
Table 6: Estimated probabilities of adherence to the Mediterranean dietary pattern and individual components during the period 2010-2015

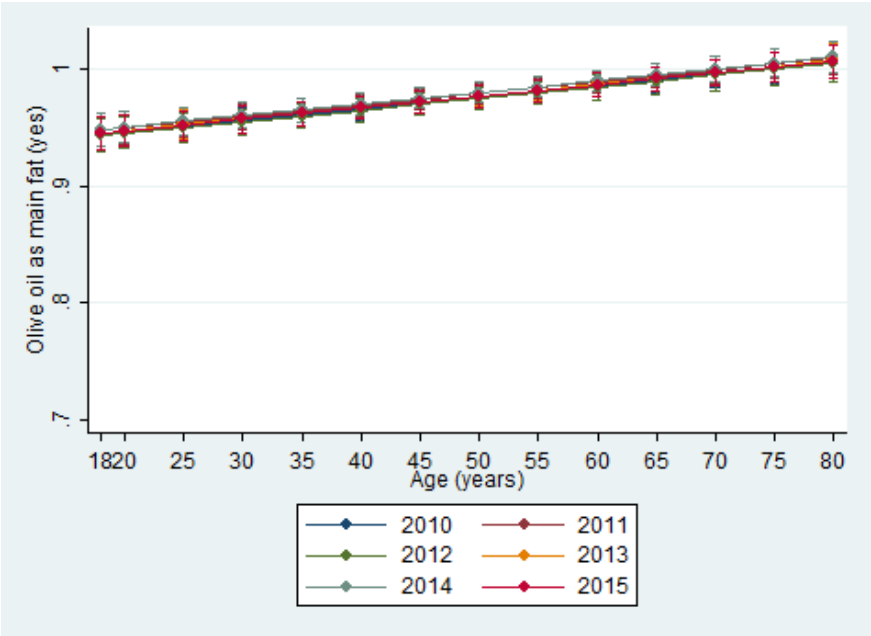
	MDP (Yes)	Olive oil (Yes)	Olive oil (≥4 sp/d)	Vegetable (≥2 s/d)	Fruits (≥3 units/d)	Red meat (<1 s/d)	Animal fats (<1 s/d)	Carbonated beverages (<1 gl/d)	Wine (≥3 gl/w)	Legumes (≥3 s/w)	Fish (≥3 s/w)	Sweets (<3 t/w)	Nuts (≥1 s/w)	White meat (Yes)	Soffrito (≥2 t/w)
Year															
2010	0.13 [0.11,0.14]	0.97 [0.96,0.98]	0.28 [0.25,0.30]	0.53 [0.51,0.56]	0.16 [0.14,0.18]	0.66 [0.64,0.69]	0.97 [0.96,0.98]	0.82 [0.80,0.84]	0.28 [0.26,0.30]	0.05 [0.04,0.06]	0.10 [0.09,0.12]	0.52 [0.49,0.55]	0.09 [0.08,0.11]	0.57 [0.54,0.60]	0.56 [0.54,0.59]
2011	0.15 [0.13,0.17]	0.98 [0.97,0.98]	0.38 [0.35,0.40]	0.57 [0.54,0.60]	0.14 [0.12,0.16]	0.67 [0.64,0.70]	0.97 [0.96,0.98]	0.84 [0.82,0.86]	0.31 [0.28,0.33]	0.05 [0.04,0.06]	0.08 [0.07,0.10]	0.54 [0.52,0.57]	0.12 [0.11,0.14]	0.58 [0.55,0.60]	0.54 [0.51,0.56]
2012	0.15 [0.13,0.17]	0.97 [0.96,0.98]	0.41 [0.38,0.44]	0.51 [0.48,0.54]	0.12 [0.10,0.14]	0.7 [0.67,0.72]	0.98 [0.97,0.99]	0.83 [0.81,0.85]	0.33 [0.31,0.36]	0.04 [0.03,0.05]	0.08 [0.06,0.10]	0.57 [0.54,0.60]	0.15 [0.13,0.16]	0.58 [0.56,0.61]	0.37 [0.34,0.40]
2013	0.13 [0.11,0.15]	0.97 [0.96,0.98]	0.40 [0.37,0.42]	0.52 [0.49,0.55]	0.12 [0.11,0.14]	0.69 [0.67,0.72]	0.98 [0.97,0.99]	0.84 [0.82,0.86]	0.31 [0.29,0.34]	0.04 [0.03,0.05]	0.08 [0.07,0.10]	0.55 [0.52,0.57]	0.17 [0.15,0.19]	0.62 [0.60,0.65]	0.32 [0.30,0.35]
2014	0.14 [0.12,0.16]	0.98 [0.97,0.98]	0.33 [0.30,0.36]	0.56 [0.54,0.59]	0.10 [0.09,0.12]	0.67 [0.64,0.69]	0.98 [0.97,0.99]	0.85 [0.83,0.87]	0.31 [0.29,0.34]	0.05 [0.04,0.06]	0.09 [0.07,0.11]	0.57 [0.55,0.60]	0.20 [0.18,0.22]	0.63 [0.60,0.65]	0.33 [0.31,0.36]
2015	0.15 [0.13,0.17]	0.97 [0.96,0.98]	0.33 [0.31,0.36]	0.56 [0.54,0.59]	0.10 [0.09,0.12]	0.69 [0.67,0.72]	0.98 [0.97,0.98]	0.87 [0.85,0.88]	0.31 [0.28,0.33]	0.04 [0.03,0.05]	0.08 [0.07,0.10]	0.57 [0.54,0.60]	0.24 [0.21,0.26]	0.61 [0.58,0.64]	0.34 [0.32,0.37]
Observations	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430	7430

