Progress in Nutrition 2018; Vol. 20, N. 3: 344-360 DOI: 10.23751/pn.v20i3.5544

Original article

"Mediterranean Diet 'reflections'". Estimating adherence to the Mediterranean diet through secondary data

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Summary. *Purpose:* to compare several countries against many Mediterranean adherence indices, calculated by looking at 19 European Member States. The value of a population-level Mediterranean Diet Index, the Mediterranean Adequacy Index (P-MAI) is at the core of the analysis. *Design/methodology/approach:* the EFSA's Concise European Food Consumption Database (mean g/day/per capita) and the FAO-FBS dataset (grams and calories/day/per capita values) were used as the unique sources currently available, in order to derive a simple yet harmonised secondary-data framework, which could serve for policy analysis and policy making therein of. *Findings:* The adherence to a Mediterranean-like dietary pattern outlines a general rank correlation among countries, and a broader north-south divide within Europe. Scores remain relatively stable across time. Although there has been a decrease in Mediterranean adherence in southern Europe, some central and northern European regions have seen gains. *Research limitations/implications:* Several data gaps do not allow a full comparison across all the indices used (i.e., lack of foodstuff detail of key-foods of the Med diet). A further problem of Med-adherence indices is that it does not consider the overall caloric intake. *Practical implications:* The relatively low discriminatory power of the emerging clusters of countries, reflecting the national diets- limits their usefulness in terms of policy-making recommendations. Furthermore the indices used were originally built on first-hand data (i.e., cohort studies relying on real persons), and not on aggregated mean-median values at population level (secondary data). Social implications In a period in which the interest for the health outcomes of the Mediterranean diet is on the rise in terms of preventive medicine, the P-MAI is an interesting indicator due to its user-friendliness, which allows the classification of European countries' diets using food intake data. *Originality/value:* Mediterranean adherence indices may be useful as synthetic indicators for monitoring the evolution of diets and for identifying sub-regions with similar dietary patterns or changes. The P-MAI index in particular, due to its simplicity, may help to monitor the overall healthiness of national diets, and could help to inform subsequent nutrition policies, including emerging labelling provisions both at National and European level, in order to achieve public health targets (i.e., reduction of NCDs).

Keywords: Mediterranean Diet, National Food Patterns, monitoring

Introduction

The "Mediterranean Diet" is a dietary pattern relying for the most part on fresh fruits&vegetables (including seeds, nuts and legumes), whole grains and olive oil, and on relatively low consumption (2-3 times per week) of animal (by)products such as meat and dairy products (but with high intake of fish), and a sparing ethanol intake, generally during meals (1,2).

The Mediterranean Diet is globally recognised as one of the healthiest dietary patterns, and one of the most studied as well. In spite of existing only one model, it is apparent that there are different regimes which may fit to the "Mediterranean Diet" definition, also outside the key-countries of the Mediterranean basin, and which proved to be healthful as well (3). The health and social benefits of the Mediterranean diet have been extensively documented (4-8) and although a causal link between Mediterranean Adequacy and mortality (prevention) has been suggested (9), it has not been definitely demonstrated (10). Since 2010 UNESCO awarded the Med Diet with the Intangible Cultural inheritage status.

However, is still unclear if Mediterranean countries maintained along time adherence to the Med diet, or -due to increasing trade in processed foods, long food chains and globalisation- transited to other dietary patterns. Another concern regards the real "existence" of something like the Mediterranean diet outside abstractions. Criticisms have been raised about the delimitation and definition of "what is" eventually a Mediterranean dietary pattern.

This paper tries to answer to both questions. Even if there are several metrics and underneath biological rationales endorsing Mediterranean-style diets (linking food items to health outcomes), there is a core of food which eventally cannot be missed inside a balanced Med Diet. Also, as authors are going to demonstrate, the resilience of dietary patterns-including the Med diet in southern EU countries is apparent, in spite of a general loss of adherence to the original model, and gains from Northern countries due to specific policy making interventions along the last decades.

The challenge of comprehensive database to monitor food patterns

National dietary assessment and its consequent monitoring represent a key aspect in public health management. While cross-country comparisons are complex to study, they have received support from the European Commission (EC) (11,12). Furthermore, complicated, resource-intensive, nationwide food consumption surveys, which aim to estimate dietary patterns, are not currently carried out on an annual basis. This was examined in the European Food Consumption Survey Methods project (EFCOSUM project) (13) and subsequently taken on by the European Food Safety Authority (EFSA), which then went on to establish the Network of Food Consumption Data (former Expert Group on Food Consumption Data) and set up the Concise Database (14,15) and the Comprehensive Database (16), in order to collect EU- harmonized data. The increasing attention paid to comparable, compatible and reliable individual food consumption data –with in mind a wide EU- risk assessment standardization- led EFSA to launch the EU-MENU programme to support Members State in collecting harmonized data (17).

This seems particularly relevant considering preliminary cues for the worsening of national dietary patterns in recent decades, at least with respect to a number of EU countries. According to a set of 88 health indicators collected in the European Community Health Indicators Monitoring (ECHIM, www.echim.org/) database, fruit and vegetable consumption ranks 49th and 50th respectively (www.echim.org/indicators.html) reflecting a minor importance to the health-status - in front of other, more prominent indicators.

Furthermore, the number of EU countries that failed to comply with WHO guidelines for sugar consumption has increased from 1961 to 2003 from 8 to 10 and in the last 40 years, sugar energy shares converged with all countries at around 11% level (18, 19). Although- according to identical sources during the same period-, countries with an adequate intake of fruits and vegetables more than doubled. The Food Balance Sheets (FBS) published by the Food and Agriculture Organisation (FAO) of the United Nations[1] showed an increase in the consumption of animal protein and saturated fat in the same last 40 years timeframe, particularly within Mediterranean countries, such as Greece, Italy, Spain, and Portugal (20). However, there remain remarkable differences across countries, especially in terms of saturated fat intake (Fig. 1), in spite of an apparent convergence phenomenon: countries with high consumption levels of saturated fatty acids (15%) like Finland or Ireland reduced them to close to the recommended maximum, (18,19). Given the difficulties associated with analysing individual dietary patterns (16,21), and hence in inferring how dietary patterns converge or diverge with the Mediterranean diet across countries and across time, it would be useful to examine existing aggregated population-level food consumption datasets. This is an "a priori approach" of food consumption patterns – as

[1] FAO – Food and Agriculture Organisation of the United Nations-Food Balance Sheet in FAOSTAT (http://faostat3.fao.org/faostat-gateway/go/to/home/E).

defined by Efsa- and "is based on prevailing knowledge concerning favourable or adverse effects of various dietary constituents. Diets are assessed for the presence or absence of certain food or nutrient characteristics, and the resulting score is then operationalised as a dietary exposure variable" (22)- but without an empirical, *a-posteriori* assessment of the health outcomes as integral part of the research. The Mediterranean Adequacy Index (MAI) is one of the most predictive indicators of a Mediterranean diet (9, 23, 24). The MAI inversely correlates with 25 years of figures for deaths from coronary heart disease (6).

