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Mediterranean diet scoring systems: understanding the evolution and applications for Mediterranean and non-Mediterranean countries

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Abstract

The Mediterranean diet (MedD) is a flexible dietary pattern which has such variability that has led to inconsistencies in definitions and assessment. The purpose of this narrative review is to evaluate scoring systems in a cultural and geographic context, from Mediterranean and non-Mediterranean countries, for comparison and application. The early MedD scoring systems (i.e. Trichopoulou's MedD Scale (T-MDS) and alternative MedD Scale (aMed)) are widely applied throughout the world but use population-specific median cut-offs which limit interpretation and cross-study comparisons. The T-MDS and aMed also do not account for non-traditional MedD foods which are consumed in greater quantities than when the scoring systems were developed. Scoring systems developed after the MedD pyramid publication in 2011 have generally used these recommendations as a basis for food group intake cut-offs, incorporating more foods/food groups as negative components, and some have included dietary and lifestyle behaviours. The different approaches to MedD assessment have created much variability in the foods/food group components included in scoring systems. Assessments that include dietary and lifestyle behaviours may reflect the nutrition transition occurring in Mediterranean countries and better guide clinical intervention approaches. While the new scoring systems are theorised to better capture MedD adherence and behaviours, comparisons are sparse in the literature and none exists outside of Europe. Consensus on food and dietary behaviours to include as well as the methodology for assigning points in MedD scoring systems is needed to advance our understanding of MedD and health relationships to promote public health messaging and clinical application.

Key words: **Mediterranean diet: Dietary pattern scoring systems: Mediterranean lifestyle: Dietary assessment**

Epidemiological studies have provided us with a broader understanding of the relationship between diet and disease states, but this understanding is shaped by the inherent limitations of dietary assessment tools applied to a given study population. The study of the Mediterranean diet (MedD) is an *a priori* approach to diet pattern analysis as it includes elements of a dietary pattern with available evidence[1]. This approach is important when considering the wide application of the MedD, the multiple tools for assessing adherence and the potential health benefits.

The potential cardiovascular health benefits of consuming a MedD were first brought to the attention of the world by Ansel Keys[2]. Since then, additional health benefits have emerged including reduced overall mortality as well as reduced risk of some cancers, neurodegenerative diseases and diabetes[3]. While there is no single MedD, the traditional dietary pattern is characterised by intake of foods from the olive-growing region of the Mediterranean basin observed up till the 1960s with emphasis on a high intake of vegetables, cereals, fruits, olive oil, legumes, fish, moderate intake of wine, with limited red and processed meats and processed sweets[4]. Olive oil and lipid ratios that reflect a primarily plant-based diet with moderate wine consumption are hallmarks of the traditional MedD. The broad definition and lack of specific terms[5] to define the MedD, i.e. nutrients rather than food groups, or specific Mediterranean foods within the food groups, make it difficult to identify and quantify the MedD. However, the MedD pyramids help with defining the diet and have evolved over the last 25 years[6–10]. The MedD pyramid evolution reflects the nutritional transitions that have occurred in the Mediterranean region

Abbreviations: aMed, alternative Mediterranean diet Scale; MDS, Mediterranean Diet Scale; MDSS, Mediterranean Diet Serving Score; MedD, Mediterranean diet; MediCul, Mediterranean Diet and Culinary Index; MEPA, Mediterranean Eating Pattern for Americans; NU-AGE, New Dietary Strategies Addressing the Specific Needs of Elderly Population for Healthy Aging in Europe; SSB, sugar-sweetened beverages; T-MDS, Trichopoulou Mediterranean Diet Scale; T-MDS, Trichopoulou's Mediterranean Diet Scale.

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and variabilities that allow for application to other cultures and traditions. The most recently published and applied MedD pyramids were developed by an International group of MedD researchers, the International Foundation of MedD[6,9,11].

Lifestyle is also emphasised in the MedD. This is fitting, since the origin of the word 'diet' is the Greek concept of 'diaita', meaning lifestyle. The traditional MedD is a lifestyle and cultural practice. Indeed, UNESCO recognised the MedD as an intangible heritage in 2013[12]. In the UNESCO statement, specific foods are not highlighted, rather the food-based lifestyle and cultural heritage of that region '. . . a set of skills, knowledge, rituals, symbols and traditions, ranging from the landscape to the table. Eating together is the foundation of the cultural identity . . . '[12]. The 2011 MedD pyramid recognised these lifestyle activities including: physical activity, adequate rest, culinary activities, conviviality, biodiversity and seasonality, and traditional, local and eco-friendly products[6]. The interpretation of some of these recommendations, such as 'traditional, local, and eco-friendly products', will vary throughout the world; therefore, special cultural consideration is needed with the growing popularity of the MedD for its potential health impacts. The latest revision of the MedD pyramid places greater emphasis on the environmental impact of foods, sustainability of the food system and the need for individual countries to adapt the MedD to their 'food systems and culture-rooted cuisines'[9].

While the unique dietary and lifestyle features of the MedD have individual health associations, it is the synergistic effect of the diet components that infers its unique health benefit[13–17]. This is encompassed by MedD scoring systems; they encapsulate this dietary pattern into a numeric score for assessment with health outcomes. Reviews of the validity, reliability and content of MedD scoring systems for adherence have been conducted[18–20]. Despite these examinations, a comparative application of these scoring systems in Mediterranean and non-Mediterranean countries has not been evaluated. This review will discuss scoring systems used in both Mediterranean and non-Mediterranean countries to obtain an understanding of cultural and geographic similarities and differences, with the goal of enhancing future applications of MedD assessment around the world. To provide a historical and time-dependent landscape for comparisons and applications, we will first review the evolution of the MedD in both Mediterranean and non-Mediterranean countries.

Evolution of Mediterranean diet scoring systems in Mediterranean countries

The Mediterranean region encompasses land from three continents and a number of cultural and religious traditions. This has resulted in a slightly different interpretation of the MedD dependent on the region in which the scoring system was originally intended. For example, wine or alcohol consumption was removed from some scoring systems to account for religious beliefs, or adjustments made for the predominant source of grains by region of the Mediterranean. These adaptations present a challenge in standardising the components that make up the MedD, even within Mediterranean countries. This section will review the evolution of the most prominent MedD scoring systems from Greece, Spain and Italy as these were the Mediterranean countries first studied for the health effects of the MedD; then, MedD scoring systems from Eastern Mediterranean and Southern Mediterranean regions will be discussed. For all scoring systems, a higher score reflects higher compliance to the traditional MedD or MedD pyramid recommendations.

Mediterranean region: Greece

The first MedD scoring system and the most commonly applied, with slight modifications over the years, is the MedD Scale (MDS) originally devised by Trichopoulou (T-MDS) and colleagues in 1995 (see Table 1)[21]. In 2003, fish was added as a beneficial component to the T-MDS[15]. Furthermore, in 2005, Trichopoulou modified the T-MDS's lipid ratio to include PUFA to the MUFA:SFA ratio and only included fruits, rather than both 'fruits and nuts' together[22], for use in nine European countries in the EPIC study (Denmark, France, Germany, Greece, Italy, the Netherlands, Spain, Sweden and the UK). Understanding the evolution of the T-MDS and other Mediterranean-based MedD scoring systems is essential for scholars studying the MedD to be able to interpret and apply research findings published at different points in time. Throughout this review, the year of publication will be assigned to the T-MDS to allow for rapid identification and to reflect the slight but meaningful differences in reported intakes from these three original T-MDS publications.

The Panagiotakos Mediterranean Diet Score (MedDietScore), developed in 2006, is also a commonly applied scoring system based on the MedD pyramid recommendations[7,23]. This system includes eleven foods/food group questions on a 0–5 scale resulting in a wider ranging score (0–55). Some differences from the T-MDS are that the MedDietScore includes potatoes and olive oil (instead of MUFA:SFA ratio) as positive factors, but nuts are not included, and white meat/poultry is a negative factor. Dietary intake from FFQ data was first applied for monthly intakes but was converted to weekly intakes for ease of use[23,24].

Mediterranean region: Spain

The T-MDS, 2003, was applied to a Spanish population in a few different ways, depending on the study. All of the Spanish T-MDS adaptations used tertiles rather than median cut-off values, others replaced the lipid ratio with olive oil and other food group changes (see Table 1)[25–28]. The Mediterranean-Like Diet Score was developed in 2011 and included components of the T-MDS, 2005 with some changes to meats and dairy groups (See Table 1)[25].

Two scoring systems out of Spain are based on the 2011 MedD pyramid[6]. The Mediterranean Diet Serving Score (MDSS) uses a weighted scoring system and includes upper and lower limits for food group intake on a meal, day or week frequency[29]. The MEDLIFE tool is the only assessment tool to incorporate a number of dietary behaviours and lifestyle factors with the food intake questions[30,31]. This scoring system includes

Table 1. Mediterranean diet scoring system food components in Mediterranean countries