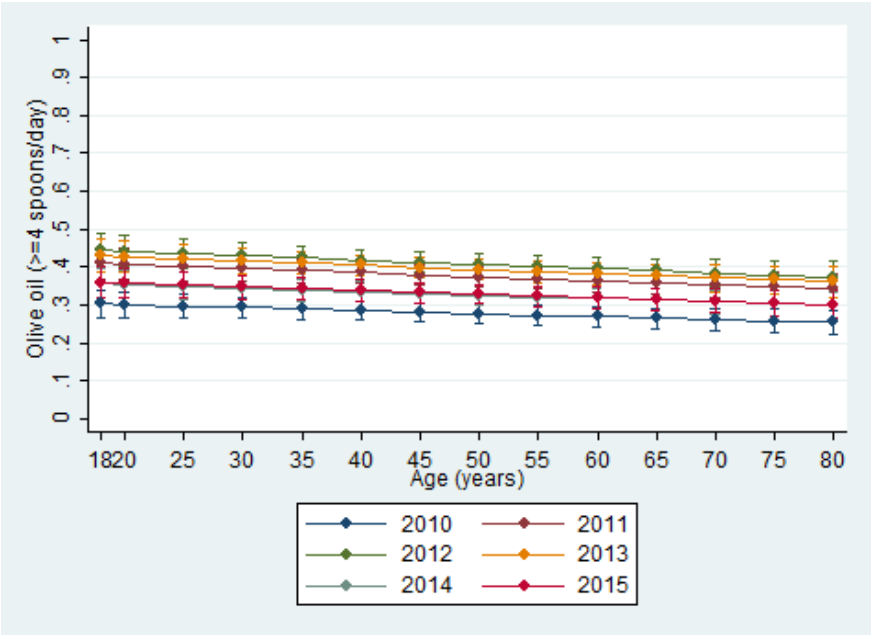
Values are marginal probabilities with 95% confidence intervals estimated for year of recruitment from multivariable PWRM .

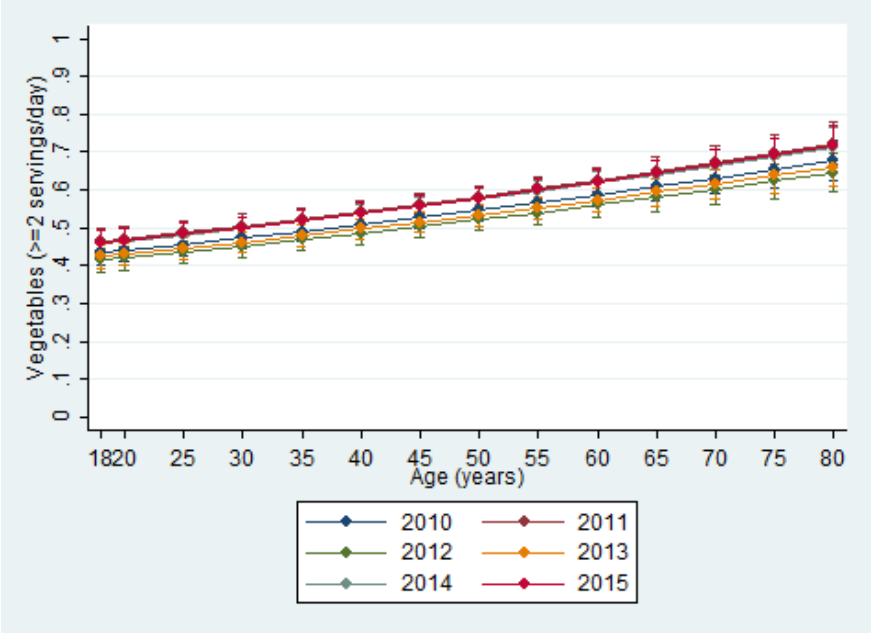
Abbreviations: sp = spoons; d = day; s = servings; gl = glass; w = week; t = times.