This study aims to analyse the possibility of building a Mediterranean diet adequacy index-, the Population level Mediterranean Adequacy Index, P-MAI- to allow for monitoring dietary trends using figures from national Food Balance Sheets (FBS), which are published annually on the FAO website (2011).While the index *per se* is not new (MAI), it has never been applied before to aggregated data at population-level (P-MAI). At the same time, more precise *food-intake* data collected at EU Member State level (EFSA Concise Food Consumption Database, hereinafter "CONCISE") are available, but under a more limited timeframe (*i.e., differently from FAO FBS,* only in selected years of surveys, not harmonised at the EU level and with each Member State having different surveys years).

These two sources of data –even if different by nature-enable us to draw some kind of comparison on specific periods of time (i.e. *the years* during which the dietary surveys were carried out in the Member States based on individual national dietary surveys (14).

Therefore, the index proposed in this study is the P-MAI (Population-level Mediterranean Adequacy Index), which provides geographical and temporal insights into food consumption patterns across the EU Member States. In this way, it creates a *user-friendly* tool for public health policy-making, at a time when there is increasing focus on food-related diseases and costs.

Methods

The P-MAI, as previously stressed, is an extension of the original (and well-established) concept (MAI) proposed by Alberti and Fidanza (2004) to measure the adequacy of *national diets* against the Mediterranean diet. Both MAI and P-MAI are calculated as the *ratio* between the summed weight (or the summed energy value) of food items from the core Mediterranean Diet (vegetables, fruit, cereals, red wine, vegetable oils, potatoes and fish) and of non-core foods (meat, dairy products, animal fat, eggs and sugar) (9 ,25).

The P-MAI was computed using the average intake of 15 food groups and 21 sub-groups from the EFSA CONCISE European Food Consumption Database (g/day/per capita intakes), hereafter referred to as the CONCISE database/data, and from the FAO Food Balance Sheets (FBS database/data) (g or kcal/day/per *capita* intakes 1961-2007). The CONCISE database comprises mean food consumption data for adults (aged 16-64 years) departing from different food categories. FBS data were calculated by dividing the total amount of food available for consumption by the aggregate population of a given country[2].

It is important to point out that some foods were not included in the CONCISE database, for example, vegetable oils and red wine. Red wine was also not available in the FBS database. Instead, 'wine' (FBS database) and 'wine and substitutes' (CONCISE database) were used. Furthermore, as vegetable oils were not recorded separately from animal fats, the broader category 'fats' was excluded when using the CONCISE database.

Countries were selected based on national surveys availability inside the CONCISE and consequently, more available FBS data were in turn included for comparison. This means that all FBS data were aligned to those in the CONCISE database according to survey year. However, in a separate analysis relying on longitudinal FBS data only -Spain and Greece were added, as examples of Mediterranean countries. Whilst data for Estonia in 1961 was not available in the FBS database. In fact, in order to assess historical trends, P-MAI scores were estimated in both 2007 and 1961 using FBS data (the only dataset allowing for this diachronic assessment).

[2] The total amount is obtained by examining production and *import* figures, less *export* and *re-use* figures (supply fed to livestock or used for seed, and losses during storage and transportation). divided by the national population level for the given year. FBS are inherently advantageous as they take into account both *domestic and non-domestic* food consumption (catering, restaurants, etc.).

Energy intake was derived from the FBS (grams instead were used for CONCISE).

All data was entered into Excel spreadsheets versions (2010 and 2013) and Scott's choice analysis, was used to identify the number of classes with internal and external consistency (26). The Scott's choice test is a simple rule for describing an optimal grouping for the identification of clusters of countries (see Figure 1 below).

Concordance between the different elaborations of P-MAIs (CONCISE vs. FBS, FBS grams and FBS calories, and FBS time series) was measured using Spearman's rank (ρ) and the Kendall's Tau (τ) correlational analysis. Other correlations were included once added other diet-focused indices, in order to compare the resulting classification with that determined by P-MAI.

The indices are:

a) A simplified form of the Diet Quality Index for the Mediterranean Region (Med-DQI) developed by Gerber (2006)(27). The Med-DQI is a screening tool which gives scores (from 0 to 2) for the intake of the following food items, meats, olives, fish, cereals, fruit and vegetables, as based on Table 1.
With regard to the analysis of the Med-DQI, neither cholesterol nor SFAs were included –in spite of being present in the original DQI- due to a lack of European population-level data. Instead, to make directly comparable the DQI with the other Indexes, the complement to 10 of the Gerber's Index was calculated, such that the higher value obtained, the better the diet.
b) The Global Nutrition Index (GNI), (28), accounting for three indicators of nutritional status: deficits, excess, and food security.
c) The Mediterranean Score (29). This score seizes the adherence to the Med-diet and relies on specific cut-off points for healthy vs unhealthy foods (i.e. 1 point for healthy foods such as cereals, fruit, vegetables and legumes, fish and moderate ethanol amounts; 0 points for 'unhealthy', non-Mediterranean foods such as meat and dairy products). Unfortunately, the ratio between monounsaturated/saturated fats, as originally indicated in Trichopoulou (2003)(29) could not be provided. Therefore, olive oil consumption versus animal fat consumption was used instead as a proxy for the monounsaturated fats-saturated fats ratio. Nor was it possible to analytically separate legumes from vegetables using the CONCISE database.

$$h = \frac{3{,}5 \cdot S}{\sqrt{N}}$$

Figure 1. The Scott's choice test for the optimal number of classes/members of a class

Other indices were also initially considered within this analysis, namely, the Mediterranean-Style Dietary Pattern Score (MSDPS) proposed by Sanchez-Villegas *et al*. (2002) (30); the Mediterranean Dietary Pattern (MDP) by Rumawas *et al*. (2009) (31); and the Mediterranean diet score by Panagiotakos *et al*. (2006) (32). However, these were *subsequently excluded* either due to a lack of available data (i.e. on *trans* fatty acids), or due to other classification difficulties.

A one-way analysis of variance (ANOVA) was performed to measure the impact of the aforementioned data sources (CONCISE or FBS) as a major contributor to changes in the P-MAI value, in order to depurate results from *dataset effects*. The rank correlation coefficients (the Spearman's Rho ρ and the Kendall Tau τ) were used in the analysis to measure correlations among GNI and Med-DQI with the other indices.

Table 1. Scoring system derived as simplification of the Diet Quality Index for Mediterranean Region

Scores	Meats (g)	Olive oil (ml)	Fish (g)	Cereals (g)	Vegetables+fruit (g)
0	<25	>15	>60	>300	>700
1	25-125	15-mag	60-30	300-100	700-400
2	>125	<5	<30	<100	<400

Results and Discussion

Results showed that, the estimated Population-level Mediterranean Adequacy Index (P-MAI) scores in European countries when estimated from average food intake from the CONCISE (Table 2) varied from 0.86 to 2.34, whereby higher scores indicated increased adherence to a Med-Dietary pattern.

FBS data were aligned to those in the CONCISE database according to survey year[3].

[3] Where figures in the CONCISE dataset referred to multiple years, the mean of the corresponding years in the FBS was used (e.g. if CONCISE(country i)1986-87 was the reference period of the survey, then a mean of FBS(i)1986 and FBS(i)1987 was calculated for country i).