	Greece			Spain					Italy			
Components	T-MDS, 95/03[15,21]	T-MDS, 2005[22]	MedDiet Score[23]	mT-MDS[25,26]	rMED[27]	MLDS[25]	MEDLIFE Sotos*[30]	MDSS[29]	Italian MedD Index[44]	LBAS[51]	QueMed[46]	Medi-Quest[47]
Cereals	+	0	0	+	+	+	+	+	+†	+	0	0
Whole-grain cereals/bread	0	0	0	0	0	0	0	0	0	0	+	+
Non-refined cereals	0	+	+	0	0	0	0	0	0	0	0	0
Potatoes	0	0	+	0	0	0	–	–	–	0	0	0
Vegetables	+	+	+	+	+‡	+	+‡	+	+‡,§	+	+‖	+
Fruits	0	+	+	+	0	+	+¶	M	+	+	+**	+
Fruits and nuts	+	0	0	0	+††	0	0	0	0	0	0	0
Nuts	0	+	0	+	0	+	+‡‡	M	0	0	0	0
Legumes/pulses	+	+	+	+	+	+	+	+	+	+	+	+§§
Olive oil	0	0	+	+	+	+	+	+	+	+	+	+
Vegetable oils	0	0	0	0	0	0	0	0	0	0	0	0
Butter	0	0	0	0	0	0	0	0	–	0	–‖‖	–
Dairy and dairy products	–	–	–¶¶	–¶¶,***	–	0	0	M	0	–	0	–†††
Low-fat dairy products	0	0	0	0	0	+	+	0	0	0	0	0
Fish/seafood	+	+	+	+	+	+	+	+	+	+	+	+
Eggs	0	0	0	0	0	0	0	M	0	0	0	0
Meat or meat products	–	–	–	–	–	–‡‡‡	0	0	0	–	0	–
Red meat	0	0	0	0	0	0	–§§§	–	–	0	–§§§	0
White meat (Poultry)	0	0	-(P)	0	0	0	+	M	0	0	+	0
Moderate alcohol	+	+	+	0	+	0	0	+	+	+	0	+
Moderate red wine	0	0	0	+	0	+	0	0	0	0	0	0
Moderate wine	0	0	0	0	0	0	+	M‖‖‖‖	0	0	+	0
MUFA:SFA ratio	+	+¶¶¶	0	0	0	0	0	0	0	0	+	0
SSB	0	0	0	0	0	–	–	0	–	0	–****	0
Pastries	0	0	0	0	0	–	–	0	0	0	0	–
Sweets	0	0	0	0	0	0	0	–††††	0	0	–‡‡‡‡	0
Cakes, pies/cookies	0	0	0	0	0	0	0	0	0	0	–	–
Added sugar	0	0	0	0	0	–	0	0	0	0	0	0
Fast food/takeout food	0	0	0	0	0	–	0	0	0	0	0	0

T-MDS, Trichopoulou-Mediterranean Diet Scale; mT-MDS, modified T-MDS; rMED, revised T-MDS; MLDS, Mediterranean-Like Diet Score; MDSS, Mediterranean Diet Serving Score; MedD, Mediterranean Diet; LBAS, Literature-Based Assessment Score; SSB, sugar-sweetened beverages.

* Also included in the score are use of herbs, spices, garnish (+), snacks (–), salt at meals (–), as well as lifestyle behaviours; + included in score as beneficial component; – included in score as negative component; M included in score as moderate intake with upper and lower intake cut-offs; 0 not included in score.

† Specifically pasta.

‡ Excluding potatoes.

§ Specific Mediterranean vegetables.

‖ Including raw and cooked.

¶ And fruit and vegetable juices.

** And dried fruits.

†† And seeds, excluding juices.

‡‡ And olives.

§§ And nuts.

‖‖ Including cream and margarine.

¶¶ Full fat only.

*** In Sanchez *et al.* 2006 only.

††† Excluding milk and yogurt.

‡‡‡ Excluding poultry and rabbit.

§§§ And processed meats.

‖‖‖ Wine and beer.

¶¶¶ MUFA + PUFA:SFA.

**** And/or carbonated beverages.

†††† Including SSB.

‡‡‡‡ Manufactured sweets.

foods/food groups in totals per d rather than breaking down to the meal intake as done by Monteagudo and colleagues. Dietary habits and specific physical activity, rest, social habits and conviviality questions are also included, with scoring for each question using a simple yes/no (1/0 points) format[30,31].

The fourteen-point Mediterranean Diet Adherence Score (MEDAS)[32] is a self-report screening questionnaire that was developed for use in the PREDIMED study for rapid adherence assessment. It has also been used to determine MedD adherence from FFQ or diet record data. This tool has been adapted and applied around the world (see Table 2)[33–43].

Mediterranean region: Italy

MedD scoring systems from Italy have used modifications to the T-MDS or have been developed independently. The Italian arm of the EPIC study modified the T-MDS into the 'Italian Mediterranean Index' using tertiles for cut-offs[44]. This scoring system is specific to the cultural food practices of Italy (see Table 1).

In southern Italy, in 2016, Zito and colleagues applied a short MedD questionnaire with up to nine total points from FFQ dietary data[45]. Additionally, two assessment tools were developed in northern and southern Italy for direct patient use, the QueMed and MEDI-Quest, respectively (Table 1). The QueMed is a self-administered questionnaire that assigned points for responses of never or seldom (0) to high frequency (5)[46]. The MEDI-Quest scoring system included traditional and non-traditional food groups with pre-defined food group cut-offs for assigning 0, 1 or 2 points[47]. The MEDI-Quest only evaluates frequency of intake and was developed as a nutrition education tool as well as for MedD assessment[47].

Eastern and southern Mediterranean region

The Lebanon MedD Index and Israeli(i)-MEDAS represent the eastern Mediterranean region. The Lebanon MedD Index used factor analysis from a traditional Lebanese dietary pattern to identify nine foods/food groups[48]. While this tool differed in some components from the MedD, core components such as olive oil, fruit and vegetables are consistent with other MedD scoring systems[48]. A scoring system was recently developed to represent the southern Mediterranean region using the MedD pyramid[6]. The Moroccan-modified MedD includes twelve components, with foods within the food groups specific to the Southern Mediterranean food culture as well as western-type foods[49].

Multi-country-derived MedD scoring system

An *a posteriori* calculation was determined by Sofi and colleagues[50] in 2012 proposing cut-offs for intake based on the literature rather than the median or tertile intakes of the study population. This calculation used food groups of the T-MDS, 2003 except for replacing the lipid ratio with olive oil. A subsequent meta-analysis (2014) and application (2017) of the literature-based score (LBAS) has intake cut-offs that are more in line with MedD pyramid recommendations (Table 1)[51,52]. While this scoring system removes the limitation of median intakes from the T-MDS, it does not account for non-traditional MedD intake such as sweets, processed or fast food/takeout foods, or sugar-sweetened beverages (SSB). Ignoring the intake of non-traditional foods in a MedD scoring system will likely underestimate true intakes, especially when applied to non-Mediterranean countries.

Consistencies and deviations of scoring systems developed in Mediterranean countries

The application of MedD scoring systems in the Mediterranean region has evolved over the last 25 years to better reflect the lifestyle and dietary changes that this region faces, particularly in the younger generations. As illustrated in Table 1, the scoring systems out of Greece only measure 'traditional' MedD foods. Some scoring systems out of Spain and Italy have begun to also include non-traditional foods (sweets, processed or fast food/takeout food, SSB) as negative components which is more in line with modern food intakes around the world. While the inclusion of more foods better aligns with modern food intakes, this has also increased variability and inconsistency in the MedD literature.

Evolution of Mediterranean diet assessment tools in non-Mediterranean countries

The application of MedD scoring systems originally developed to assess food intake patterns of adults in the Mediterranean region is commonly applied to non-Mediterranean countries with varied levels of adjustment and validation for the specific population. The most commonly used application is a modification of the T-MDS, 2003 by Fung and colleagues in 2005 called the Alternative Mediterranean Diet Scale (aMed), see Table 3 and 4[53,54].

The MEDAS tool has garnered worldwide popularity in recent years as a rapid and direct assessment measurement. For example, MEDAS was validated for direct self-report use in Germany, the UK, Canada and the USA[33,34,41,42]. The multiple study applications have strengthened the validity and reliability for use in research and clinic settings or via telephone interviews[33–35]. Table 2 outlines the application and evolution of MEDAS throughout the world. Of note, some have modified the MEDAS to remove or add questions and thus have resulted in scores that range from 0–12 to 0–17[38,43]. The scores vary slightly depending on the country of origin and study design (see Table 2). For instance, young adults in a university setting had the lowest average MEDAS score (males 4·11 (2·33) and females 5·00 (1·9)) when using the 0–14 scale[42]. Comparing Mediterranean and European countries, differences were also observed (see Table 2)[36].

Non-Mediterranean European countries

Differences in lifestyle and diet on the European content impact health outcomes. The northern European country's climate, food procurement and preferences differ from the Mediterranean basin.

Table 2. MEDAS validation studies in non-Mediterranean countries

Continent	Population	Changes	MEDAS* mean scores	Mean	SD
Europe	German women in LIBRE multicentre study (*n* 68)[33]	No changes to foods/food group, included portion size photographs.	NA		
	Adults at high risk for CVD from Bristol UK (*n* 96)[34]	Included portion size photographs. Only included SSB, not carbonated and/or SSB.	NA		
	Portuguese adults (*n* 224) for telephone interview validation[35]	No changes		7·3	2·2
	Adults from Greece, Cyprus, Italy, Spain, Portugal, Republic of North Macedonia and Bulgaria (*n* 402) validation and comparison study[36]	No changes	All countries Spain (*n* 40) Bulgaria (*n* 59)	6·2 8·4 4·5	2·0 1·7 1·2
Australia	Adults in the HELFIMED RCT (*n* 182)[37]	No changes	Baseline 3 months 6 months	4·6 7·1 7·4	0·3 0·3 0·3
Asia	Israeli adults in Hadera District Study (*n* 1104)[38]	Fruit group was without any fruit juice; moderate wine was changed to alcohol; only included SSB, not carbonated and/or SSB; salty snacks and savoury pastries were added as negative components; whole grains, non-sweetened dairy, and hummus/tahini salad were added as positive components. Score range 0–17	MEDAS 6·0 range:(5–7). I-MEDAS 8·0 range: (7–9)		
	Korean normal-weight (*n* 211) and overweight (BMI > 27) adults with at least one weight-related complication (*n* 116)[39]	The sofrito question faced translation difficulty, question changed to whole grains. Perilla oil was included with olive oil in both oil questions. Beans and tofu replaced legumes or pulses; breads were included with sweets.		6·2	2·2
South America	Brazilian adults (*n* 101)[40]	Changes to better reflect dialec of Brazilian Portuguese. Some words or phrases altered but not to change overall meaning. For instance, white meat example was changed to reflect white meat foods eaten in Brazil. Only included SSB, not carbonated and/or SSB.		5·3	2·5
North America	Cardiac Rehabilitation programme participants in Toronto, Canada (*n* 150)[41]	No wine/alcohol. Only included SSB, not carbonated and/or SSB. Pictures added for food serving sizes. Score range 0–13	Interview Self-report	8·9 10·2	2·3 1·9
	230 US adult food shoppers, 127 University students enrolled in 3 courses with varied levels of nutrition education[42]	No changes	Females Males	5·0 4·1	1·9 2·3
	Adult US participants from NHS I and II, HPFS (*n* 6868)[43]	Removed olive oil as main fat question and sofrito intake. Score range 0–12.	NHS 4·2. HPFS 4·5		

SSB, sugar-sweetened beverages; NHS, Nurse's Health Study; HPFS, Health Professionals Follow-up Study; NA, Not Available.
* MEDAS components[32], include one point for intake above recommended cut-offs for vegetables, fruits, nuts, legumes/pulses, olive oil, fish, sofrito and preference for white meat over red meat and olive oil as the main source of fat. One point for moderate wine intake. One point for intake below the recommended cut point for butter/cream/margarine, red meat and sausages, SSB and/or carbonated beverages, and commercial pastries. See ref. 32 for list of how the intake questions were asked.