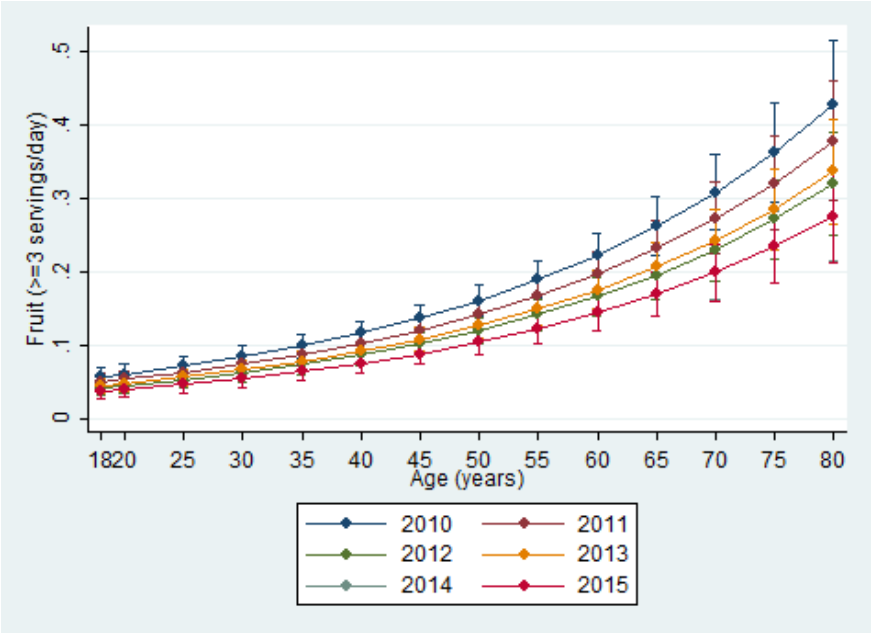
Figure 2. Trends of adherence to the MDP and individual components according age and year of recruitment

