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Reproducibility and validity of the Mediterranean Diet Quality Index (KIDMED Index) in a sample of Portuguese adolescents

Mariana Rei[1,2,3]*, Milton Severo[4,5] and Sara Rodrigues[3,4]

[1]*Faculty of Medicine of the University of Porto, Al. Prof. Hernâni Monteiro, 4200-319 Porto, Portugal*
[2]*Faculty of Psychology and Education Sciences of the University of Porto, Rua Alfredo Allen, 4200-135 Porto, Portugal*
[3]*Faculty of Nutrition and Food Sciences of the University of Porto, Rua do Campo Alegre nº 823, 4150-180 Porto, Portugal*
[4]*Epi-Unit – Institute of Public Health of the University of Porto, Rua das Taipas nº135, 4050-600 Porto, Portugal*
[5]*Department of Public Health and Forensic Sciences and Medical Education, Faculty of Medicine of the University of Porto, Al. Prof. Hernâni Monteiro, 4200-319 Porto, Portugal*

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Abstract

The Mediterranean Diet Quality Index (KIDMED Index) is frequently used to evaluate adherence to the Mediterranean Dietary Pattern among children and adolescents, through sixteen questions with the associated total score ranging from −4 to 12. However, in the authors' best knowledge, the psychometric properties of this index had not yet been investigated in Portugal. Thus, the main purpose of the present study was to investigate the reproducibility and the validity of the KIDMED Index in a sample of 185 Portuguese adolescents. The reproducibility was tested by comparing the application of the KIDMED Index at two different times (2-week interval), using McNemar test and Kappa statistics. There was moderate agreement ($\kappa_w = 0{\cdot}591$; 95 % CI 0·485, 0·696) and no significant change (P-value = 0·201) in the KIDMED Index classification, between the two applications. The validity was explored by comparing the results obtained by the KIDMED Index and by the average of 3-d Dietary-Record (DR), using Spearman's correlation coefficient and Kappa statistics. There was weak correlation ($\rho = 0{\cdot}317$; P-value < 0·001) and slight agreement ($\kappa_w = 0{\cdot}167$; 95 % CI 0·071, 0·262) between the KIDMED Index classification and the 3-d DR-derived KIDMED score, and moderate correlation ($\rho = 0{\cdot}423$; P-value < 0·001) and fair agreement ($\kappa_w = 0{\cdot}344$; 95 % CI 0·202, 0·486) between the terciles of the KIDMED Index and the Mediterranean Adequacy Index scores. The results suggested an acceptable reproducibility and validity of the Portuguese version of the KIDMED Index, in alignment with the few studies investigating psychometric properties of this index in other countries.

Key words: Mediterranean dietary pattern: Mediterranean Diet Quality Index index: Reproducibility: Validity: Portuguese adolescents

The Mediterranean Dietary Pattern (MDP) is characterised by a high intake of fruits, vegetables, pulses, nuts, breads and unrefined cereals – such as pasta and rice; olive oil as the principal source of added fat; moderate to high intake of fish, crustaceans and mollusks; moderate intake of dairy products – mostly cheese and yogurt – and eggs; low intake of red meat and moderate intake of wine during meals[1,2].

Since 2010, the MDP was classified as an Intangible Culture Heritage of Humanity by the United Nations Educational, Scientific and Cultural Organization's[3]. In addition to this recognition, the MDP is thought to be a healthy eating pattern. It has been related to nutritional adequacy and lower risk of inadequate intake of micronutrients over the entire lifespan[4,5]; reduced risk of all-cause mortality, CVD, neurodegenerative diseases, type 2 diabetes and cancer in adults[6–11]; as well as a protective effect for childhood overweight and obesity, which determines a reduction of the risk of developing chronic non-communicable diseases into adulthood[5,12]. MDP is also considered the most sustainable eating pattern because it results in a lower environmental impact through the consumption of more plant-derived products and fewer animal products[13,14].

Since the 1960s until the first decade of the 21st century, Mediterranean countries, in general, have demonstrated a downward trend in adherence to the MDP – although less pronounced in the last decade – especially in the younger generations[15–19]. In alignment to this fact, it is considered that health promotion strategies should prioritise the promotion

Abbreviations: ICC, intraclass correlation coefficient; KIDMED Index, Mediterranean Diet Quality Index; MAI, Mediterranean Adequacy Index; MDP, Mediterranean Dietary Pattern.