From the results obtained, a geographical gradient can be seen in Table 3, for example, Italy was among the highest in terms of P-MAI scores according to all three calculations (P-MAI, MDQI, and MSC). In general, a North-South trend can be observed with northern countries in the cluster of lower P-MAI scores (i.e. lower adherence to the Mediterranean diet). At the lowest levels, Scandinavian countries maintain their ranking in the first two (lower adherence) clusters, despite differences between the CONCISE database and FBS database computations. The Netherlands, Iceland and Finland remain in the first cluster, whereas Norway moves from the first cluster to the

Table 2. P-MAI (Population-level Mediterranean Adequacy Index) scores for the aggregated average national diets, estimated by food weight (g) from the FAO Food Balance Sheets ("FBS") and the EFSA CONCISE database ("CONCISE"). For comparability reasons

	FBS g*	CONCISE g* (mean values)	Delta (% difference between the 2 values)	Delta (absolute g)	Years of reference (EFSA)
AUT	1.18	2.20	86.42	1.02	Average 2005-2006
BEL	1.14	2.12	85.94	0.98	2004
BGR	1.35	1.88	39.35	0.53	2004
CZE	1.13	1.59	40.30	0.46	Average 2003-2004
DEU	1.05	1.67	59.29	0.62	1988
DNK	1.09	1.31	20.63	0.22	Average 2000-2001-2002
EST	1.39	1.49	7.23	0.10	1997
FIN	0.81	0.86	6.34	0.05	2002
FRA	1.1	1.70	54.25	0.60	1999
GBR	1.31	1.53	16.97	0.22	Average 2000-2001
HUN	1.33	1.48	11.01	0.15	Average 2003-2004
IRL	1	1.67	66.80	0.67	Average 1997-1998-1999
ISL	0.98	1.01	3.48	0.03	2002
ITA	1.5	2.34	56.30	0.84	Average 1994-1995-1996
NLD	0.79	1.17	48.20	0.38	Average 1997-1998
NOR	1.07	0.95	11.11	0.12	Average 1993-1997
POL	1.47	2.30	56.43	0.83	2000
SVK	1.42	2.26	59.26	0.84	2006
SWE	0.78	1.28	63.78	0.50	Average 1997-1998-1999

**EFSA, European Food Safety Authority; FBS, FAO-Food Balance Sheets. P-MAI calculated as the ration between Med foods (vegetables, fruit, cereals, red wine, vegetable oils, potatoes and fish) and of non Med foods (meat, dairy products, animal fat, eggs and sugar).*
Austria (AUT); Belgium (BEL); Bulgaria (BGR); Czech Republic (CZE); Germany (DEU); Denmark (DNK); Estonia (EST); Finland (FIN); France (FRA); United Kingdom (GBR); Hungary (HUN); Ireland (IRL); Iceland (ISL); Italy (ITA); the Netherlands (NLD); Norway (NOR); Poland (POL); Slovakia (SVK).

second from the CONCISE database to the FBS database. Sweden moves from the second to the first and Denmark remains in the second cluster in both the CONCISE and FBS calculations. Interestingly, when adopting the synth-MDQI, Norway scores in the first cluster of Mediterranean Diet adherence. However, this may be biased, as cholesterol and SFAs were not included in this synth MDQI, and historically Nordic countries have a high intake of these, as observable when considering food matrices of departure. In both the CONCISE and FBS databases, Poland, Slovakia and Italy showed/had the best Mediterranean adherence scores.

Italy shows relatively good fruit and vegetable consumption (respectively 203g/day and 249g/day, about 4 to 5 portions, against a virtual recommendation of at least overall 4 portions-or 400 g/day- from WHO in 1991) (33), low meat intake (137g/day- against the standard Med Diet advice of a moderate consumption of 2-3 servings per week- no WHO recommendations here) and low sugar intake (19g/day.- well below the 10% of total energy intake as suggested by WHO). In general, Italy has a more homogeneous ranking along the different datasets used with only minor variations in the ranking in response to the use of different Med Diet indicators or datasets used.

The high P-MAI value (i.e. adherence to the Mediterranean diet) for Italy is not surprising. However, other figures require insight into the data in order to be explained further. For example, taking into account the CONCISE database result for Austria, the relatively high P-MAI (2.20) was due to its relatively high fruit and vegetable consumption (202g/day and 211g/day respectively, and 59g/day of potatoes), as well as its low intake of dairy products (171g/day) and sugar (23g/day). As regards Poland, which has a P-MAI value of 2.30 in the CONCISE database, we note a high consumption of vegetables (292g/day), potatoes (304g/day) and fruit (282g/day). Although consumption levels for meat (259g/day) and dairy products (181g/day) are high, the overall P-MAI remains relatively good and potatoes play a key role here, as they are considered as 'vegetables' inside the traditional P-MAI score (even if this is questionable from a public health perspective: in the UK potatoes are not valid for the "5 a day" F&V purposes- see the Discussion section later on). We should however take into account here the fact that the FBS P-MAI based on grams is slightly lower than he FBS P-MAI based on kilocalories (1.47 and 1.49). This could mean that allegedly calorie-dense, healthy foods play some minimal role in meliorating the score (again, potatoes, or alcohol).

As for Germany, according to the CONCISE database, vegetable consumption is relatively high (252g/day, and 125g/day for potatoes) as is fruit consumption (190g/day), while dairy product consumption stands at 313g/day. Beer consumption, which covers 184g/day of the 231g of alcoholic beverages consumed on a daily basis, is not taken into account in this computation because of the potential bias of the indicator used (excessive consumption, which is unhealthy, equally enhances the score a higher value since - to determine the "right amount" of alcohol to be consumed in order to have health benefits- no thresholds are in place for the traditional P-MAI- as on the contrary, other indicators do, such as the MDS).

In fact, FBS-based computations for Germany show lower P-MAI values (0.97 based on kilocalories and 1.05 based on grams), most likely due to the FAO's more detailed food categories (in particular, the vegetable oil/animal fats ratio and wine).

Despite this, there is a noticeable divergence *versus* the same indicator (P-MAI) when relying on the CONCISE dataset (with a value of 1.67) as illustrated via a comparison of the CONCISE database vs. FBS (Z-scores) (see Figure 2).

Results from the historical trend observing the P-MAI score both in 2007 and 1961 using FBS dataset, showed that during this time period, P-MAI scores decreased in most countries. Across all countries (i.e. Mediterranean and northern European countries), average P-MAI decreased from 1.83 to 1.37 (from 1961 to 2007) and the standard deviation (SD) decreased from 1.27 to 0.34 (Table 3). This may be interpreted on the one hand as result of more globalised lifestyles and dietary patterns; on the other one, as public health policies in charge to Nordic countries governments to meliorate dietary behaviours since the '70es. In the same period, all core-Mediterranean countries experienced decreases in P-MAI (Italy: -1.32; Portugal: -2.03; Spain: -2.25; and Greece: -2.59). On a relative scale, southern European countries (Greece, Italy,

Table 3. Clusters determined by Scott's choice applied to -P-MAI calculated from FBS - calories and grams and CONCISE database (g). by CONCISE database countries (*) and according FBS years. The MDQI and MSC scores and rankings ("Cluster") are added for comparison.