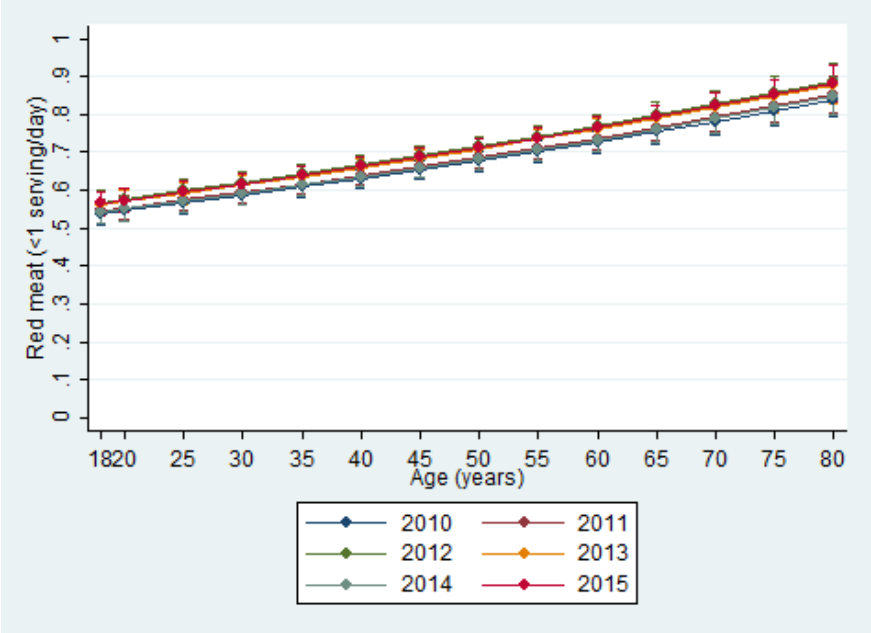


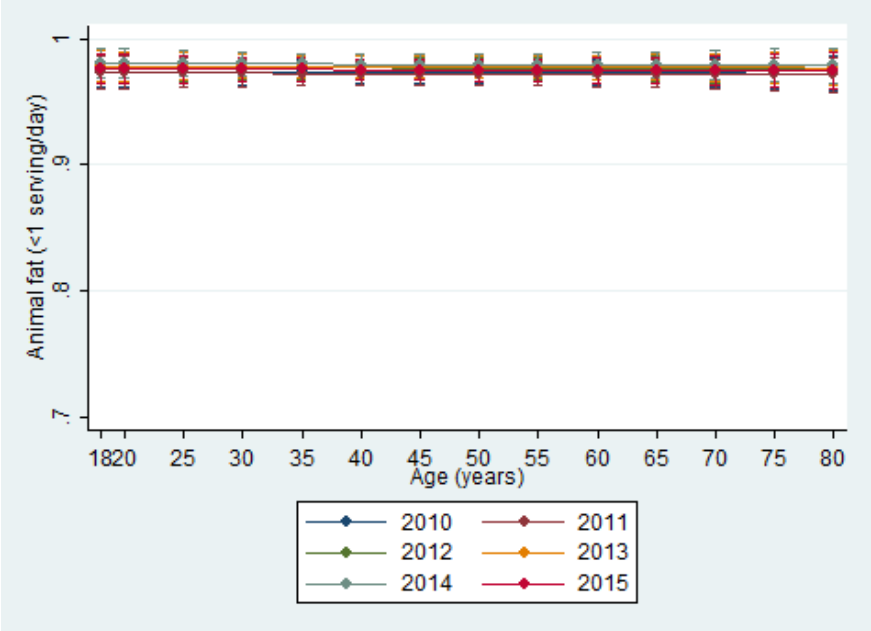


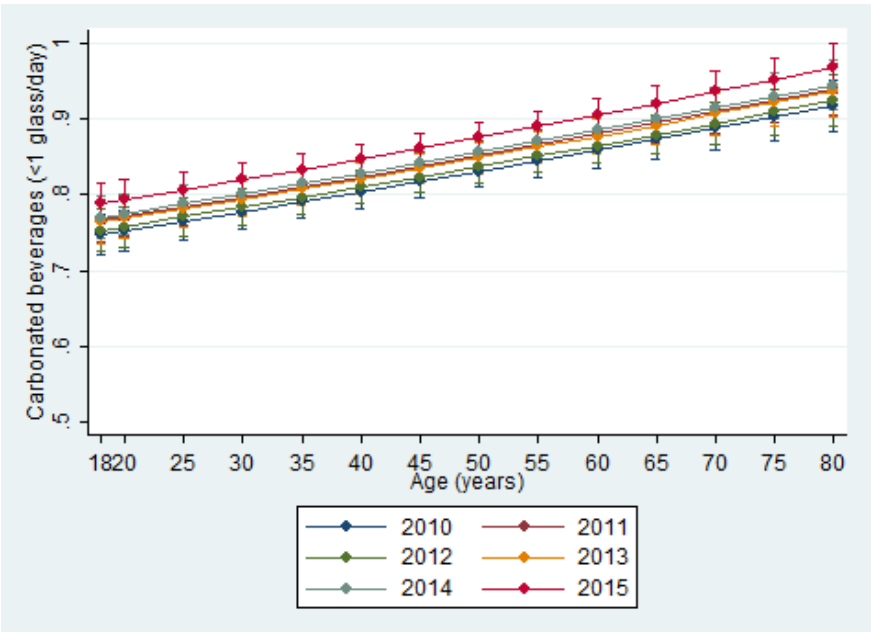


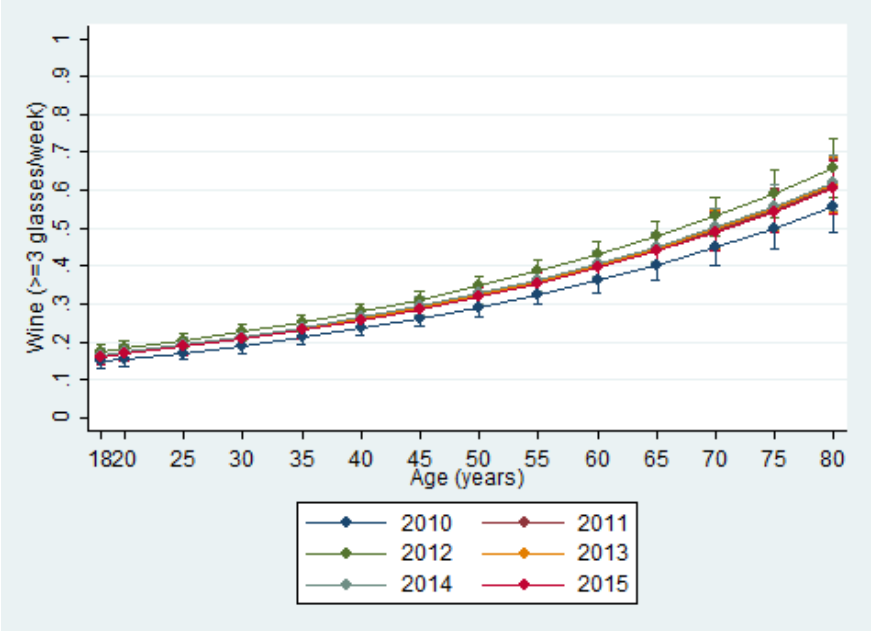

Vegetables (>=2 servings/day)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
2010
2011
2012
2013
2014
2015

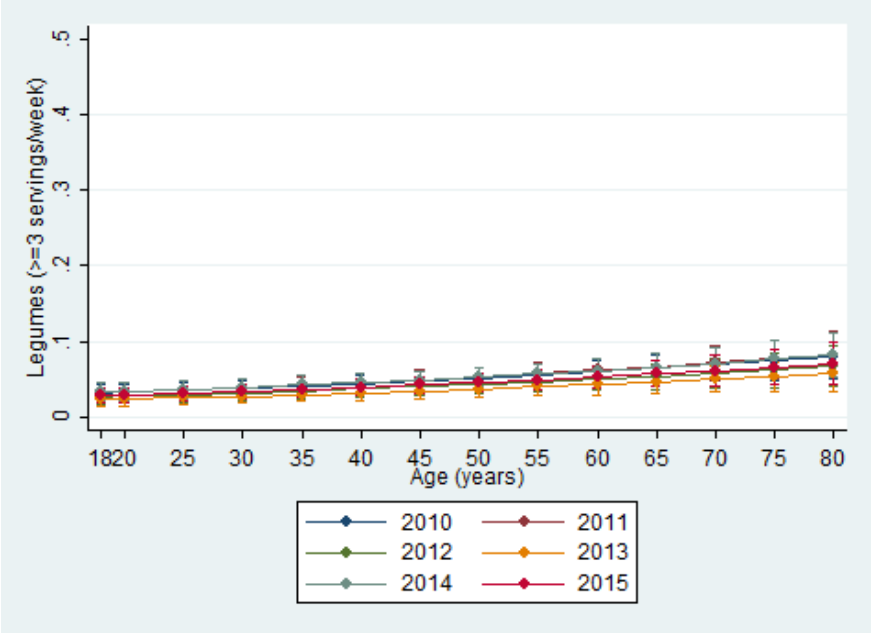

Fruit (>=3 servings/day)
0 .1 .2 .3 .4 .5
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
2010
2011
2012
2013
2014
2015