* **Corresponding author:** Mariana Rei, email mariana.cc.rei@gmail.com

of the MDP in the general population and more specifically in the first two decades of life[12,15].

This health promotion strategies require the study of the overall diet quality, and in such regard, two approaches can be distinguished: the *a priori* approach – in which scores or indexes are based on guidelines for a healthy diet – and the *a posteriori* approach – using statistical methods, such as cluster, principal component and exploratory factor analyses are applied to drive dietary patterns that are available in the data – both with specific advantages and limitations[20–22].

Various *a priori* approaches, in this case, based on MDP principles were developed to evaluate children and adolescents' adherence to MDP[12]. Nevertheless, the Mediterranean Diet Quality Index (KIDMED Index) – an Index based on MDP principles consisting of sixteen closed-ended questions, with the associated total score ranging from −4 to 12[23] – has been the most used one[12]. The KIDMED Index was developed and validated by Serra Majem *et al.* in 2004, to assess the eating habits of 3850 Spanish children and adolescents, aged between 2 and 24 years, as part of the EnKid study[23].

In some situations, instead of developing new instruments, it is possible to adapt those that already exist for other populations[24]. The practical value of a questionnaire depends on its reproducibility – how well data collected can be reproduced – and validity – how well it measures what it is intended to measure. However, once a questionnaire is reproducible and valid in one population, it cannot be assumed that this is the case in all populations[25].

There are a few studies investigating psychometric properties of the KIDMED Index. After its development, the reproducibility of this index was recently tested in Croatia[26], Colombia[27] and Brazil[28] and its validity by the HELENA study in nine European countries, namely, Austria, Belgium, France, Germany, Greece, Italy, Hungary, Spain and Sweden[29]. In the Croatian, Colombian and Brazilian studies, it was proven that the KIDMED Index is a reliable instrument for assessing adherence to the MDP, and in the HELENA study, the KIDMED Index was considered one of the most appropriate and valid MDP scores for European adolescents.

To the best of the author's knowledge, based on an extensive literature review, there has been no study investigating psychometric properties of the KIDMED Index in Portugal. Thus, the main purpose of the present study was to investigate the reproducibility and the validity of the KIDMED Index in a sample of Portuguese adolescents.

Methodology

Ethical procedures

This research project was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Ethics Committee from the Institute of Public Health of the University of Porto. Moreover, written authorisation was requested from the Portuguese Government's Education General-Direction – through their Scholar Inquiries Monitorization system, with the registration number 0702600001 – and from both School Groups directors. Written informed consents from the adolescent's tutors, as well as authorisation from the adolescents themselves, were obtained to rightfully proceed on gathering data. The data were then anonymised – a numerical code, which only the main researcher had access to, was given to each participant and was destroyed after gathering the data – and treated with confidentiality, and all computerised information was kept in a computer, safeguarded by a password and all paper information in a closed cabinet, located at a secure office. The participants had the right to leave the investigation at any given time, without any need for further explanation.

Study sample

Among all the fourteen public school groups from a city located in the northern district of Portugal, selected for convenience of access, only five possessed classes from the 5th to the 12th school years. Thus, two school groups were chosen to conduct the investigation, the westernmost and easternmost, in order to obtain the most heterogeneous sample possible. The student's classes were randomly selected (two different classes per each school year in a total of sixteen different classes per each school group), and all students from the same class (averaging twenty-seven students per class) were eligible for participating in the investigation.

Formal consent requests were sent for 860 students, in order to obtain parents' authorisation for at least 240 – participation rate of 27·9 %. The students who presented formal consent but did not meet the selection criteria – (i) adolescents who have not the Portuguese nationality, due to any eventual deficit on comprehending and expressing themselves in the Portuguese language; (ii) adolescents who required special educative needs and, therefore, were unable to fill the KIDMED Index and the 3-d Dietary-Record (DR) autonomously; (iii) adolescents with specific diets (such as vegetarianism) or with diets conditioned by the presence of diseases (such as coeliac disease or allergy to cows' milk protein), as they reflect different eating patterns from MDP, which is the object of evaluation of the KIDMED Index – were excluded at the end of the data collection phase. The final sample comprised 185 adolescents, aged between 10 and 19 years.