Country	P-MAI CONCISE (g)	Cluster	Country	P-MAI FAO FBS (g)	Clusters	Country	P-MAI FAO FBS (cal)	Clusters	Country	MDQI CONCISE (g)	Clusters	Country	MDQI FAO FBS (g)	Clusters	Country	MDS CONCISE (g)	Clusters	Country	MDS FAO FBS (g)	Clusters
FIN	0.86	1	SWE	0.78	1	ISL	0.68	1	CZE	3	1	SVK	2	1	NLD	1	1	ISL	2	1
NOR	0.95		NLD	0.79		DNK	0.82		DNK	3		AUT	3	2	NOR	2	2	DEU	3	2
ISL	1.01		FIN	0.81		NLD	0.93		EST	3		POL	3		GBR	2		NOR	3	
NLD	1.17		ISL	0.98	2	DEU	0.97	2	IRL	3		DEU	3		IRL	2		NLD	3	
SWE	1.28	2	IRL	1		FIN	1.03		HUN	3		EST	3		ISL	2		FIN	3	
DNK	1.31		DEU	1.05		SWE	1.04		NLD	3		IRL	3		FIN	2		CZE	4	3
HUN	1.48		NOR	1.07		FRA	1.05		BEL	4	2	HUN	3		EST	2		SWE	4	
EST	1.49		DNK	1.09		NOR	1.15		BGR	4		CZE	3		BEL	3	3	DNK	5	4
GBR	1.53		FRA	1.1		BEL	1.16		DEU	4		GBR	3		SWE	3		AUT	5	
CZE	1.59	3	CZE	1.13		HUN	1.18		SVK	4		NLD	3		CZE	3		BGR	5	
IRL	1.67		BEL	1.14		IRL	1.22	3	SWE	4		FRA	4	3	DNK	3		EST	5	
DEU	1.67		AUT	1.18	3	AUT	1.23		GBR	4		BGR	4		HUN	3		POL	5	
FRA	1.70		GBR	1.31		CZE	1.32		ISL	5	3	DNK	4		SVK	3		GBR	5	
BGR	1.88		HUN	1.33	4	GBR	1.35		AUT	5		FIN	4		BGR	3		FRA	5	
BEL	2.12	4	BGR	1.35		SVK	1.47	4	FIN	5		ISL	4		POL	4	4	IRL	5	
AUT	2.20		EST	1.39		POL	1.49		FRA	5		SWE	4		FRA	4		ITA	5	
SVK	2.26		SVK	1.42		EST	1.52		ITA	5		BEL	5	4	AUT	4		BEL	6	5
POL	2.30		POL	1.47		BGR	1.89	5	POL	5		NOR	5		DEU	5	5	HUN	6	
ITA	2.34	5	ITA	1.5		ITA	1.95		NOR	5		ITA	7	5	ITA	6	6	SVK	6	

(*) Country indicated by the three digits standard

P-MAI CONCISE (g): Population-level Mediterranean Adequacy Index calculated on EFSA's Concise database (grams-based calculation); P-MAI FAO FBS (g): Population-level Mediterranean Adequacy Index calculated on FAO Food Balance Sheets database (grams-based calculation); P-MAI FAO FBS (cal): Population-level Mediterranean Adequacy Index calculated on FAO Food Balance Sheets database (calories-based calculation); MDQI CONCISE (g): Mediterranean Diet Quality Index (synth version based on available aggregated data) calculated on EFSA's Concise database (grams-based calculation); MDQI FAO FBS (g): Mediterranean Diet Quality Index (synth version based on available aggregated data) calculated on FAO Food Balance Sheets database (grams-based calculation); MDS CONCISE (g): Mediterranean Diet Score calculated on EFSA's Concise database (grams-based calculation); MDS FAO FBS (g): Mediterranean Diet Score calculated on FAO Food Balance Sheets Database (grams-based calculation).

Austria (AUT); Belgium (BEL); Bulgaria (BGR); Czech Republic (CZE); Germany (DEU); Denmark (DNK); Estonia (EST); Finland (FIN); France (FRA); United Kingdom (GBR); Hungary (HUN); Ireland (IRL); Iceland (ISL); Italy (ITA); the Netherlands (NLD); Norway (NOR); Poland (POL); Slovakia (SVK).

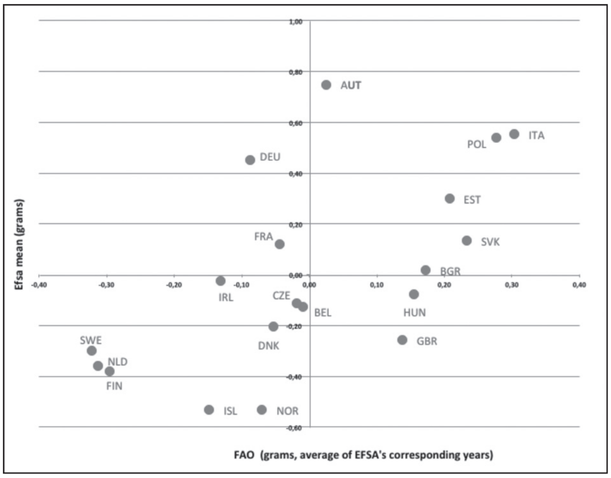

Figure 2. Biplot of P-MAI (Population-level Mediterranean Adequacy Index) Z- scores for the Efsa mean national diet, estimated from the EFSA concise database, by food weight versus the FAO FBS data. Scores are standardized and compared with the average of the variable. Data collection period as per Table 1. Norway (NOR); United Kingdom (GBR); Belgium (BEL); Ireland (IRL); Iceland (ISL); Finland (FIN); Sweden (SWE); Czech Republic (CZE); Denmark (DNK); Netherlands (NLD); Poland (POL); Germany (DEU); Hungary (HUN); France (FRA); Austria (AUT); Slovakia (SVK); Italy (ITA); Bulgaria (BGR); Estonia (EST).

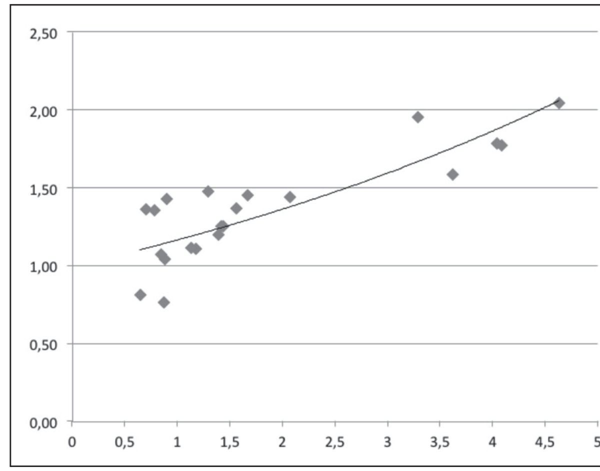

Figure 3. P -MAI (Population-level Mediterranean Adequacy Index) scores for the aggregated average national diets from FAO FBS in 2007 – X axis- and 1961 Y axis-, and change in selected EU Member States (calories-based computation) (Pearson correlation: 0,84 p-value not significant 1.58).