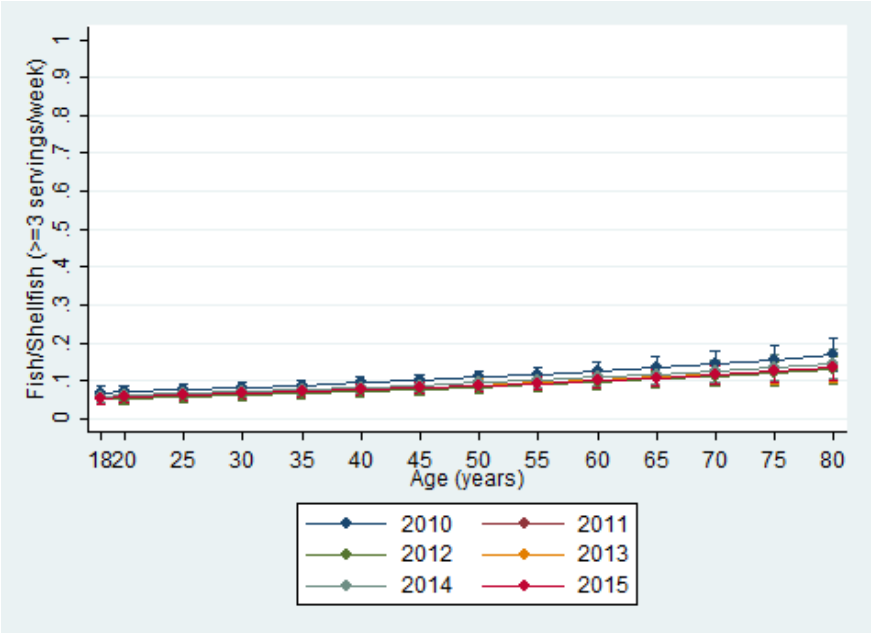

Red meat (<1 serving/day)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
2010
2011
2012
2013
2014
2015

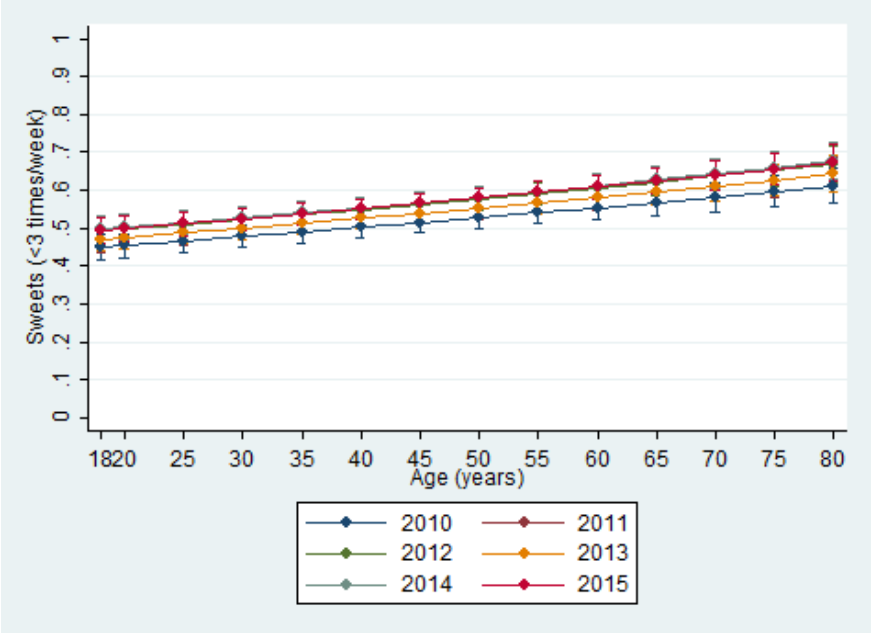

Animal fat (<1 serving/day)
.7
.8
.9
1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
2010
2011
2012
2013
2014
2015


Carbonated beverages (<1 glass/day)
.5
.6
.7
.8
.9
1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
2010
2011
2012
2013
2014
2015


Wine (>=3 glasses/week)
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
2010
2011
2012
2013
2014
2015


Legumes (>=3 servings/week)
0
.1
.2
.3
.4
.5
1820
25
30
35
40
45
50
55
60
65
70
75
80
Age (years)
2010
2011
2012
2013
2014
2015