Throughout the school season, between January and March 2020, during the early phase of the investigation, the 3-d DR were delivered as to be filled by each of the participants. After the 3-d DR were submitted, the KIDMED Index (Portuguese version – Annex A) was directly applied (self-administration) and, 2 weeks later, it was reapplied (Fig. 1).

In order to undertake this investigation, personal data were simultaneously gathered, such as sex, age, the participants' scholar degree, both parents' scholar degree, the total household monthly income and their aggregate composition.

From the 240 students who accepted to participate on the investigation, 185 students met the selection criteria and delivered the 3-d DR, but only 140 fully filled the 3-d DR – answer rate of 75·7 %. All 185 students who met the selection criteria and delivered the 3-d DR filled the KIDMED Index on the first

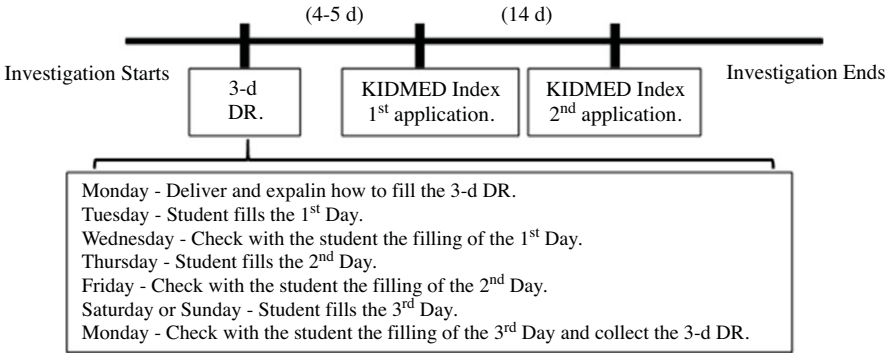

Fig. 1. Data gathering timeline. KIDMED Index, Mediterranean Diet Quality Index; DR, Dietary-Record.

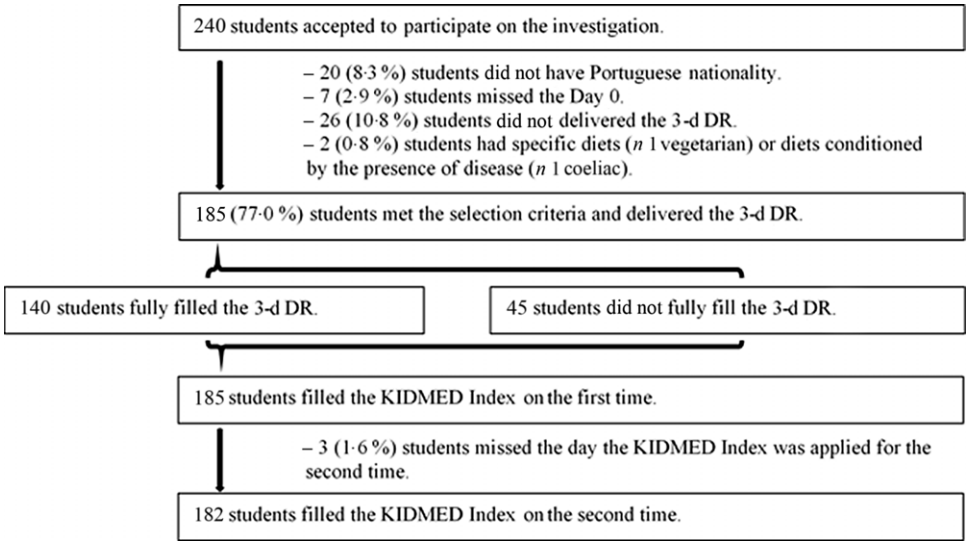

Fig. 2. Participation flow chart. KIDMED Index, Mediterranean Diet Quality Index; DR, Dietary-Record.

time – answer rate of 100 % – and 182 students filled the KIDMED Index on the second time – answer rate of 98·4 % (Fig. 2).