Spain and Portugal) halved their P-MAI, whereas northern European countries (Norway and the UK, but also Finland and Sweden) increased their adherence to the Mediterranean Diet.

For these FBS-based historical trends, as expected, g-based values and kcal-based values were positively correlated (Pearson = 0.77), as was the FBS database correlated with the CONCISE database (0.71).

However, a substantial stability of patterns for the interested countries emerges (Figure 3)-, P -MAI scores for the aggregated average national diets from FAO FBS in 2007 – X axis- and 1961 Y axis-, in selected EU Member States (calories-based computation) showed a Pearson correlation of 0,84 and a R-squared of 0,617.

Finally, P-MAI values did not appear to be associated with total energy intake, regardless of the dataset used for the P-MAI estimate (CONCISE, FBS(g), or FBS(kcal)), with r varying from -0.16 to 0.25 and 0.07, respectively, in 2007 in the FBS data.

For the sake of comparison we provide detailed P-MAI values for the indicator used, whether it be the CONCISE datatabase, FBS database (g), or FBS database (kcal) (see Tables 2 and 3).

Given that one of the goals of this study was to assess the P-MAI's discriminatory power, it was tested against rank correlation both internally (CONCISE P-MAI and FBS P-MAI) and externally, taking into consideration other food quality indices capable of providing further insight. In particular, the simplified form of the Diet Quality Index for the Mediterranean Region (synth Med-DQI) developed by Gerber (2006) (27) was added for comparative purposes (limited to food items with and without cholesterol and saturated fatty acids), as the Global Nutrition Index (GNI) of Rosenbloom *et al*. (2008) (28).

Spearman's rank (ρ_s) and Kendall's tau (τ) correlations were calculated to compare the list of countries as classified by the P-MAI ranks (derived from the CONCISE and FBS(g)), obtaining ρ = 0.72 (p-value 0.002) and τ = 0.54 (p-value 0.001). When comparing P-MAI ranks derived from the CONCISE and FBS(kcal), ρ =0.67 (p-value 0.004) and τ = 0.50 (0.003) were found. All coefficients showed a high level of concordance (value^3 0.5).

An overview on how such indicators performed in the clustering analysis is shown in Table 3, whereas a correlation matrix across the indicators used can be seen in Table 4.

Comparison with the Rosenbloom Global Nutritional Index (GNI), which sums up both food deprivation and overweight burden (the index combines deficits, excesses and food security), failed to show any correlation with P-MAI. Examining the CONCISE P-MAI ranks versus the GNI ranks for the same countries results in no correlation found for any of the rank-correlation indices and for any of the datasets used. The Diet Quality Index for Mediterranean Region (Med-DQI) developed by Gerber (2006) (27), provided clustering with some differences from the P-MAI. This may be explained by the different items taken into account (i.e. mostly nutrients instead of real foods), but also by the cut-off based system (assigning values ranging from 0 to 2 according to consumption thresholds). This implies an underestimation of specific food consumption not reaching the threshold level of the specific nutrient.

Discussion

The health status of persons and even more of population is linked to a number of factors, only a part of which refer to a healthy diet (Waxman, 2005/34). A healthy diet is in fact only part of broader healthy life-

Table 4. A comparison across the indicators, either considering absolute values or ranks

Spearman rank correlation	**nCLUS-PMAI-CONCISE-mean**	**nCLUS-PMAI-FBS-calories**	**nCLUS-PMAI-FBS-grams**	**Rank MDQI-CONCISE**	**Rank MD QI-FBS**	**Rank MDS -CONCISE**	**Rank MDS-FBS**
nCLUS-PMAI-CONCISE-mean	1	1	1	0	0	1	0
nCLUS-PMAI-FBS-calories		1	1	0	0	0	1
nCLUS-PMAI-FBS-grams			1	0	0	0	1
Rank MDQI-CONCISE				1	0	0	0
Rank-MDQI-FBS					1	0	0
Rank MDS CONCISE						1	0
Rank MDS-FBS							1
nCLUS-PMAI-CONCISE-MEAN sign +			sign +	sign +	sign +	sign -	sign +
nCLUS-PMAI-FBS-CALORIES sign +				sign +	sign +	sign +	sign +
nCLUS-PMAI-FBS-GRAMS sign +					sign +	sign -	sign +
Rank-MDQI-CONCISE sign -						sign +	sign +
Rank-MDQI-FBS						sign +	sign -
Rank-MDS-CONCISE sign +							
Rank-MDS-FBS							

style. However, to measure the adherence to a healthy diet is of the upmost interest since it is one of the most controllable variable either individually or inside public policy initiatives. Furthermore, the focus on diets instead than on food items is increasingly prevalent, as a full risk- assessment cycle requires also *exposure data* (consider the Trans Fatty Acids-TFAs debate at the EU level, if provide for labelling on food or not, due to the unquestionable risk characterization, but also with a low exposure of the population) (35EC, 2005)) and also a risk-benefit assessment -(i.e., for eating oily fish- with benefits from omega 3 fatty acids and risks from PCBs, heavy metals and dioxins- (EFSA,2015/36)). Clear trade-offs hence refer more and more to the balanced consumption of foods more than on the mere intake (or avoidance) of a food matrix..

Once cleared this aspect, it can be disclosed that to a certain extent, P-MAI appears to discriminate between different diets across Europe and to detect changes over time. Across databases, eastern European countries seem to have a higher adherence to a Mediterranean-like dietary pattern than northern and central European countries. This is perhaps due to a lower meat consumption, which can most probably be attributed to reduced access to meat and to higher potato consumption levels. The apparent phenomenon of converging diets in Europe is interesting and has been investigated elsewhere (18,37).

As potatoes and starchy foods are a controversial category as regards their place in the Mediterranean diet, they have alternatively been included either in the list of Mediterranean foods or on the contrary, in the list of non-Mediterranean foods (Tables 5 and 6).

For this reason, P-MAI scores were higher when potato values were calculated in grams rather than in calories. This is due to the relatively low energy density of potatoes compared to other food categories. On average, the difference between the P-MAI with potatoes and the P-MAI without potatoes equals a value of 47.5% for FBS g/day computations, but "only" 20.9% for calories/day computations (Table 5). The inclusion of potatoes in Med Foods seems to increase discrimination between MS dietary patterns -resulting in higher standard deviation values-, but the scientific rationale of such inclusion is questionable from a public health perspective.

When ranking and clustering was carried out using the Scott's choice test (Tab. 3) for the FBS(g) P-MAI, most countries maintained their position or at least maintained their original cluster from the CONCISE (Tab.6). The only major changes were seen with Estonia (from 0.71 to 1.39 and from cluster 2 to 4), Poland (from 0.76 to 1.47 and from cluster 2 to 4) and the UK (from 0.72 to 1.31 and from cluster 2 to 3). Italy and Slovakia remained at the top of the ranking of countries for Mediterranean Adequacy in both cases, other countries worsened passing onto calories-based computation and others ameliorated. However, non-Med foods (meat, dairies, fats) are generally denser from a caloric perspective than Med- foods (cereals, F&V, legumes..,), i.e., *a lower intake of Non-Med foods gives better scores than a proportionally increased intake of Med foods- even if hardly there is a general rule (olive oil is more caloric than butter; cereals have the same 4 calories per g than meat)*. Many of the Nordic countries maintained both their position and clusters. Despite their relatively high potato consumption, scoring positively- adherence to the Mediterranean diet was low and no significant effect was seen by including starchy foods in the list of Mediterranean foods.