Fish/Shellfish (>=3 servings/week)
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
1820
25
30
35
40
45
50
55
60
65
70
75
80
Age (years)
2010
2011
2012
2013
2014
2015


Sweets (<3 times/week)
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
1820
25
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35
40
45
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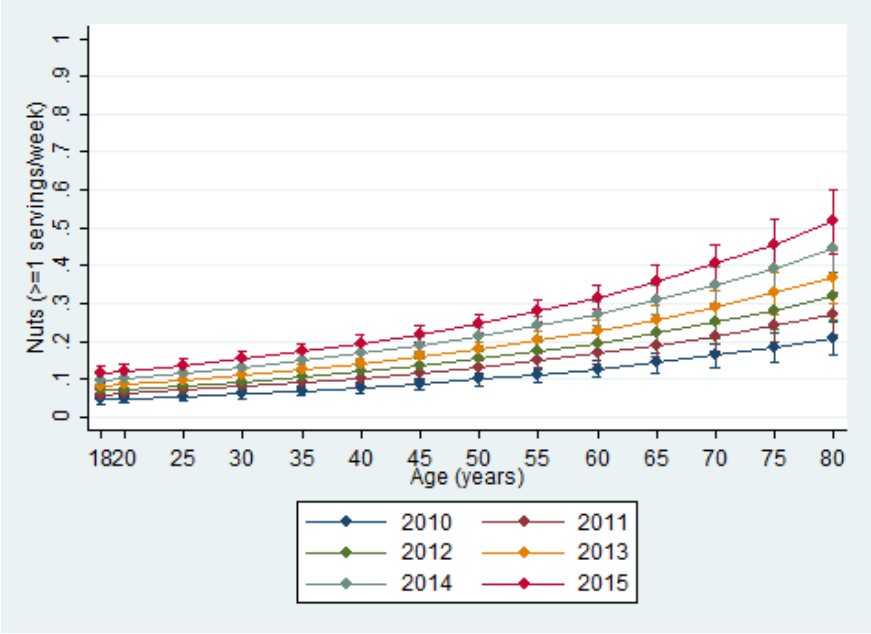
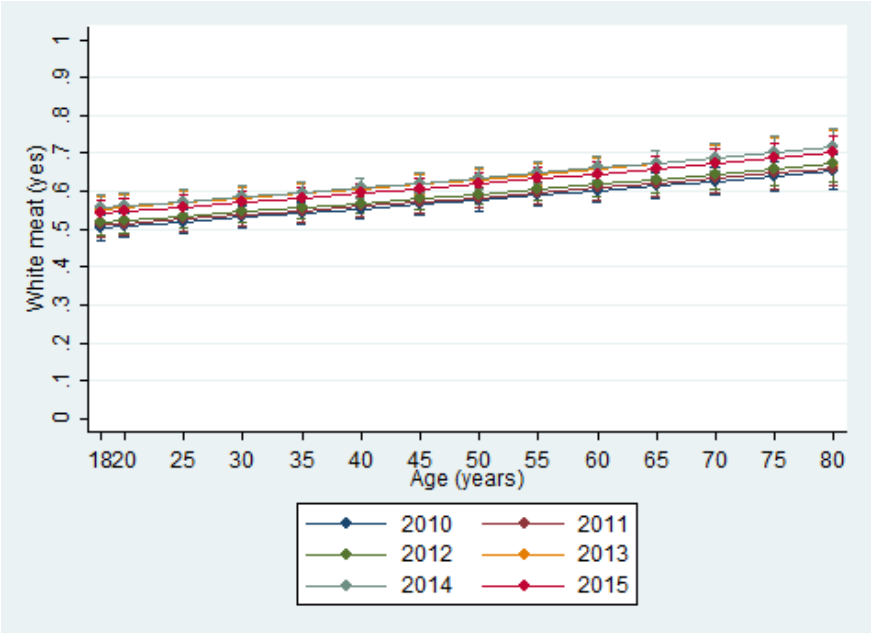
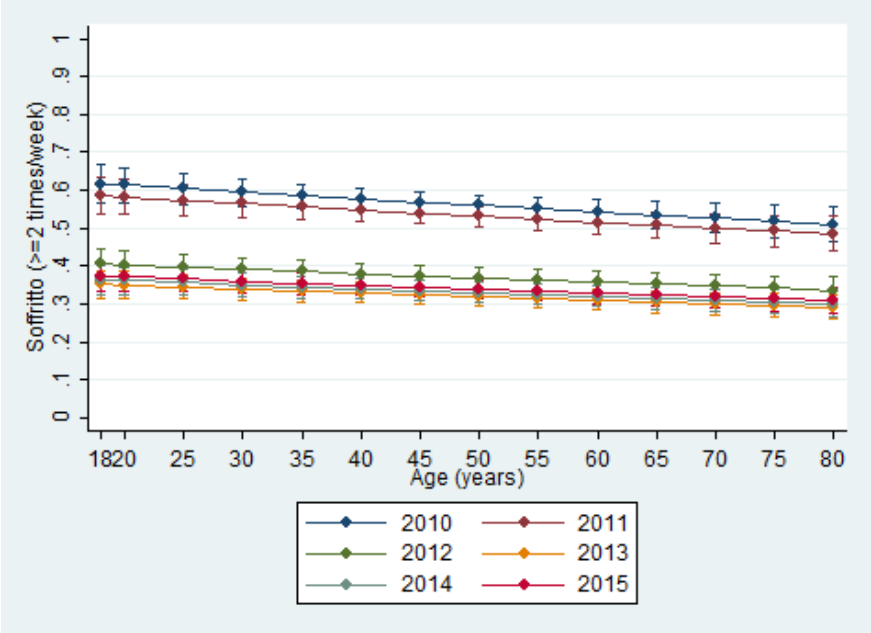
60
65
70
75
80
Age (years)
2010
2011
2012
2013
2014
2015