Dietary assessment methods

Mediterranean Diet Quality Index – KIDMED Index. The KIDMED Index evaluates children and adolescents' adherence to MDP. The Portuguese version of this instrument was previously developed by the authors, through the translation and cross-cultural adaptation of the original Spanish version[23] (data not shown). The index includes sixteen yes-or-no questions evaluating food intake that can be self-administered or conducted via an interview[23]. A positive answer to questions with a negative connotation with MDP adherence (*n* 4) are scored −1 point, while questions with a positive connotation (*n* 12) are scored +1 point. The associated total score ranges from −4 to 12, allowing the classification of the adherence to the MDP as low (≤3 points), moderate (4–7 points) and high (≥8 points)[23].

Dietary records. The DR are open-ended, self-administered questionnaires (or filled by someone else in the case of children or people with trouble on recording the food and beverages consumed) that require a minimum of 3 d (two weekdays and one weekend day) for subjects to record all food and beverages consumed over this period, at the time the food and beverages are eaten[30]. The consumed items can be measured using a kitchen weighing scale or can be estimated using a portion-size guide (e.g. three-dimensional food models, two-dimensional aids such as photographs) or in reference to standard household measures (e.g. spoons, cups, bowls)[30]. In this study, the consumed items were measured using a kitchen weighing scale or estimated with the help of images of standard household measures[31].

Trained staff provided instructions on how to record consumption, and the fully filled DR answers were entered into the Eat24 Software programme[32] – a programme based on information from the Portuguese Food Composition Table[33] – for analysis. Data regarding food and beverages intake obtained by the 3-d DR were grouped and recodify according to each item of the KIDMED Index (Table 1).

In order to summarise the information of the DR groups of food and beverages (g/d), obtained with the Eat24 Software, it additionally calculated the Mediterranean

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Table 1. Mediterranean Diet Quality Index (KIDMED Index) questions and criteria obtained from 3-d dietary record (DR) data

KIDMED index question	Criteria to obtain 1 point according to 3-d DR data
Question 1. Do you eat a piece of fruit or drink fresh fruit juice every day?	+1 point: if the intake of fruit or fresh fruit juice was at least 1 unit every day of the 3-d DR
Question 2. Do you eat a second piece of fruit every day?	+1 point: if the intake of fruit was higher than the 1 unit every day of the 3-d DR
Question 3. Do you eat fresh vegetables (example: salads) or cooked vegetables (example: soup) regularly, once a day?	+1 point: if the intake of vegetables was at least once every day of the 3-d DR
Question 4. Do you eat fresh or cooked vegetables more than once a day?	+1 point: if the intake of vegetables was more than once every day of the 3-d DR
Question 5. Do you eat fish/seafood (e.g. hake, sardines, octopus, shrimp) regularly (at least 2 to 3 times a week)?	+1 point: if the quantity of fish, crustaceans or mollusks was higher than 0 g at least 1 d of the 3-d DR
Question 6. Do you go, once or more a week, to fast-food restaurants like hamburger places?	−1 point: if the quantity of fast food was higher than 0 g at least 1 d of the 3-d DR
Question 7. Do you like and eat pulses (e.g. beans, peas, chickpeas, broad beans, lentils) more than once a week?	+1 point: if the quantity of pulses was higher than 0 g at least 1 d of the 3-d DR
Question 8. Do you eat pasta or rice almost every day (5 d or more a week)?	+1 point: if the quantity of pasta or rice was higher than 0 g every day of the 3-d DR
Question 9. Do you eat cereal or cereal products (e.g. oats, bread) for breakfast?	+1 point: if the quantity of bread and toasts consumed for breakfast was higher than 0 g at least 1 d of the 3-d DR
Question 10. Do you eat nuts (e.g. walnuts, almonds, hazelnuts) regularly (at least 2–3 times a week)?	+1 point: if the quantity of nuts and seeds was higher than 0 g at least 1 d of the 3-d DR
Question 11. Do you use olive oil at home?	+1 point: if the quantity of olive oil was higher than 0 g at least 1 d of the 3-d DR
Question 12. Do you take breakfast every day?	0 points: if he/she took breakfast every day of the 3-d DR
Question 13. Do you eat dairy products (yogurt, milk, cheese) for breakfast?	+1 point: if the quantity of dairy products for breakfast was higher than 0 g at least 1 d of the 3-d DR
Question 14. Do you eat commercially baked goods or pastries (e.g. cookies, cakes, croissants, donuts) for breakfast?	−1 point: if the quantity of cake and cookies for breakfast was higher than 0 g at least 1 d of the 3-d DR
Question 15. Do you eat 2 yogurts and/or 2 slices of cheese a day?	+1 point: if the quantity of yogurt or cheese was higher than 2 units or 2 slices, respectively, every day of the 3-d DR
Question 16. Do you eat sweets and candies several times a day (e.g. chocolates, gums, sweets)?	−1 point: if the intake of sweets and candies was more than once at least 1 d of the 3-d DR