When examining calories instead of grams, the effects of *ranking variations* were subtle, yet present- the SD –reasonably- increased. The UK and Ireland each gained a rank in the clusters partition (from 1.02 to 1.35 and 0.94 to 1.22 respectively), as does Estonia (from 1.08 to 1.52).

It is possible to draw similar conclusions from the EFSA database. Here, it is important to bear in mind that starchy foods only play a minor role in the diet, regardless of whether calories or grams are used as indicator units.

It is possible to advance similar considerations to those pinpointed for potatoes about other food items that do not yet have a clear nutritional status, such as *beer* or *fruit juices* with low fruit content[4]. When including them in the P-MAI (CONCISE g)-by food weight-, with the assumption of beer at the numerator (ethanol was positively considered within the MDS) and soft drinks at the denominator, the indicator

[4] Soft drinks are considered drinks with a fruit content lower than 'nectar', as defined by the European Commission (EC) Directive 2001/112, typically containing 25-50% fruit, but with added sugars.

Table 5. PMAI on the datasets FBS (grams and calories) and CONCISE (mean and median values), with potatoes/starchy foods alternatively included in Med foods (NUMERATOR) or in non Med foods (DENOMINATOR)

	FBS Grams			FBS Calories			CONCISE MEAN		
	Potatoes in "non-med foods"	potatoes in "med-foods"	delta(%)	potatoes in "non-med" foods	potatoes in "med" foods	delta(%)	potatoes in "non med foods"	potatoes in "med foods"	% Delta
AUT	0,9	1,18	31,1	1,08	1,23	13,9	1,78	2,20	23,9
BEL	0,81	1,14	40,2	0,99	1,16	17,2	1,48	2,12	43,6
BGR	1,07	1,35	26,2	1,69	1,89	11,8	1,32	1,88	42,5
CZE	0,75	1,13	50,7	1,1	1,32	20	1,09	1,59	45,8
DEU	0,68	1,05	54,4	0,78	0,97	24,4	1,18	1,67	42,1
DNK	0,77	1,09	41,6	0,68	0,82	20,6	0,94	1,31	39,8
EST	0,71	1,39	95,8	1,08	1,52	40,7	0,79	1,49	88,6
FIN	0,58	0,81	39,7	0,85	1,03	21,2	0,61	0,86	40,5
FRA	0,82	1,1	34,1	0,91	1,05	15,4	1,39	1,70	22,2
GBR	0,72	1,31	81,8	1,02	1,35	32,7	1,04	1,53	48
HUN	0,94	1,33	41,5	1,01	1,18	16,8	1,04	1,48	41,6
IRL	0,55	1	81,8	0,94	1,22	29,8	0,78	1,67	114,2
ISL	0,75	0,98	30,7	0,6	0,68	13,3	0,85	1,01	19,8
ITA	1,26	1,5	19	1,78	1,95	9,6	1,97	2,34	18,7
NLD	0,54	0,79	46,3	0,77	0,93	20,8	0,79	1,17	48,6
NOR	0,74	1,07	44,2	0,96	1,15	19,5	0,64	0,95	48,9
POL	0,76	1,47	93,4	1,1	1,49	35,5	1,09	2,30	110,1
SVK	1,2	1,42	18,3	1,23	1,47	19,5	1,52	2,26	48,3
SWE	0,59	0,78	32,2	0,91	1,04	14,3	0,84	1,28	52,2
Mean	0,8	1,15	47,53	1,03	1,23	20,89	1,11	1,62	50,96
SD	0,2	0,22		0,29	0,32		0,37	0,45	

(*) Country indicated by the three digits standard; Austria (AUT). Belgium (BEL); Bulgaria (BGR); Czech Republic (CZE); Germany (DEU); Denmark (DNK); Estonia (EST); Finland (FIN); France (FRA); United Kingdom (GBR); Hungary (HUN); Ireland (IRL); Iceland (ISL); Italy (ITA); the Netherlands (NLD); Norway (NOR); Poland (POL); Slovakia (SVK).Mediterranean Foods as by original Mediterranean Adequacy Index: vegetables, fruit, cereals, red wine, vegetable oils, potatoes and fish. Non Mediterranean Foods as by original Mediterranean Adequacy Index: meat, dairy products, animal fat, eggs and sugar

shows substantial variations as compared to the baseline model. The mean P-MAI value without including beer and soft drinks is 1.37 (SD 0.43), but changes to 1.28 (SD 0.40) with both foods included in the abovementioned positions.

Although the inclusion of beer inside Med-foods is questionable, as several countries have a high average beer consumption (i.e. the Czech Republic 373g/day, Ireland 299g/day, and the UK 257g/day), fruit juices with added sugar and a low fruit content require also proper examination from a public health perspective. In fact, there are also quite high consumption levels for these fruit juices across the EU (Norway 330g, Iceland 339g, Belgium 275.2g, and the UK 219g).

With regard to scores other than the P-MAI, after taking into account the basic Mediterranean Score index (MDS), the scope was enlarged to include non-Mediterranean foods, as well as potatoes and eggs,

Table 6. PMAI on the datasets FBS (grams and calories) and CONCISE (mean and median values), with potatoes/starchy foods ("POT") alternatively included in Med foods or in non-Med foods. Clusters provided depending on the rankings.