Application of previously developed scoring systems

The EPIC study used the T-MDS, 2005 and found that highest MedD adherence was in Greece, followed by Spain, Italy, then France; the Netherlands had the lowest average T-MDS, 2005 score[22]. The Sofi LBAS, with pre-determined food group intake cut-offs, was applied to dietary data in the Health Alcohol and Psychosocial Factors in Eastern Europe study which included urban centres in Poland, Russia and the Czech Republic. High LBAS scores occurred in only 25 % of all subjects with the lowest scores from the Russian cohort[55]. When compared with the T-MDS, 2005, the LBAS demonstrated greater odds reduction of all cause and cardiovascular mortality[55].

Scoring systems for specific use in the UK

The PyrMDS scoring system used a different approach than T-MDS and is based on the 2011 MedD pyramid recommendations to assess MedD adherence in the UK, EPIC-Norfolk prospective cohort (Tables 3 and 5)[56]. A new scoring system, the New Dietary Strategies Addressing the Specific Needs of Elderly Population for Healthy Aging in Europe (NU-AGE) Index, was developed to assess MedD like intake patterns in a year-long intervention study in older adults throughout Europe (Tables 3 and 5)[57,58]. Similar to the Alternative Healthy Eating Index[59], the NU-AGE Index uses a continuous scale (0–10) for sixteen food items, which is a different approach than other MedD scoring systems[57]. PyrMED, Nu-AGE Index and LBAS used pre-determined cut-offs for assigning points within the scoring systems; these studies demonstrate utility for populations outside of the Mediterranean region.

Australia

As the original associations between the MedD and health expanded, so too did research and assessment outside of

British Journal of Nutrition

European countries. Some studies applied scoring systems developed in Mediterranean countries, while others developed new MedD adherence tools.

Application of previously developed scoring systems

An early assessment of the MedD in 1999 was conducted in Melbourne with application of the T-MDS, 1995 (energy adjusted) to FFQ dietary data from Anglo-Celt Australian and Greek-Australian older adults[60]. Eighty-one percentage of the Greek-Australian sample had four of eight possible points, whereas only 28 % of the Anglo-Celt Australians reached that level of MedD adherence[60]. In 2011, the Melbourne Collaborative Cohort Study applied the T-MDS, 2003 with olive oil instead of the MUFA:SFA ratio to measure MedD adherence[61]. More recently, the MEDAS was also applied in a Australian randomised controlled trial[37].

Scoring systems for specific use in Australia

Two new scoring systems were developed in Australia (see Tables 3 and 5). The fifteen-point MedLey tool was used to monitor dietary changes over the course of a 6-month intervention study[62]. Additionally, in 2018, the MedD and Culinary Index (MediCul) was developed for self-report of Australian adults and older adults and includes food groups as well as dietary and lifestyle behaviours[63,64]. Lifestyle questions included home gardening, frequency of cooking main meals at home (alone and with others) and daytime napping habits[63].

Asian countries

MedD scoring systems have been adapted to Chinese, Korean, Japanese and Iranian food culture. Most have applied either the T-MDS or aMed, although one new tool was developed for assessing MedD in Japan.

Application of previously developed scoring systems

The first international study assessing the MedD in those with Asian heritage involved Chinese cohorts from four different geographic locations: a rural area of southern China, Hong Kong, San Francisco and Sydney[65]. The dietary intakes, assessed via a validated FFQ, were applied to an eight-component MedD scoring system first used by DeGroot and colleagues in Greece (Table 5)[13]. The Chinese cohorts who were older had higher rates of adherence; these rates were even higher than some findings in Greece[65]. The aMed or T-MDS has also been applied in Chinese populations with mixed results on chronic disease outcomes[66–70]. These differential findings are possibly due to differences in dietary patterns of older and younger adults and geographic location of the population (urban/rural, mainland or Singapore Chinese heritage)[65].

A large epidemiological study of the Korean population applied principles of the aMed score to develop a Korean-modified MedD score[71]. Some of the food groups were modified, and foods included within the groupings reflected Korean dietary intakes (Table 5). Specifically, the MUFA:SFA ratio was removed due to lack of information on the fatty acids of foods in the Korean diet[71]. Even with the removal of a key MedD feature, higher Korean-modified MedD scores associated with lower prevalence of the metabolic syndrome, abdominal obesity and hypertriacylglycerolaemia[71].

The Okinawan people of Japan are known for longevity, and the traditional Okinawan diet is a prominent factor in that longevity; in fact, the diet shares similarities with the MedD pattern[72]. The T-MDS, 2005 was applied to data from adults in the Japanese annual nationwide nutrition survey (Table 3 and 5), and results showed that the T-MDS, 2005 did not correlate with the Japanese dietary recommendations but that MedD adherence significantly increased with age[73]. The Japanese-modified T-MDS, 2005 did associate positively with a number of beneficial food groups and nutrients and was inversely associated with total and LDL-cholesterol but no other measures of cardiometabolic risk[73].

Scoring system for specific use in Asia

A specific Japanese MedD scoring system reflects MedD pyramid recommendations as well as Japanese intake patterns and was shown to be inversely associated with obesity[74]. The components of the Japanese MedD scoring system can be found in Table 5.

Mexico and South American countries

Application of previously developed scoring systems

A study of middle-aged women in Mexico applied the T-MDS, 2003, with the addition of sweets and sugar products[75]. The Sahrai *et al.*'s study labelled the MedD scoring system as 'aMed', which is typically the abbreviation used for Fung's modifications of the T-MDS, 2003. However, this study did not use the Fung modifications as dairy products were included as a negative factor and fruits and nuts were grouped together. Instead, the changes were based on Wu and colleague's modifications to the T-MDS, 2003, see Table 5[76]. The inclusion of the specific foods within these food groups (i.e. white flour products, rice, pasta, baked goods) likely made a meaningful difference as the Wu-modified T-MDS, 2003 score associated with lower waist circumference and waist:hip ratios in Mexican women[75]. In 2020, the MEDAS scale was carefully translated and applied in Brazilian Portuguese-speaking adults (Table 2)[40].

Scoring systems for specific use in Chile

Leighton and colleagues developed a MedD scoring system that applied the principles of the traditional MedD with customary Chilean food practices[77]. The graded scoring system reflected a gradual increase in MedD scores over the 12-month study and improved metabolic syndrome markers[77]. The Chilean MedD Index is a slightly modified version from that of Leighton and colleagues[78]. This score preserved the integrity of the MedD while including cultural practices in Chile. Likeness of the two geographic regions may influence some of the easily applicable aspects of the MedD to the Chilean diet[79].

Table 3. Mediterranean diet scoring systems in non-Mediterranean countries

Continent, country	Author/date	Scoring system	Population	Study type for initial calculation	Dietary assessment methodology	Cut-offs	Score range
Europe	Tong/2016[56]	PyrMDS	EPIC-Norfolk (UK). Men and women (*n* 25 639) 40–79 years at baseline between 1993 and 1997.	Cohort study	FFQ, prior year	Continuous scoring from 0 to 1 for 15 food groups, accounts for overconsumption	0–15
	Jennings/2019[57]	NU-AGE Index	NU-AGE (*n* 1142) 5 European countries: Italy, UK, Netherlands, Poland, France.	RCT	7-d food diaries	Continuous scoring of 16 dietary components between 0 and 10.	0–160
Australia	Davis/2017[62]	MedLey 15 point MedD tool	Australian RCT (*n* 166)	RCT	3-d weighted food records	Group-specific baseline mean, 0 or 1 point each for 15 food intake questions	0–15
	Radd-Vagenas/2018 (a)[63](b)[64]	MediCul	Australian (a) Older adults, MCI Cohort (*n* 68)/(b) Middle aged and older adults (*n* 84)	Cross-sectional validation study, two time points.	Self-Administered 50-question paper survey for past 6 months of dietary intake, at least 1 week apart.	Frequency and amount of intake for foods and dietary behaviours, score for each food group varied.	0–100
Asia	Woo/2001[65]	8 category Mediterranean score	Four cohorts of Chinese individuals: rural village outside of Pan Yu-southern china (*n* 153), Hong Kong (*n* 1001), Sydney Australia (*n* 168), San Francisco, CA USA (*n* 358).	Cohort Study	Population-specific FFQ over 7 d	1 point for meeting predetermined intake criteria for 8 food groups based on g/d	0–8 for men, 0–7 for women.
	Chan/2013[66]	T-MDS	Chinese older adults (2000 men, 2000 women) >65 years in Hong Kong	Cohort study subsample.	FFQ, prior year/T-MDS, 2003 methodology	Sex-specific medians and alcohol cut-offs	0–9
	Kanauchi/2016[74]	jMD	Japanese men and women (*n* 1048) from 8 work settings and a university.	Cross-sectional study	Self-administered diet history questionnaire	1 point for meeting recommended amount based on MedD pyramid, otherwise 0.	0–13
	Kim/2018[71]	Modified MDS based on Fung's aMed	Korean National Health and Nutrition Examination Survey 2012–2015. Adults 19–67 years (*n* 8387)	Cross-sectional study	Korean FFQ/modified aMed methodology	Sex-specific medians and alcohol cut-offs	0–9
	Murakami/2019[73]	T-MDS, 2005 Japanese application	Annual Japanese nationwide nutrition survey (*n* 6552 men and 9066 women)	Cross-sectional national study	1-d weighted household dietary record/T-MDS, 2005 methodology	Sex-specific medians and alcohol cut-offs	0–9
South America	Leighton/2009[77]	Chilean Med diet score	12 month intervention study at a worksite in Chile (*n* 145)	Pragmatic Intervention Trial	Nutritionist interviewed questionnaire (direct participant responses)	0,0·5, or 1 point for specific serving sizes	0–14
	Echeverria/2017[78]	Chilean-MDI	Nationwide self-selected sample of internet users in Chile (*n* 24 882)	Cross-sectional study	Self-reported 22 MedD questions via internet survey	0,0·5 or 1 point for specific serving sizes	0–14
USA	Fung/2006[53]	aMed	Nurse's Health Study. (*n* 71 058 women)	Cohort study	Harvard FFQ, prior year/T-MDS methodology	Sex-specific medians and alcohol cut-offs	0–9
	Rumawas/2009[93]	MSDPS	Framingham Heart Study Offspring Cohort (*n* 3021)	Cohort study	Harvard FFQ, prior year/based on MedD pyramid and accounts for overconsumption and non-traditional MedD foods	Continuously scaled for 13 food components based on % of intake	0–100