Nuts (>=1 servings/week)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
2010
2011
2012
2013
2014
2015


White meat (yes)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
2010
2011
2012
2013
2014
2015


Soffritto (>=2 times/week)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
1820 25 30 35 40 45 50 55 60 65 70 75 80
Age (years)
2010
2011
2012
2013
2014
2015

5. DISCUSSION

In this study, we focused, firstly, on identifying the factors associated to the adherence to the MDP and, subsequently, on investigating the trends of adherence to the MDP and consumption of individual food items during the period 2010-2015. The assessment of trends in food consumption are essential for re-evaluating dietary guidelines and verifying the effectiveness of interventions promoting healthy dietary habits and lifestyle [108]. We found that age, nutritional status and being married, ex-smoker and physically active were factors associated with a better adherence to the MDP. In addition, we found that only 14% of subjects had a dietary pattern consistent with MDP and the trend of adherence was constant during the five years considered in the present study. However, the consumption of some foods, included in the Mediterranean score, changed during these years. In particular, we observed an intensive increment of the consumption of nuts and a slight increment of white meat consumption. On the other hand, we observed a decrement in the consumption of fruit, sweets and carbonated beverages and in the use of soffritto.

Consistently with some [109], but not all [92,96,110,111], previous findings, we did not find any sex difference in the adherence to the MDP. A possible explanation may be that, differently from the past, also men, nowadays, tend to take care of food purchasing and preparation of meals.

With regard the age, with the only exception of olive oil and use of soffritto, older subjects highly consumed healthy food avoiding untypical food of MD, in opposition with that of younger did. Such dietary habits led to a higher adherence to the MDP in older than in younger. The prevalence ranged from values close to 0% in younger to values around 30-40% in older. Such association with age was independently from socio-anagraphical, nutritional status and lifestyle variables. Thus, factors other than the above-mentioned lifestyles should account for the better adherence to the MDP in older adults. It is possible that the elderly simply maintain traditional dietary habits acquired in infancy, remaining

less affected by the process of diet-westernization. On the contrary, young people seem more willing to accept food cultures coming from the rest of the world. Therefore, our results support the hypothesis of a departure, also in Northern Italy, from the MDP.

Concerning nutritional status, the adherence to the MDP decreased with increasing BMI. Indeed, a lower BMI was associated with a greater consumption of wine and nuts. On the contrary, a higher BMI was associated with greater consumption of red meet and carbonated beverages, and also of olive oil and use of soffritto. The inverse association between adherence to the Mediterranean diet and obesity has been reported by several cross-sectional [100,112,113] and longitudinal studies [114,115]. Similarly, a high consumption of meat and processed meat [116], as well as carbonated beverages [117], has been associated with an increased risk of obesity. Thorniest is the association between olive oil and risk of obesity. Observational and intervention trials consistently showed that a MD rich in olive oil does not contribute to obesity and may actually help curb it [118]. The PREDIMED study has, indeed, shown that an olive oil-rich diet was effective in the prevention of weight gain [119]. However, there is few data on the role of olive oil, independently form the Mediterranean diet, in preventing or managing obesity [118]. In a previous cross-sectional study, we found that olive oil consumption was associated with a higher prevalence of obesity and greater abdominal visceral adipose thickness [100]. In our study, obese subjects had a lower adherence to the MDP, and, therefore, it is possible that a high consumption of olive oil in association with dietary habits not representative of the MDP, may increase the risk of developing obesity. It is indeed plausible that the calories provided by olive oil, instead of being balanced by the lower caloric intake arising from increased consumption of fruits and vegetables, have gone in addition to those arising from the consumption of carbonated beverages, red meat and other high-energy-density foods, resulting, therefore, in excess, and increasing the risk of obesity.

Our results suggest that being married or cohabitants increased the adherence to the MDP. This result agrees with previous investigations [110] and agrees with the recommendation of eating together with other people, as sharing food in the company of family and friends around the table represents social support and a sense of community, and the pleasure associated with the conviviality of meals may positively affect food behaviours, and in return, health status [7]. Moreover, the economic aspect may be a further explanation of this result. it is plausible that living with another person ensures a higher income with resulting increased possibility of food choice. In fact, a recent systemic review, suggested that a possible cause of the decline of MDP could be the increasing prices of some of the main food items of the Mediterranean pyramid [120].