	Pot "Non-Med"			Pot "Med"			Pot "Non-Med"			Pot "Med"			Pot "Non-Med"			Pot "Med"	
	FBS g	**Cluster**		**FBS g**	**Cluster**		**FBS cal**	**Cluster**		**FBS cal**	**Cluster**		**CONCISE** mean	**Cluster**		**CONCISE** mean	**Cluster**
NLD	0,54	1	SWE	0,78	1	ISL	0,6	1	ISL	0,68	1	FIN	0,61	1	FIN	0,86	1
IRL	0,55		NLD	0,79		DNK	0,68		DNK	0,82		NOR	0,64		NOR	0,95	
FIN	0,58		FIN	0,81		NLD	0,77		NLD	0,93		IRL	0,78		ISL	1,01	
SWE	0,59		ISL	0,98	2	DEU	0,78		DEU	0,97	2	NLD	0,79		NLD	1,17	
DEU	0,68		IRL	1		FIN	0,85	2	FIN	1,03		EST	0,79		SWE	1,28	2
EST	0,71	2	DEU	1,05		FRA	0,91		SWE	1,04		SWE	0,84		DNK	1,31	
GBR	0,72		NOR	1,07		SWE	0,91		FRA	1,05		ISL	0,85		HUN	1,48	
NOR	0,74		DNK	1,09		IRL	0,94		NOR	1,15		DNK	0,94	2	EST	1,49	
CZE	0,75		FRA	1,1		NOR	0,96		BEL	1,16		GBR	1,04		GBR	1,53	
ISL	0,75		CZE	1,13		BEL	0,99		HUN	1,18		HUN	1,04		CZE	1,59	3
POL	0,76		BEL	1,14		HUN	1,01		IRL	1,22	3	CZE	1,09		IRL	1,67	
DNK	0,77		AUT	1,18	3	GBR	1,02		AUT	1,23		POL	1,09		DEU	1,67	
BEL	0,81		GBR	1,31		AUT	1,08		CZE	1,32		DEU	1,18		FRA	1,70	
FRA	0,82		HUN	1,33	4	EST	1,08		GBR	1,35		BGR	1,32	3	BGR	1,88	
AUT	0,9	3	BGR	1,35		CZE	1,1	3	SVK	1,47	4	FRA	1,39		BEL	2,12	4
HUN	0,94		EST	1,39		POL	1,1		POL	1,49		BEL	1,48		AUT	2,20	
BGR	1,07	4	SVK	1,42		SVK	1,23		EST	1,52		SVK	1,52	4	SVK	2,26	
SVK	1,2	5	POL	1,47		BGR	1,69	4	BGR	1,89	5	AUT	1,78		POL	2,30	
ITA	1,26		ITA	1,5		ITA	1,78		ITA	1,95		ITA	1,97	5	ITA	2,34	5

(*) Country indicated by the three digits standard. Austria (AUT); Belgium (BEL); Bulgaria (BGR); Czech Republic (CZE); Germany (DEU); Denmark (DNK); Estonia (EST); Finland (FIN); France (FRA); United Kingdom (GBR); Hungary (HUN); Ireland (IRL); Iceland (ISL); Italy (ITA); the Netherlands (NLD); Norway (NOR); Poland (POL); Slovakia (SVK). Mediterranean Foods as by original Mediterranean Adequacy Index: vegetables, fruit, cereals, red wine, vegetable oils, potatoes and fish. Non Mediterranean Foods as by original Mediterranean Adequacy Index: meat, dairy products, animal fat, eggs and sugar.

which within Trichopoulou's highly relevant results showed an increase in the mortality rate of 1.07 (0.95-1.21 and 0.98-1.17 respectively). For comparative purposes, in this study there was an increased hazard of 1.05 for saturated fats, 1.06 for meat and 1.11 for dairy products. Results suggest that when eggs and potatoes were considered part of the Mediterranean diet entries, as expected they gave rise to a higher apparent adherence to the Mediterranean diet, with a number of countries benefitting from same (including Italy, Austria and Estonia). This loophole, due to the inability of the traditional Med Diet to reflect on either new foods nor on foods traditionally outside the Med pattern, requires for sure additional research and modelling (Table 7).

Also, some considerations can be drawn about the different data sources used. Previous international comparisons (38, 39[5]-"Dafne") relied exclusively on other datasets, such as the FAO Food Balance Sheets, a food supply database, or Dafne, a household food availability database. Both of these datasets provided data obtained via the food balance method (FBS) or from household food purchases (Dafne) whereas on the contrary the EFSA dataset collected data from national food consumption surveys. While the known limitations of the EFSA dataset include its lack of harmonisation in collection and survey methods, the different timeframes of the national surveys and under-reporting, it may still provide more accurate information than previously used datasets. As for the P-MAI, the apparent discrepancies between the CONCISE and FBS average values could be due to waste along the food consumption chain (from distribution to consumption). In fact, FBS are corrected for food reused for other production purposes, but not for retail/kitchen waste or table leftovers.

For future research, it would be worth exploring whether Mediterranean diet adherence depends on socio-economic or cultural factors, i.e. the degree of inequality in income distribution inside a given country (using the Gini Index; (40)). We also used wine and wine substitutes as well as beer as a proxy of moderate alcohol consumption (an element of the Mediterranean diet). This may be misleading, as alcohol is known to damage health. Moreover, starchy foods (refined, as opposed to whole foods) contribute to a higher P-MAI. However, if they are not consumed as a substitute animal protein, they do not lead to a healthier diet, which can lead to an increased BMI (9, 41).

In this study, we estimated the P-MAI with weight or energy content, depending on the available data. Where data was missing, it was recommended to use the number of grams consumed daily (25, 9). In countries where EFSA data was available, the P-MAI (estimated in 1961 and 2007) demonstrated a decline in all southern European countries surveyed, confirming changes in the consumption of the Mediterranean diet.

Table 7. The MDS with potatoes and eggs regarded as Mediterranean entries or not (original model of Trichopoulou)- EFSA mean data considered, grams.

	MDS (pot + eggs as MED)		MDS Original
GBR	2	NLD	1
NOR	2	NOR	2
NLD	2	GBR	2
IRL	2	IRL	2
EST	3	ISL	2
HUN	3	FIN	2
FIN	3	EST	2
BEL	3	BEL	3
DNK	4	SWE	3
SWE	4	CZE	3
ISL	4	DNK	3
BGR	5	HUN	3
SVK	5	SVK	3
FRA	5	BGR	3
DEU	5	POL	4
POL	5	FRA	4
CZE	5	AUT	4
AUT	6	DEU	5
ITA	7	ITA	6

(*) Country indicated by the three digits standard. Austria (AUT); Belgium (BEL); Bulgaria (BGR); Czech Republic (CZE); Germany (DEU); Denmark (DNK); Estonia (EST); Finland (FIN); France (FRA); United Kingdom (GBR); Hungary (HUN); Ireland (IRL); Iceland (ISL); Italy (ITA); the Netherlands (NLD); Norway (NOR); Poland (POL); Slovakia (SVK).

[5] Dafne stands for DAta Food NEtworking, and aims at the creation of a pan-European food data bank

According to FBS data, the reason for this lies in increased meat consumption, rather than in the reduced consumption of fruit and vegetables or vegetable oils. Reductions have been observed in the consumption of beans and wine only. Furthermore, southern European diets have also increased their total food and energy intake, which is not reflected in the P-MAI. Several countries in northern and central Europe had higher levels of Mediterranean diets in 2007 than in 1961, as measured by the P-MAI. However, this change coincided with a general increase in energy intake (kcal). More generally, most national diets tend to display some sort of 'inertia' in terms of the P-MAI, which can easily be attributed to dietary cultures and recipes.

When measured with the FBS, more food in terms of both weight and energy was consumed in 2007 than in 1961 in all countries. National diets, which were below average P-MAI in 1961, were generally still below average in 2007. The 2007 P-MAI scores are correlated with those in 1961 (Pearson's r = 0.84), Table 8.

For comparative purposes for each food category in the EFSA database, Confidence Intervals (CI) have been derived in order to assess whether related FAO data fall inside them. The results obtained were informative and lead to the following consideration. Categories that were too broad in scope did not allow values to overlap in the 2 datasets (i.e. values inside the confidence intervals), even if there appeared to be a strong correlation (i.e. countries with a high consumption of dairy products were the same across databases, although the intake varied significantly depending on the source used, which in turn may depend upon a different level of aggregation of single food items).