Table 3. (*Continued*)

Continent, country	Author/date	Scoring system	Population	Study type for initial calculation	Dietary assessment methodology	Cut-offs	Score range
	Wu/2009[76]	Modified T-MDS	Breast cancer case–control study in Asian Americans (*n* 1248 cases, 1148 controls).	Cohort study	Multiethnic Cohort Study FFQ/based on T-MDS, 2003 methodology, energy adjusted (g/1000 kcals)	Median intake	0–10
	Mattei/2017[88]	T-MDS	Boston Puerto Rican Middle aged and older adults, *n* 1194	Cohort study	FFQ, prior year/energy-adjusted T-MDS, 2003 methodology	Sex-specific medians and alcohol cut-offs	0–9
	Yang/2014[96]	mMedD score	Male fire fighters (*n* 780) from Midwest.	Cross-sectional study	Self-reported lifestyle questionnaire with Med diet components	0–4 point scale based on serving sizes and frequency of intake	0–42
	Steffen/2014[90]	mMedD score based on T-MDS	CARDIA study, 18–30-year-olds at baseline (*n* 4713)	Cohort study	Interviewer-administered diet history questionnaire/modified from T-MDS, 2003	Sex-specific medians and alcohol cut-offs	0–19
	Cerwinske/2017[99]	MEPA	18–79-year-old employees (*n* 21) and patients (*n* 49) at a University Medical Center, Chicago, IL.	Cross-sectional validation study	MEPA direct assessment screening tool (self-reported)	1 point for meeting pre-determined food group serving sizes and frequencies, otherwise 0 point.	0–16
	Sotos-Prieto/2019[97]	mMDS	"Feeding America's Bravest" Study firefighters from Indianapolis, IN (*n* 420)	Cross-sectional baseline data from RCT	Self-reported mMDS and lifestyle questionnaire	0–4 score for 13 food domains, 0–2 for alcoholic beverages and 0–5 for two questions on type of oil.	0–51
	Weaver/2020[100]	MEPA-III	Parkinson's disease patients (*n* 42)	Cross- sectional validation study.	MEPA direct assessment screening tool (self-reported)	1 point for meeting pre-determined food group serving sizes and frequencies, otherwise 0 point. 21 item survey	0–21
	Lan/2020[98]	MEDI-Lifestyle	New England Firefighter recruits in a fire academy. (*n* 92)	Cross- sectional validation study.	Self-reported MEDAS and lifestyle questions with pre-determined	7 dichotomously assessed items with pre-determined lifestyle behaviour cut-offs.	0–7

PyrMDS, Pyramid-based Mediterranean Diet score; NU-AGE, New Dietary Strategies Addressing the Specific Needs of Elderly Population for Healthy Aging in Europe; MediCul, MedD and Culinary Index; T-MDS, Trichopoulou-Mediterranean Diet Scale; jMD, Japanese MedD Score; aMed, alternate Mediterranean Diet Scale; MDI, MedD Index; MSDPS, Mediterranean-Style Dietary Pattern Score; MedD, Mediterranean diet; mMedD, modified MedD; BPRHS, Boston Puerto Rican Health Study; mMedD, modified MedD; MEPA, Mediterranean Eating Pattern for Americans; RCT, randomised controlled trial; MCI, mild cognitive impairment.

Table 4. Mediterranean diet scoring system food components from US studies

Components	aMed[53]	MSDPS[93]	Modified T-MDS[76]	BPRHS, T-MDS Mattei[88]	mMedD, Steffen[90]	mMedD, Yang[96]	mMedD, Sotos-Prieto[97]	MEPA[99]	MEPA-III[100]
Breads/starches	0	0	–*	0	0	–†	–†	0	0
Cereals/grains	0	0	+	0	–‡	0	0	0	0
Whole grains (bread/cereals)	+	+	0	+	+	+	+	+	+
Potatoes	0	M	0	0	0	0	0	0	0
Vegetables	+§	+	+	+	+	+	+	+‖	+‖
Fruits	+	M	+¶	+	+**	+	+	+††	+††
Nuts	+	0	0	0	+	0	+	+	+
Legumes	+	0	+	0	+	0	+	+	+
Legumes and nuts	0	M‡‡	0	+	0	0	0	0	0
Olive oil	0	+§§	0	0	0	+	+	+	+
Avocado	0	0	0	0	0	0	0	0	+
Butter/cream	0	0	0	0	0	0	0	–	–
Dairy and dairy products	0	–	–	–	–	0	0	–‖‖	+¶¶, –‖‖
Fish/seafood	+	+	+	+	+	+	+	+	+
Eggs	0	M	0	0	+	0	0	0	0
Meat or meat products	0	–	–	–	0	0	0	0	0
Red and processed meat	–	0	0	0	–	0	0	–	–
White meat (Poultry)	0	M(P)	0	0	+(P)	0	0	-(P)	-(P)
Moderate alcohol	+	0	–	+	+	+	+	+	+
Moderate wine	0	+	0	0	0	+, –***	+, -***	0	0
MUFA:SFA ratio	+	0	+	0	+†††	0	0	0	0
SSB	0	0	0	0	–‡‡‡	–	–	0	–
Sweets	0	M	0	0	0	–	–	–	–
Sauces	0	0	0	0	–	0	0	0	0
Fast foods	0	0	0	0	0	–	–	–	–
Snacks	0	0	0	0	–	0	0	0	0
Coffee and tea	0	0	0	0	+	+	+	0	0
Unsweetened beverages	0	0	0	0	0	0	0	0	+
Pre-packaged foods	0	0	0	0	0	0	0	0	–
Fried foods	0	0	0	0	–§§§	–	–	0	0

aMed, alternate Mediterranean Diet Scale; MSDPS, Mediterranean-Style Dietary Pattern Score; BPRHS, Boston Puerto Rican Health Study; T-MDS, Trichopoulou-Mediterranean Diet Scale; MedD, Mediterranean diet; mMedD, modified MedD; MEPA, Mediterranean Eating Pattern for Americans; SSB, sugar-sweetened beverages; M, Moderation. + included in score as beneficial component; – included in score as negative component; M included in score as moderate intake with upper and lower intake cut-offs; 0 not included in score.

* Total CHO.
† White bread/starches.
‡ Refined grains.
§ Excluding potatoes.
‖ And green leafy vegetables.
¶ And nuts.
** And fruit and vegetable juice.
†† And berries.
‡‡ And olives.
§§ Only oil used.
‖‖ Full fat cheese/cream cheese.
¶¶ Milk and yogurt.
*** Beer.
††† MUFA + PUFA:SFA.
‡‡‡ Diet beverages.
§§§ Fried vegetables.

Table 5. Mediterranean diet scoring system food components in non-Mediterranean countries

	Europe		Australia		Asia					South America	
Components	PyrMDS[56]	NU-AGE Index[57]	MedLey Tool[62]	MediCul[63]	8 category MedD score[65]	MDS, Chan[66]	jMD[74]	Modified aMed[71]	T-MDS, Japan[73]	Chilean MedD score[77]	Chilean-MDI[78]
Breads/starches	0	0	+	0	0	0	+*	0	0	0	0
Cereals	M	0	+	0	+	+	0	0	+	0	0
Whole grains (bread/ cereals)	0	M	0	+	0	0	0	+	0	+	+
Potatoes	–	0	–	0	0	0	M	0	0	0	0
Vegetables	+	+	+	+	+	+	+	+	+	+†	+†
Fruits	M	+	+	+	+	+‡	+	+	+‡	+	+
Nuts	M	+	+	+	0	0	0	0	0	0	+
Legumes	+	+	+	+	+	+	+	+	+§	+‡	+
Canola oil/vegetable oils	0	0	0	0	0	0	0	0	0	+/M	+
Olive oil	+‖	+	+	+	0	0	0	0	0	+	+
Avocado	0	0	0	0	0	0	0	0	0	+	+
Dairy and dairy products	M	0	–	–	–	–	M	+	–	0	0
Full-fat dairy products	0	0	0	0	0	0	0	0	0	–¶	–¶
Low-fat dairy products	0	+	0	0	0	0	0	+	0	+**	+**
Fish	+	+	+	+	0	+	+	+††	+	+	+
Eggs	M	+	–	–	0	0	M	0	0	0	0
Meat or meat products	0	0	0	0	–	–	–	0	–	0	0
Red meat	–	0	–	–	0	0	0	–	0	0	0
Processed meat	–	0	0	–	0	0	0	–	0	–‡‡	–‡‡
Lean meat (Poultry)	0	+(P)	0	0	0	0	0	0	0	+	+
White meat (Poultry)	M	0	–	–	0	0	M	+	0	0	+(P)
Moderate alcohol	+	+	0	+	+	+	+	+	+	0	0
Moderate wine	0	0	+§§	0	0	0	0	0	0	+	+
MUFA:SFA ratio	0	0	0	0	+	+	+	0	+‖‖	0	0
SSB	0	0	–	–	0	0	0	0	0	0	–
Sweets	–	0	–	–	0	0	–	0	0	0	0
Added sugar/high sugar	0	–	–	0	0	0	0	0	0	–	–
Fast foods	0	0	0	–	0	0	0	0	0	0	0
Salt at meals	0	–¶¶	0	0	0	0	0	0	0	0	0
Coffee and tea	0	0	0	+	0	0	0	0	0	0	0

PyrMDS, Pyramid-based Mediterranean Diet Score; NU-AGE, New Dietary Strategies Addressing the Specific Needs of Elderly Population for Healthy Aging in Europe; MediCul, MedD and Culinary Index; MDS, Mediterranean Diet Scale; jMD, Japanese MedD Score; aMed, alternate Mediterranean Diet Scale; T-MDS, Trichopoulou-Mediterranean Diet Scale; MedD, Mediterranean diet; MDI, MedD Index; SSB, sugar-sweetened beverages; M, Moderation. + included in score as beneficial component; – included in score as negative component; M included in score as moderate intake with upper and lower intake cut-offs; 0 not included in score.