Adherence to the MDP tended to increase with educational level, consistently with previous investigations [92]. This result was not completely significant, presumably because of the low number of patients with a very low educational level. For the same reason, previous studies [111] did not find any association between the educational level and the adherence to the MDP. It is plausible to think, in fact, that those who have a higher educational level are more aware of the role of nutrition on health status.

Consistently with previous studies, ex-smokers had a higher adherence to the MDP [92,110]. Ex-smokers are more likely to make positive decisions concerning their health. Previous studies suggest, indeed, that ex-smokers are more health-conscious and have a responsible profile [121].

Physical activity during leisure time was positively associated with adherence to MDP. Similar results have been reported in previous investigations [92,110], suggesting that those who practice physical activity are more health conscious and probably know the role of nutrition on health status, body composition and physical performance.

After identifying the factors associated with the Mediterranean diet, we analysed the trends of adherence to the MDP and of individual food consumption during the period 2010-2015.

A first study found a decrease of the level of adherence to the MDP in the period 2000-2003 compared to 1961-1965. This decrement was more evident among subjects of Mediterranean countries [122]. Subsequently, in 2005-2010, it has been recorded a deep decline in the adherence to the MDP, with prevalence falling from over 30% to 18% among population of Southern Italy [96]. These declines seem to be caused by a Westernization process of the diet [122], at first, and, more recently, by the economic crisis begun in 2008 [96]. Our study, started in 2010, shows that the food pattern of only 14% of individuals reached accordance with the MDP and that this prevalence remained constant during the period considered in the present study. The prevalence of adherence was slightly lower than that recorded in 2010 in Molise region (Italy) [96], however, this difference can be attributed to the different food culture between North and South Italy and/or to the different score used for defying the MDP. Our result agrees, instead, with the prevalence of adherence reported in Spain in 2009-2010 using the same Mediterranean score.

The fact that the trend of adherence to the MDP has remained constant over the last five years would seem to suggest that the negative trend was stopped, reaching the minimum level. Although this finding may be considered a satisfactory result, on the other hand, a so low overall level of adherence, together with the fact that a small number of young people followed a dietary pattern consistent with the MDP, could mean the disappearance of the MDP in the next years. Hence the importance of outreach interventions that promote the health benefits derived from following a dietary pattern consistent with the MDP.

Our study also shows the trends of consumption of individual food components of MDP. Indeed, even though the adherence to the MDP has not changed during the last five years, the consumption of some foods changed. In particular, we recorded a strong increase in the nuts consumption from 2010 to 2015. We hypothesize that this increase is due to the dissemination of the results obtained in recent trials and observational cohorts, that suggest a lower risk of CVD, cancer, cognitive impairment, all-cause mortality, and

mortality from respiratory disease, diabetes, and infections associated to the consumption of nuts [123]. In addition to nuts consumption, we also observed a slight, but positive increase in the consumption of white meat. We explain this result as a consequence of the economic crisis, which has led people to prefer, for a reason of price, the white meat rather than red meat. Positive is also the slight decrease recorded for the consumption of carbonated beverages and sweets. Less comforting is the decrement in the consumption of fruit and in the use of soffritto.

A recent study [108], evaluating the trends of food consumption in a sample of 3036 subjects within the Seguimento Universidad de Navarra (SUN) prospective cohort, observed an increment in the consumption of fruit, vegetable, low-fat dairy products, lean meat, fish, whole grain, nuts and a decrease in legumes, whole-fat dairy products, red meat, sugar-sweetened beverages and wine. These findings partially agree with our results, but some differences arisen. The reasons of this may be many. First of all, Italian and Spanish food cultures, although the two countries are both part of the Mediterranean countries, are different. Second, the SUN cohort only includes university graduates and may be that they were more aware about their dietary habits.

Our study has the following strengths. First, to our knowledge, this is the first study that investigates the determinants and the trend of adherence to the MDP in Northern Italy and after the last study published in 2010. Second, the large sample size ensured more accurate estimates, as can be seen by the restricted confidence intervals. Third, we used a validated questionnaire, previously used in the PREDIMED trail, for defying the accordance of dietary pattern to the MDP. However, being a qualitative questionnaire, we could not evaluate the amounts of each food and the intake of macro and micro-nutrients, but only the frequencies of food consumption. This is the first limitation of our study. Second, we used a cross-sectional design and this did allow us to evaluate the intra-person changes in food consumption. Third, we enrolled subjects seeking a weight loss or

maintenance programme. This characteristic may affect the generalizability of our findings to other groups or population. Fourth, we did not adjust our models for individual income. However, we adjust for education and occupation that could reflect the socioeconomic status of the recruited subjects. Finally, as in any observational study, potential residual confounding could not be ruled out.

In conclusion, socio-demographic factors, nutritional status and lifestyle are associated with adherence to the MDP. The changes, observed during the last five years, in some food groups suggest an improvement of diet quality, but other changes suggest the opposite. So much so that the prevalence of adherence to the MDP did not change in this time-period. Additional strategies will be need to promote healthy dietary habits, especially among subjects at risk for poor-diet quality.

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