Other categories, even if they were more restricted, showed that despite the same direction being seen in the CONCISE and FBS (expressed by the correlation); the magnitude was quite different to the well-known variation expected between FBS and real consumption (fish and starchy products). Hence, it generally did not allow FBS values to fall inside the confidence intervals of the CONCISE DB. As for wine, there was a degree of correlation and, in some national cases, an overlapping between FBS and survey data is apparent. This similarity between data from the CONCISE and FBS, which on the contrary food availability record at home, could easily be explained by the fact that wine is not processed at home meaning that waste can be reduced. Hence, wine intake and availability are similar, unlike other food categories for which waste within the home environment is to be expected.

Such comparisons may also drive reflections on the impact that adult consumption levels have on the overall population. Although, as confidence intervals from the CONCISE data in most cases did not include corresponding FBS values, it could be deduced that this is not in fact the case.

Table 8. P-MAI (Population-level Mediterranean Adequacy Index) scores for the aggregated average national diets from FAO FBS in 2007 and 1961, and change in selected EU Member States (calories-based computation).

	1961	**2007**	**Change**	**Change %**
Norway	0.7	1.36	0.66	94.7
Great Britain	0.78	1.36	0.58	74.3
Belgium	1.56	1.37	-0.19	-12.2
Ireland	0.89	1.43	0.54	60.4
Iceland	0.64	0.82	0.18	27.5
Finland	0.88	1.04	0.16	18.3
Sweden	0.84	1.07	0.23	27.6
Czech Republic	1.29	1.48	0.19	14.4
Denmark	0.87	0.77	-0.10	-11.8
The Netherlands	1.17	1.11	-0.06	-5.3
Poland	1.66	1.45	-0.21	-12.5
Germany	1.13	1.11	-0.02	-1.3
Hungary	1.39	1.20	-0.19	-13.8
France	1.41	1.25	-0.16	-11.1
Austria	1.43	1.26	-0.17	-12.1
Slovakia	2.07	1.44	-0.63	-30.2
Italy	3.28	1.96	-1.32	-40.3
Portugal	3.62	1.59	-2.03	-56.1
Bulgaria	4.08	1.77	-2.31	-56.5
Spain	4.04	1.79	-2.25	-55.7
Greece	4.63	2.04	-2.59	-55.9
Mean	1.83	1.37		
St.Dev	1.27	0.34		
Pearson correlation	0.75			
Pearson correlation (calories/PMAI 2007)	0.07			

Table 9. Correlation and overlapping between FAO and EFSA DB (grams) for specific food categories

Food Category	Pearson's correlation r CONCISE - FBS (g)	Countries presenting overlapping Confidence Intervals (i.e., comparable values)
Fish	0.59	Austria (P <0.01)
Cereals	0.25	France (P <0.01 and P< 0.05), Germany (P< 0.01)
Fruit	-0.3	none
Vegetables	0.34	none
Dairy products	0.72	none
Meat	0.08	Slovakia (P <0.01 and P< 0.05)
Sugars and sweeteners	0.41	none
Starchy products	0.62	Austria (P <0.01 and P< 0.05)
Wine products	0.81	Austria (P <0.01 and P <0.05), Czech Rep. (P <0.01 and P <0.05), Slovakia (P <0.01 and P <0.05), Sweden (P <0.01).
Eggs	0.22	Poland P < (0.01)

However, we believe that the P-MAI, for all its simplicity, may be worth exploring as an initial summary population-level measure of the level. Such an index is currently available in several forms (42, 9, 41).

Another outcome of this study was the comparison between different databases, which can provide problematic results from a public health perspective. When political and administrative resources are limited and there is a need to address emerging issues (such as diet) at population level, the use of different indicators and databases may result in different policy indications. Although we were already aware (43) that variations in percentiles of national populations exist, whereby there are higher variations between countries. This contribution once again underlines the difficulties encountered when managing the need for country-specific policies and the need for specific relief for specified target groups (percentiles) of the populations, at the time of adopting aggregated data.

Limitations

A first limitation is that some foods were not included in the CONCISE database- for example, vegetable oils and red wine-distorting the overall value of the indices.

Another limitation depends on the different years of surveys in the CONCISE, which make inherently difficult to compare Mediterranean Diet adherence during diverse temporal windows- as well as the different survey methodologies (i.e., 24 hours recall, 48 hours recall, etc)

Also, with regard to the FAO FBS, they are not deflated for domestic food waste (i.e., apparent consumptions may be exaggerated).

In addition, the use of dietary indices, which, in this case, rely on average or median data do not account for the variability in the population's dietary habits.

Furthermore, many indices used relying on population-level data discount the lack of all the information: i.e, for the Med Diet Score the ratio between monounsaturated/saturated fats, as originally indicated in Trichopoulou (2003) (28) was absent, nor was it possible to analytically separate legumes from vegetables departing from the CONCISE database; neither the Med- DQI was able to capture TFAs or cholesterol.

Another major limitation of this study is that the indices used were originally built on first-hand data (i.e., cohort studies relying on real persons), and not intended for aggregated mean-median values analysis at population level (secondary data). Eventually, a further problem of Med-adherence indices is that *it does not consider the overall caloric intake* and also, specific nutrients or other indicators of nutritional status such as BMI. Further considerations reflect the uncertain status inside the Mediterranean diet of food items, i.e. soft drinks, potatoes or beer/ethanol. This will likely also present a challenge in terms of the scientific background and overall conceptual framework.

Nonetheless such indicators fitted the clustering purposes only and obviously, the paper did not intend to infer health-based outcomes, such as hazard ratios presented in the original works.

In conclusion, it is apparent that there is something like a real "Mediterranean Diet" and Mediterranean dietary lifestyle. However, internationalisation of food consumption and trade, global lifestyles and attention to preventive medicine-(starting from healthier diets)- result in an increase in Med diet patterns in Nordic EU countries and a relative loss in traditional Southern ones.

In the end, different dietary patterns seem to continue to exist across Europe, which is consistent with the findings of other studies. Future refinements require a better definition of the Mediterranean diet (42). Moreover, proper consideration should be paid to food categories with still uncertain Mediterranean-taxonomy (i.e. potatoes, beer or fruit juices with a low fruit content). Equally, a future refinement could intend to model FAO FBS data in order to mimic real survey data, should there be a lack of such data. Consequently, correction factors for Mediterranean countries could be extrapolated (i.e., *food waste- in order to better describe real at home intake of F&V, for which the difference between intake surveys data and FBS seems relevant*).

The P-MAI is an interesting indicator due to its user-friendliness, lack of a-aprioristic assumptions or modelling with a minimal recourse to hypothesis - and allows the classification of European countries' diets using food intake data. In fact, exploring variations with a one-way ANOVA and considering the 3 comparable data sources used (FAO FBS calories, FAO FBS grams, and EFSA mean values in grams), we cannot reject the null hypothesis that mean values are not the same. Therefore, using different data can lead to not completely different results (F 4.73, F critical 3,16). The residual variance/overall variance ratio, is in fact 0.88 (values closer to 1 imply that -regardless the dataset used- the results can still be compared, suggesting *that different dietary patterns count more than diverging collections methods/dataset).*

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