* All grains.
† Excluding potatoes.
‡ And nuts.
§ And pulses.
‖ Primary lipid.
¶ Not fermented.
** Or fermented.
†† And peanuts.
‡‡ And fatty meats.
§§ Red wine.
‖‖ MUFA + PUFA:SFA.
¶¶ Salt in general.

Canada

Application of previously developed scoring systems

In 2019, the MEDAS tool was adapted for use in a Canadian cardiac rehabilitation programme[41]. The original MEDAS (interviewer-administered) was compared with a self-administered version with sample pictures of portion sizes and food examples relevant to the typical Canadian diet. Psychometric validation of the MEDAS tool in this population verified internal consistency, reliability and criterion and construct validity[41].

Scoring systems for specific use in Canada

A French–Canadian group developed a MedD scoring system to determine adherence to a MedD intervention in mid-aged women based on the Oldways MedD pyramid[80]. This tool reflected changes in intake for MedD adherence and cardiometabolic markers[80].

USA

Most of the research on the MedD and health in North America has been conducted in the USA.

Application of previously developed scoring systems

The aMed is the most widely used MedD scoring system for epidemiological purposes in the USA and has demonstrated associations with all-cause mortality, obesity, heart disease, cognitive impairment and cancer[53,54,81–84]. MedD assessment in US cohort studies is often accompanied by other dietary pattern assessments (i.e. Healthy Eating Index (HEI) or Alternative Healthy Eating Index). The comparisons between dietary patterns often demonstrate superior risk reduction from HEI or Alternative Healthy Eating Index compared with aMed. HEI and Alternative Healthy Eating Index include refined grains, added sugars and saturated fats for limited intake; these scores also have a wider scoring range (0–100) compared with the 0–9 score range for aMed. One reason the aMed may not demonstrate similar risk reduction may be due to the narrow score range and inadequate inclusion of food components that are typically seen in Western diets.

The MedDietScore[23,24] was applied to the Chicago Health and Aging Project[85], Memory and Aging Project[86] and the Building Research in Diet and Cognition[87] study with grams of intake translated to serving sizes. These studies have cognition outcomes with Chicago Health and Aging Project and Building Research in Diet and Cognition focusing on urban African American older adults[85,87]. While the MedDietScore does not measure intake of non-Mediterranean foods, it provides a graded scale to reflect dietary changes in an intervention study.

Some epidemiological studies that focus on the health of racial and ethnic minorities in the USA have assessed diet by modifying the T-MDS or aMed to capture study population usual intakes (Table 3 and 4)[76,88,89]. The CARDIA study, for example, assessed MedD adherence with a modified MDS (mMDS) calculated based on the T-MDS, 2003 and aMed[90]. Even with relatively similar total energy intakes, participants with lower mMDS scores had more than two servings of snack foods (high in solid fat and/or added sugar) compared with those with a higher mMDS[90]. A recent CARDIA publication applied the MedDietScore from FFQ data with the MUFA:SFA ratio replacing olive oil. Regardless of the scoring system used, those with higher MedD adherence in the CARDIA study at baseline were more likely to be white and more physically active[90,91]. A complete assessment of MedD adherence in racial and ethnic US minorities is beyond the scope of this review but has been previously addressed by Sotos-Prieto & Mattei[92].

Scoring systems for specific use in the USA

Scoring systems developed in the USA account for non-traditional MedD foods and behaviours in different ways (Table 4). The MSDPS is based on MedD pyramid recommendations, accounts for overconsumption of foods, includes Mediterranean and non-Mediterranean food intake and is continuously scaled[93]. While this scoring system attempts to remove the limitations of prior MedD adherence scores for a non-Mediterranean population, it is a complex calculation that, to date, has only been applied by one group outside of the original application studies[94,95].

A modified MedD score was developed specifically for the lifestyle of US firefighters (Tables 3 and 4); this scoring system included graded points (0–4) and non-traditional MedD foods[96,97]. Another scoring system, MEDI-Lifestyle, focused on lifestyle factors[98]. The MEDI-Lifestyle assessed diet with the MEDAS (total score weighted as one component) along with six other lifestyle questions including non-smoking, weight control (BMI $\leq 30\ kg/m^2$), physical activity, limited television viewing, adequate sleep and napping, all one point each[98]. Lifestyle assessments of conviviality and culinary activities, unique features of the traditional Mediterranean lifestyle, were not included. Similar to findings on MedD scoring systems, the individual lifestyle factors did not inversely associate with hypertension risk, but the synergistic MEDI-Lifestyle score did demonstrate reduced risk[98]. This further exemplifies the important consideration of a healthy lifestyle rather than a limited number of healthy activities. Application of the modified MedD scores and MEDI-Lifestyle to different populations will require adaptation as some questions specifically ask about food intake and behaviours at the firehouse or at home.

A short Mediterranean-like diet pattern screening tool, the Mediterranean Eating Pattern for Americans (MEPA), was developed for use in the USA that can be delivered electronically or via phone[99]. Food groups include those typically found in MedD scoring systems with some specificity and intake amounts that reflect the typical American diet (Tables 3 and 4). MEPA-III added five more components; some food components are provided in more detail and/or had altered serving size cut-offs for point values[100]. The self-administered MEPA-III was shown to have concordance with FFQ-derived MEPA-III foods and total scores, as well as construct validity and acceptability in an older sample of Parkinson's disease patients[100,101]; acceptability and application of MEPA-III in a more racially and ethnically diverse sample of adults are warranted.

Comparisons between and across Mediterranean diet scoring systems

The ability to compare MedD adherence within and across countries and populations on a broad scale is difficult because of the

many choices in scoring systems and adaptations made for use in specific populations, cultures and countries. Some studies have directly compared different scoring systems in the same population or used the same scoring system to compare different populations, as described below.

Comparing the same Mediterranean diet scoring system across different populations

Comparison of the same tool across different populations has occurred using the MEDAS and MDSS. The MEDAS was assessed in adults from five Mediterranean countries and two Balkan countries (Greece, Portugal, Italy, Spain, Cyprus, Republic of North Macedonia and Bulgaria) on two occasions using direct self-report and compared with a 3-d food record[36]. This study found highest adherence in the Spanish population, where the assessment tool was originally developed, with lowest adherence from Macedonia and Bulgaria. The lowest level of agreement between 3-d food records and the MEDAS was in the Balkan countries, while Greece had the highest level of agreement[36]. The MDSS was compared in Spanish, Moroccan and Palestine adults[102]. Dietary intake was assessed using three 24-h recalls, country-specific validated FFQ and the MDSS. There was no significant difference in MDSS scores between the countries; however, significant nutrient and food group differences did occur. Vegetable and nut intake was below recommendations and meat intake (white and red) above recommendations in all three countries with Palestine and Moroccan adults consuming significantly more than Spanish adults[102]. These findings highlight the importance of examining food components, not just the total score, when making cross-cultural assessments to interpret how different cultures may be adhering to MedD recommendations. For instance, high meat intake is a cultural norm in many non-Mediterranean countries and is a hurdle to address when designing and implementing MedD intervention studies and recommendations outside the Mediterranean region[103].

Comparing Mediterranean diet scoring systems within the same population

Aoun and colleagues compared five different MedD scoring systems: the T-MDS, 2003[15], MedDietScore[24], Chilean MedDietScore[77], Short MedD questionnaire[45,104] and MedD pattern score[105] in Lebanese adults using data and food groups extrapolated from the same FFQ. The scores positively correlated with one another; agreement was highest between (1) the T-MDS, 2003 and MedDietScore and (2) the T-MDS, 2003 and Short MedD questionnaire[106]. There was a high degree of non-adherence, regardless of the scale used, and no scale was associated with BMI[106]. Naja and colleagues compared the Lebanese MedD Index with the EPIC-T-MDS[22] and MedD scoring systems that were representative of four Mediterranean countries: Greece (MedDietScore[23]), Italy (Italian-TDS[44]), Spain (r-Med[27]) and France (MedD Quality Index[107]). Fruits, vegetables and olive oil were the common factors included in all scales tested; fish was included in all scales except the Lebanese MedD Index[48]. Lipids were assessed differently by region of origin. The French and Lebanese scales included cholesterol and SFA, while the ratio of MUFA:SFA was used in the Spanish, Greek, Italian and EPIC scales[48]. Both Lebanese-based studies found that older participants reported greater adherence to the traditional MedD.

A short (nineteen open-ended questions) food intake survey for Greek adults was used to test the T-MDS and MEDAS, compared with T-MDS derived from FFQ dietary data to determine if a shorter overall dietary assessment tool could be used in place of the FFQ in epidemiological studies[108]. The FFQ-T-MDS estimated intake using g/d, whereas the shorter food intake survey used servings/d. The two T-MDS scoring systems were moderately correlated ($r_s = 0{\cdot}31$) and even less with MEDAS ($r_s = 0{\cdot}23$)[108].

Two comparisons of different MedD scoring systems were assessed in Spanish populations, one in a healthy young undergraduate sample of Spanish students and the other from the control group of the Multi-Case Control study of Spanish adults[109,110]. The Spanish young adult study used dietary data from a FFQ to calculate ten MedD scoring systems. Most of the scoring systems were in fair agreement with one another ($r_s = 0{\cdot}5$–$0{\cdot}7$) and satisfactorily measured MedD adherence[109]. Using factor analysis, fruits, vegetables and the MUFA:SFA ratio strongly correlate with the MedD factor[109]. More recently, Olmedo-Requena and colleagues found similarly moderate correlations between five scoring systems in a sample of Spanish adults[110]. Data from all scales tested (T-MDS, 2003, aMed, rMED, MedDietScore and LBAS) were normally distributed; however, the MedDietScore's distribution showed higher variability, likely due to the wider scoring range[110].

The first assessment of multiple MedD scoring systems outside of the Mediterranean region was from the UK, EPIC-Norfolk prospective cohort study using four MedD assessment methods (T-MDS, 2005, LBAS, rMED and PyrMDS)[56]. The T-MDS, 2005 used median intake cut-offs and a 0–9 point range, rMED used tertile cut-offs with a 0–18 point range, LBAS used literature-based serving size cut-offs with a 0–18 point range and PyrMDS used MedD pyramid recommended intakes with a 0–15 point range. The PyrMDS included more food groups than the other scoring systems and had the strongest association with CVD outcomes[56]. All scoring systems had fair to moderate correlations with one another. The lowest correlation was between T-MDS, 2005 and PyrMDS ($r_s = 0{\cdot}53$), while the highest correlation was between T-MDS, 2005 and rMED ($r_s = 0{\cdot}81$), the latter correlation only differed in cut-offs[56]. Comparisons of MedD scoring systems applied to countries outside of Europe and the Mediterranean basin are needed to critically assess components of MedD scoring systems to provide empirical evidence for choosing which foods and food groups are most important in these scoring systems to strengthen this body of literature.

Considerations for application of Mediterranean diet assessment tools

There is no single measure to assess adherence to the MedD (as demonstrated above) which is not surprising considering the various approaches taken in following the MedD across the globe. However, this non-conformity and flexibility also bring significant variability to the measurement tools developed for MedD assessment. Scoring systems vary in the number of components, component categories, measurement scales, statistical

parameters used for cut-offs and the positive, negative or moderate contributions components have to the total score.[109]

Dietary measurement is strengthened when using standardised, validated tools. However, a limitation of the current MedD literature is the different scoring systems used, many of which lack full validation and reproducibility, as discussed in a comprehensive review by Zaragoza-Martini and colleagues[20]. This section considers dietary assessment methodology, the foods included (or excluded) in scoring systems, non-MedD patterns, lifestyle components, geography and differences in foods and food preparation, clinical application of scoring systems, and last, challenges and opportunities for MedD scoring system application.

Methodological challenges in dietary assessment

Most MedD scoring systems calculate dietary pattern adherence from dietary data collected from FFQ, a few use diet records or 24-h recalls. The reported intake of individual foods is grouped into food categories that are then applied to the dietary pattern scoring system calculation. The multiple step process of applying dietary pattern scoring systems can add a potential source of bias or error. When publishing dietary pattern scoring systems, the foods assigned to each food group and the groups included for the specific analysis should be included with supplementary material to limit this area of potential bias and to allow for more uniform cross-study assessments. The FFQ, the most commonly used dietary assessment method in epidemiological research, is limited by recall and estimation difficulty for usual intake over a long period of time; limited detail for preparation, mixed foods or home-made and store-bought options; and under- or over-reporting[111–113]. Some of the limitations are reconciled when extremely low or high dietary energy estimates are removed from the analysis. Study-specific alterations for MedD scoring systems are sometimes needed based on available dietary and lifestyle data. For instance, when FFQ dietary data from large US cohort studies were applied to the MEDAS, there was not available information for two of the questions, so instead of a fourteen-point scoring system, the MEDAS was reduced to a twelve-point scoring system for this application[43]. Additional areas for consideration are the application of energy adjustments, units of intake, population-based cut-offs and advances in dietary assessment technology.

Energy adjustment is recommended for comparing diet–disease relationships[113]. However, the use of energy adjustment and units of intake is applied inconsistently in MedD scoring systems. Interestingly, the Spanish application of T-MDS, 2003 from FFQ or 24-h recall dietary data found that MedD adherence had similar agreement and no proportional bias in energy-adjusted and non-energy-adjusted scores[25]. Both energy-adjusted and non-energy-adjusted MedD adherence can be found in the available literature. Serving sizes are typically used to self-report dietary intake, while g/d is an option when MedD scores are determined indirectly from other dietary assessment methods. Some argue for the simplicity and accuracy of the cut-offs for scoring using g/d[108], while others point out limitations of this use[114].

MedD scoring systems are calculated from indirect (FFQ, 24-h recalls or diet record data) or direct self-report questioning to determine adherence. The MedDietScore, although first developed using FFQ data, has been applied in a direct questioning format as have the LBAS, MediCul and MEPA-III scoring systems[52,63,87,100,115]. Alternatively, MEDAS was not only developed for use in an interview or direct self-report format but has also had dietary data applied indirectly from other assessment methodologies[36,43,108]. The low or moderate correlations observed when comparing different scoring systems, even in the same population, highlight the inherent issues when applying dietary data from different assessment methods to scoring systems, even in the same population[108].

Cut-offs, component scoring and total score are also inconsistent throughout the MedD literature. The T-MDS and aMed use median cut-offs from each study sample (in g/d or serving sizes), and the T-MDS modifications have applied tertiles as cut-offs, while other studies have used MedD pyramid recommendations or literature-based median or tertile cut-offs. The use of population-dependent, sex-specific cut-offs (median or tertiles) has resulted in vastly different food group median intakes[51] and difficulty in cross-study comparisons. Application of MedD pyramid recommended intakes for cut-offs has increased in the last few years, and this has, unfortunately, added to the variability in scoring components. Some scoring systems use weighted or graded scoring (MDSS[29], mMDS[96,97], Chilean MDI[78]), while others use 0 or 1 point for meeting the recommendation or not (MEDAS[32], MEDLIFE[30], MEPA[99,100], Japanese MedD scoring system[74]). Alternatively, some scoring systems use continuous scales (MSDPS[93], PyrMDS[56], NU-AGE Index[57]) or variable frequencies of intakes (MediCul[63,64]). Even when using the same cut-off methodology, some studies with tertiles use 0–2 points, while other apply 1–3, creating a 0–18 or 9–27 scale range. Finally, the total score and number of components within a scoring system can alter the weight of each individual component. Some scoring systems have added or removed items to accommodate cultural differences, this practice limits cross-cultural and cross-country comparisons and should be limited moving forward. Scoring systems with more components place less weight on each individual component, whereas scoring systems with fewer components have more weight from each individual component. For instance, weight of each food component in the T-MDS is 1/9th, whereas a score with more factors such as the MEDAS with 14 or the MEDLIFE with 26 has less weight for each individual component (1/14th and 1/26th, respectively). The influence of a score's individual component quantity on total score or nutrient values and health outcomes is unknown.

The application of smartphone and other technology to assess dietary intake has recently been applied to the MedD[116]. The methodological intricacies and appropriate calculation of amount ingested require further validation studies[117], but it is a promising new approach[116]. This application is best suited for use in intervention trials or clinical practice, as it is designed to provide real-time feedback for meeting food and nutrient intake goals.

Inconsistencies in food components of Mediterranean diet scoring systems

Some food components are largely universal in all scoring systems, while others may or may not be included at all or may differ in the way in which they are included. Tables 3, 4 and 5 include

an extensive list of scoring systems, with the food components listed as to whether they are considered as positive, negative or moderate contributors to MedD adherence. Even the universal MedD scoring system components, fruits and vegetables, have some variability. For instance, in some scores, the fruit group includes nuts, but most separate the two, or only include fruits. Similarly, vegetables may or may not include potatoes. Potatoes are one of the more variable components, having been included as a separate negative component, as a separate moderate component, in the grains/cereals category, or not at all. Grains are a consistent component of a MedD but are included in different ways depending on the scoring system. The term 'cereals' was first used and since then has been reframed to include only whole-grain cereals in many of the updated scoring systems, while others differentiate between whole grains and refined grains or total carbohydrates. One of the more widely used scoring systems, MEDAS, does not include cereals or grains but does include commercial pastries as a negative component.

The MedD pyramid recommends moderate intake of a variety of protein sources including legumes, fish, poultry, nuts, seeds and eggs with limited red and processed meat. There are variations in the way meat is included in scoring systems. Red and/or processed meat is consistently scored as a negative component. The original T-MDS, 1995 did not include fish, although now it is considered a consistently positive component of scoring systems. Legumes are included in most scoring systems as nuts, which are sometimes included with fruits. Nuts have also been grouped with olives[30], with legumes[47], or all three combined[93]. Most scoring systems include all nuts into the nuts category; the type of nut included largely depends on the geographic and cultural preferences of the study population. The Feeding America's Bravest study, for example, specifically excludes peanuts and peanut butter from its intervention and scoring[118], while the Korean adaptation of the aMed score included peanuts with fish as one of the beneficial food groups[71].

Unsaturated fat intake is one of the hallmarks of the MedD. The original T-MDS, 1995/2003 included a lipid ratio (MUFA:SFA) which was slightly altered in the T-MDS, 2005 (PUFA + MUFA:SFA) to encompass all unsaturated fat intake. The lipid ratio, however, cannot be used in direct self-report scoring systems. MEDAS includes two questions regarding olive oil use and also butter, cream and/or margarine intake as a detrimental component[32]. In non-Mediterranean countries, some tools continue to use the lipid ratio, while others use olive oil or other dietary lipids. For instance, Chilean MedD scoring systems have multiple positive components for PUFA and MUFA to reflect that region's intake of vegetable, olive and canola oils, and avocado[77,78]. The inclusion of avocado as a healthy unsaturated dietary fat source was also included in the MEPA-III scoring system[100]; however, it was argued against when defining a traditional MedD[119].

Wine is a traditional MedD component; however, some regions of the world and cultures have very low wine or alcoholic beverage consumption. The intake of wine or alcohol in general is the one component, when included in the scoring system, that always has an upper limit. While moderate wine consumption with meals is a unique aspect of the Mediterranean lifestyle, there are cultural and religious differences around the world that preclude its inclusion in the adaptation of scoring systems.

Dairy products are a daily recommendation on MedD pyramids but is one of the more controversial components of MedD scoring systems due to the low intake in the Mediterranean region in the 1960s. Some include the measurement of dairy products but do so negatively, while others do not include measurement of dairy intake at all. Alternatively, low fat dairy or 'milk and yogurt' or 'fermented' dairy products are sometimes included as a positive component, with high-fat dairy or sweetened dairy as a negative component. This high variability in how dairy products are accounted for in MedD scoring systems adds difficulty in determining how to assess its contribution to the MedD pattern and health implications.

Sweets are at the top of the MedD pyramid, indicating that intakes should be limited; however, sweets were not considered at all in the early adoption of MedD scoring systems. The MAI was the first to include sweets in a scoring system from the Mediterranean region; this scoring system included SSB, sweet baked goods (cakes, pies, cookies) and sugar[120]. Sweets are more commonly included as a negative component in newly developed or modified scoring systems in the last decade or so as either a dietary behaviour, SSB or commercial baked goods and/or confectionary sweets. Findings from the PREDIMED study showed that high consumption of nuts and low consumption of SSB were dietary components from the MEDAS that had the strongest inverse association with abdominal adiposity[121]. This emphasises the importance of including non-traditional MedD foods in scoring systems.

There have been suggestions that the inclusion of key nutrients rather than specific food components may aid in the standardisation of the MedD and development of a universal MedD scoring system. While nutrient assessment may eliminate the differences in specific food components included in the MedD scoring system, it will also remove the extremely important, and often overlooked, lifestyle component. Further, foods in the MedD contain essential nutrients and bioactive constituents beneficial to human health (e.g., extra virgin olive oil, fruits, vegetables). Many of the bioactive constituents of MedD foods (i.e. polyphenols, carotenoids) are more difficult to measure and content differs by location and growing conditions. A potential solution may be the inclusion of both specific food components and key nutrients, thereby expanding the use of the MUFA:SFA ratio currently used in some MedD scoring systems to also include specific fibre and added sugar recommendations.

Non-Mediterranean diet patterns

A reality for many areas of the world is regular intake of fast food/take-away and fried foods. Fast-food consumption (restaurant fast food or pizza takeout) is a common dietary behaviour in the USA and Australia[122,123]; likewise, the intake of fast foods and ultra-processed foods is increasing worldwide[124]. Fast food/takeout and/or fried foods were added to scoring systems from some countries as a negative factor[64,90,96,97,99,100]. A recent report showed that high consumption of 'western diet components' such as fried foods, refined grains, sweets, red and processed meats, full-fat dairy and pizza attenuated the positive effect of the MedDietScore on cognition in older adults in the USA[125].

This study highlights the importance of assessing MedD components as well as foods that do not align with the MedD pattern.

The traditional MedD in Crete and southern Italy had little processed foods because they were not readily available in these regions until the 1960s. This has changed, and processed foods are now available in all industrialised countries. The Mediterranean region is in a period of nutrition transition where the culture of food and lifestyle are changing. MedD scoring systems need to be able to capture the traditional as well as non-traditional foods consumed to truly identify MedD adherence and potential health benefits.

Lifestyle/dietary behaviour assessment

Meal preparation and food pattern behaviours particular to the traditional MedD such as limited snacking, lunch as the largest meal of the day, and eating meals with others, as well as lifestyle behaviours such as physical activity are not captured by the majority of MedD scoring systems[114]. The MedD pyramid recommendations have always included physical activity as part of diet recommendations[7,8,10], but physical activity is not included in scoring systems. Epidemiological studies have consistently found that those with higher MedD adherence also report higher levels of physical activity[15,26,53,82,90]. The more recent MedD pyramid recommendations also include conviviality[8], as well as rest, culinary activities and sustainable habits[6]. Sustainability has taken on a more central role in the promotion of the MedD pyramid with the inclusion of the ecological impact of the pyramid's food choices[9]. Assessment of these factors of the Mediterranean lifestyle, together with diet and/or dietary lifestyle habits, is sparse but needed to help promote these behaviours as a Mediterranean lifestyle.

The MEDLIFE tool includes the most comprehensive lifestyle assessment. The original MEDLIFE tool publication included both a dietary habits section and lifestyle questions regarding physical activity and sleep from validated surveys[30]. In a second MEDLIFE publication applied to a different sample of Spanish adults, two questions were added to the dietary behaviours section: (1) 'do you prefer and consume seasonal and traditional local products, fresh and minimally processed foods?' and (2) 'do you prefer and consume with moderation trying to choose small portion sizes?'; two additional questions in the lifestyle section were also added: (1) 'how much time do you spend having lunch during weekdays?' and (2) 'do you usually eat in company (with family, friends, and colleagues)?'[31]. This was the first questionnaire to include all aspects of the MedD pyramid's lifestyle factors; however, these new questions could not be validated in comparison with other assessment tools because no one had ever asked such questions within a dietary survey before. This tool was applied to a working population in Croatia[126] and in the Feeding America's Bravest study of firefighters[127]. These studies, unfortunately, did not include the conviviality questions in the total MEDLIFE score. The MEDLIFE scoring system is specifically validated for working adults as the lifestyle questions differentiate between weekend and weekdays and would need modification for application to other populations. The MediCul scoring system included questions on snacking and meals cooked at home[63,64]. MEPA-III included use of pre-packaged meals as a negative factor[100]. Finally, lifestyle scores have been included with MedD scoring systems in two other instances in Greek and Italian studies[128–131]. While a total score including both lifestyle and diet was not integrated, there were associations between the lifestyle factors and MedD scores.

At this time, there is a gap in knowledge regarding the added health benefit when one or more lifestyle/dietary behaviour components (i.e., conviviality, rest, culinary activities, sustainability habits and physical activity) are incorporated with the food components of the MedD. Moreover, application of these lifestyle/dietary behaviour components, in combination with food components, is grossly lacking in the MedD scoring systems. The assessment of lifestyle practices and dietary habits affiliated with the traditional Mediterranean culture is needed, especially in assessments of younger adults and outside the Mediterranean region[9].

Geographic location and differences in food and food preparation

Agricultural practices, cultivar varieties, food procurement and preparation differ throughout the world and influence the content of nutrients found in key MedD food components[132]. Hoffman & Gerber exposed many issues with application of MedD assessment in a changing Mediterranean region as well as for non-Mediterranean countries[114]. Their review focused on foods, food production and food preparation differences in Mediterranean and non-Mediterranean countries. The geographic and cultural diversity in European countries from the EPIC study demonstrates some of the differences on the continent. In a Greek population, MUFA:SFA ratio is a proxy for olive oil intake; however, animal fat is a more common source of MUFA in the diet from northern EPIC countries[114]. In some updated applications of the T-MDS, the lipid ratio has been replaced by olive oil[26,27] but not others[53,54]. This dietary fat issue was eloquently discussed by deLorgeril who pointed out that SFA are found in many processed foods and the food sources of dietary fats should be considered, not just the lipid ratio and olive oil in order to modernise the MedD concepts for application to cultures and traditions outside the Mediterranean region[4].

Climate differences and seasonality are also a factor. For instance, within the EPIC study, northern countries had lower intakes of raw vegetables compared with the southern Mediterranean countries[133]. Indeed, a study of young adults in Cyprus and the USA found that the young adults from Cyprus reported seasonality and heat as a driver for intake of more salads and lighter fare[134]. Capturing seasonal differences in dietary data is often a challenge when asking subjects to report recent intake. Some studies have tried to address seasonality in dietary assessment for shorter time frames; the MediCul scoring system included a seasonal intake question, and a novel statistical model was applied to NU-AGE dietary data to account for seasonal variation when using multiple 7-d food records throughout a year-long study[64,135].

Traditional diets and food preparation techniques from areas outside the Mediterranean basin also add complexity for application of assessment tools and defining MedD adherence. The

British Journal of Nutrition

traditional diet in Asian countries has some similarities in food group consumption with the emphasis on vegetables, legumes and non-refined grains. However, foods that are included within food group categories and food preparation and cooking techniques differ greatly. Soyabeans were not originally included as a food component of the MedD[119]. However, soyabeans are the most commonly consumed legume in Asian countries and were included in the Japanese MedD scoring system's legumes food group (tofu, fermented soyabeans and miso)[74]. The nutritional components of soya differ from other legumes in that soya products have high levels of isoflavones[136] and would not be considered a key nutrient of traditional legumes in a MedD, but for cultural adaptation purposes maybe considered in an Asian, Mediterranean-Like Diet Pattern. An early adaptation of a MedD intervention was the 'Indo-MedD' in which the recommended fat sources were walnuts, almonds, mustard seed and/or soyabean oil[137]. This study did not apply a MedD scoring system and has been specifically identified by some as a non-MedD intervention due to the use of mustard seed and soyabean oil rather than olive oil[119]. While the exclusion of foods outside of the Mediterranean basin will limit the applicability of this dietary pattern for cultures outside of this region, some basic features of the diet, i.e., olive oil as the principle fat used in cooking and food preparation or MUFA:SFA ratios need be preserved. Due to these differences, it may be more appropriate to think about both foods *and* nutrients. Future research is needed to identify the essential key nutrients and level of nutrient pattern(s) that reproduce the cardiometabolic benefits observed with the traditional MedD.

Other regions of the world, such as the agricultural areas of Chile, California, south-western Australia and South Africa have similarities with the Mediterranean basin ecosystem[79]. Cross-national studies that evaluate foods consumed, food preparation and cooking practices, and biomarkers of intake with MedD scoring systems and health outcomes are needed to better understand similarities and differences in traditional and modernised dietary behaviours in areas of the world known for longevity and for having similarities to Mediterranean climate and agriculture.

Clinical application

Time required for administration is an important consideration when choosing assessment tools for use in clinical practice. Of the possible MedD scoring system options, MEDAS is the most attractive for clinical use due to its short length overall, direct questions and easy scoring. Recently, the MEDAS was adopted and validated for use in a clinical rehabilitation unit with the addition of images to define serving sizes and food items[41]. MEDAS is designed as a rapid MedD screening tool; other scoring systems with finer grading of points are helpful in intervention studies and clinical monitoring to account for partial adoption of food behaviours.

There are a few examples of graded scoring systems from Mediterranean and non-Mediterranean countries. The MedDietScale and QueMD have the widest pre-defined component scales (0–5 for each food/food group)[24,46]. The wider range of scoring allows for more discrete differentiation between intakes and has been applied to several MedD intervention trials in the USA[87,115,138]. The Chilean MedD score has graded points with a possible total score of 14[77,78]. In the USA, a 0–4 point system for food groups/behaviours has been successfully applied to assess firefighter intakes and adherence to a MedD intervention[96,97,118]. Two scores from Europe use continuous scaling. The PyrMDS is scaled continuously 0–1 for fifteen food items, while NU-AGE is also continuously scaled (0–10) for sixteen food items[56,57]. This continuous scaling limits rapid assessment in a clinic setting but has potential if online software becomes available for feedback in real time. Last, the MediCul scoring system is validated for use in Australian older adults with chronic conditions, but the length of the survey (fifty questions and approximately 20 min to complete) is often too long in a clinical office setting. This survey could be completed prior to a clinic visit when the web-based version is used[63].

Challenges and opportunities for application of Mediterranean diet scoring systems

Assessment methodology, cultural and lifestyle factors need to be considered when applying MedD scoring systems. Understanding the impact of MedD adherence in a variety of research and geographical settings is essential to this field. Observational cohort findings from long-term, real-life application of dietary adherence cannot be recreated in a randomised controlled trial but add to this body of literature[139]. The importance of randomised controlled trial in varying geographic locations is to understand the health implications when changing the diet to a Mediterranean-Like Diet Pattern. Countries outside of the Mediterranean basin have challenges in acceptability of Mediterranean style food practices that were not an issue for the groundbreaking PREDIMED study. Therefore, feasibility and acceptability studies, with application of appropriate MedD scoring systems, are warranted first steps when conducting MedD trials in non-Mediterranean countries.

A number of other reviews have made recommendations to advance the field[5,18,20,110]. Conformity in defining the food and food groups or nutrients included in a universal MedD scoring system has been emphasised[110]; the challenge is considering the population of interest. Nomenclature may help with applying concepts of the MedD to other areas of the world. Use of the terms 'MedD style' or 'Mediterranean Like Diet' patterns when describing assessment or interventions may better capture some of the factors that need to be considered when applying MedD scoring systems and interventions to non-Mediterranean countries. Wider application of some of the more recent scoring systems in the literature as well as comparisons between scoring systems is needed to better understand differences and similarities in traditional and modern MedD intakes from Mediterranean and non-Mediterranean countries.

In the midst of a pandemic, with obesity being at its highest levels in history, energetic excess also needs to be considered. The application of the T-MDS with limited food components and use of median intakes where energetic excess is commonplace

British Journal of Nutrition

Table 6. Key and uncertain components

How to include	Component	Key or uncertain requirement	MDP recommendations[9]
Positive	Vegetables	Key: vegetables in a variety of colours and textures excluding potatoes	≥ 2 portions* per main meal in a variety of colours and textures (cooked/raw). Does not include potatoes
	Fruits	Key: fruits in a variety of colours and textures	1–2 portions* per main meal in a variety of colours and textures
	Olive oil and/or target MUFA:SFA ratio	Key: olive oil	Consumed at every main meal, olive oil should be the principal source of dietary lipids
	Legumes/pulses	Key: legumes/pulses	≥1 portion per d of legumes (plant protein)
	Fish/seafood	Key: oily fish, lean fish and shellfish	≥2 portion per week of oily fish, lean fish and shellfish
	Lifestyle	Uncertain	Physical activity (150 min/week and muscle-strengthening at least twice/week), adequate rest, conviviality, biodiversity and seasonality, traditional local and eco-friendly products, culinary activities
Positive/Moderate	Whole-grain cereals/minimally processed grain cereals	Key: whole-grain cereals	1–2 portions* per main meal of potatoes, bread, pasta, rice, couscous or bulgur (cracked wheat) (preferably as whole-grain cereals)
Moderate	Dairy products	Key: milk, yogurt and cheese	≤2 portions per d
	Wine	Key: Wine and other fermented alcohol beverages	1 glass per d for women and 2 glasses per d for men of wine or other fermented alcohol beverages as culturally acceptable
	Poultry/white meat	Key: poultry/white meat	2 portions per week of poultry and other lean white meat
	Eggs	Key: eggs	≤4 eggs per week
	Potatoes	Uncertain: potatoes are not included in some and included in combination with cereals or as an individual component in other MedD scoring systems.	Included with cereals. 1–2 portions* per main meal of potatoes, bread, pasta, rice, couscous or bulgur (cracked wheat) (preferably as whole-grain cereals)
	Nuts/seeds/olives	Key: nuts, seeds and olives	1–2 portions per d – a "handful" of nuts and seeds
Negative	Red meat	Key: red meat	≤2 portions per week and preferably lean red meat
	Processed meat	Key processed meat	≤1 portion per week of processed meat
	Sugar-sweetened beverages	Key: sugar-sweetened beverages, or included with all sweets	1–2 portions per week of sweets and ultra-processed high sugar, high fat, foods and drinks are in one group and should be limited to 1–2 servings per week.
	Sweets (pies, cookies, cakes, pastries, candies)	Key: sweets other than fruit	1–2 portions per week of sweets and ultra-processed high sugar, high fat, foods and drinks. Sweetness in the diet should preferably be added with fresh and, to a lesser extent, dried fruits, honey or carob syrup.
	Refined grains	Uncertain	Not addressed in MDP, recommendation is that cereals are consumed using whole or partly refined grains.
	Fast food/takeout/fried foods? Pre-packaged/pre-prepared foods?	Uncertain. Due to the high prevalence in Western dietary patterns, a clear definition is needed	Not addressed in MDP

* Portion = Serving or portion size based on frugality and local habits. MDP MedD Pyramid.

does not adequately capture dietary intake. The need for *a priori* cut-offs and definitions that are in accordance with foods and nutrients of the MedD was emphasised by others as well[5,18,20,110]. Therefore, increased use of MedD scoring systems that account for non-traditional MedD foods as negative components, serving size restrictions, total diet energy density and/or overconsumption is needed to fully capture modern MedD and disease relationships. Additionally, understanding what ideal nutrient profiles (i.e. fibre, phytonutrients) that can elicit a metabolic effect similar to those found from traditional MedD studies will be helpful in identifying the most appropriate scoring system for wide scale use. Reframing the MedD as a concept[4] of healthy eating and lifestyle/dietary behaviours is an opportunity which can be applied to anyone from any culture or region of the world.

Conclusions

This review highlighted the evolution of MedD scoring systems developed for use in Mediterranean countries as well as the evolution of scoring systems (either modified or new) for use in non-Mediterranean countries. The evolution reflects the emergence of MedD pyramid recommendations and inclusion of non-typical MedD foods to capture the nutrition transition observed in Mediterranean countries and for populations outside of the Mediterranean region.

While the evolution of MedD scoring systems may improve MedD adherence measurement for a specific population, we do not have a consensus to identify MedD adherence across countries and regions. This is largely due to the lack of consensus on an absolute definition of the MedD[5] and the need to consider 'Mediterranean Like Dietary Patterns' when referring to interventions and degrees of adherence outside of the Mediterranean region, especially in cultures with vastly different foods, food preparation and cooking practices. In 2020, the MedD Pyramid was updated and, for the first time, revisions addressed the use of the MedD outside of the Mediterranean regions[9]. The new guidelines suggest that the basic MedD Pyramid recommendations should be used as a guide and countries adapt the MedD Pyramid to their 'country-specific contexts and cuisines'[9]. We believe this is the first step to identifying the key basic food components that should be included in MedD scoring systems. To move the field forward, agreement to key food components is essential. In Table 6, the numerous components currently included in the MedD scoring systems are presented and, using the updated MedD pyramid, highlight the key food components of the MedD and bring awareness to the components that require more clarity and additional study.

Moving forward, the research on application of MedD scoring systems needs to capture intake of foods that are not part of the MedD, uncertain MedD components, as well as traditional MedD foods and dietary/lifestyle behaviours. The newer scoring systems that reflect the most recent MedD pyramid recommendations[6,9] such as the MDSS[29], MEDLIFE[31] and PyrMDS[56] as well as the more widely validated MEDAS may prove greater utility in identifying true intake from a variety of cultures, as it relates to a Mediterranean-Like Dietary Pattern. Ideally, there should be a simple format for use in epidemiological and intervention trials, as well as for clinical practice. However, the likelihood that one scoring system will meet all needs is unrealistic. We will continue to see the use of a number of different scoring systems. Future systematic reviews should consider the source of MedD data, country of origin and usual dietary practices when making cross-cultural assessments for MedD and health outcomes. We recommend striving for agreement on the number food groups to include, how they are measured and the dietary behaviours and lifestyle factors to include. This approach will improve epidemiological research favouring comparisons across cultures and geographic regions and further next steps in advancing our understanding of MedD and disease relationships.

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