Adequacy Index (MAI)[34] for each participant, according to the following equation:

$$\mathrm{MAI} = \frac{\begin{array}{c}\mathrm{Vegetables} + \mathrm{Fruits} + \mathrm{Pulses} + \mathrm{Nuts\ and\ Seeds} + \mathrm{Potatoes\ and\ Starchy\ Roots} + \mathrm{Pasta} + \mathrm{Rice} \\ + \mathrm{Bread\ and\ Toasts} + \mathrm{Flours} + \mathrm{Fish} + \mathrm{Crustaceans\ and\ Mollusks} + \mathrm{Olive\ Oil} + \mathrm{Water}\end{array}}{\begin{array}{c}\mathrm{Dairy\ Products} + \mathrm{Meat} + \mathrm{Offals} + \mathrm{Meat\ Products} + \mathrm{Eggs} + \mathrm{Ready} - \mathrm{to} - \mathrm{Eat\ Cereals} + \mathrm{Sweats,\ Cakes\ and\ Cookies} \\ + \mathrm{Added\ Sugar\ and\ Artificial\ Sweetener} + \mathrm{Snacks\ and\ Fast} - \mathrm{Food} + \mathrm{Added\ Salt} + \mathrm{Animal\ Fats} \\ + \mathrm{Vegetable\ Fats(except\ Olive\ Oil)} + \mathrm{Non} - \mathrm{Alcoholic\ Beverages(except\ Water)} + \mathrm{Alcoholic\ Beverages}\end{array}}$$

Because MAI values were calculated for adolescents, an adaptation to the original MAI was introduced, consisting in the inclusion of all alcoholic beverages (even wine, a drink whose moderate consumption is promoted in MDP) into the denominator of the fraction.

Statistical analysis

Statistical analysis was performed using Software Package for Social Sciences for Windows version 25.0 and the R programme, version R 4.0.0 with vcd package for calculating the Kappa values and the respective 95 % CI. Differences were considered statistically significant when P-value < 0·05.

For a power of 85 % and an α of 5 %, to obtain a significant Kappa of 0·2, the necessary number of 183 participants was calculated. The descriptive statistics analysis was performed, and the normality of the variables under study was analysed by the Kolmogorov–Smirnov test to apply the most appropriate statistical tests. Mann–Whitney U test and $\chi 2$ test, respectively for continuous and categorical variables, were used to compare the baseline characteristics of the participants who fully filled the 3-d DR with the characteristics of those who did not fully fill it.

The reproducibility of this index was tested by comparing the application of the KIDMED Index at two different times (2-week interval) to each of the participants. To determine the differences between the two applications, McNemar test was used and, to assess reliability, Kappa statistics and intraclass correlation coefficient (ICC) were used[35,36]. Kappa values range between −1 (perfect disagreement) and +1 (perfect agreement), and the strength of agreement for the kappa coefficient were classified as poor (≤0), slight (0·01–0·20), fair (0·21–0·40), moderate (0·41–0·60), good (0·61–0·80) or excellent (0·81–1)[37].

The validity of this index was explored by comparing the results obtained by the KIDMED Index and by the average of the 3-d DR of each participant. To evaluate the correlation between the two methods, Spearman's correlation coefficient (ρ) was used – strength of the correlation very weak if $|\rho| < 0{\cdot}2$, weak if $0{\cdot}2 \leq |\rho| < 0{\cdot}4$, moderated if $0{\cdot}4 \leq |\rho| < 0{\cdot}6$, strong

Table 2. Sample characteristics
(Median values and interquartile ranges (IQR); numbers and percentages)

	Total students (*n* 185)		Students who fully filled the 3-d DR (*n* 140)		Students who did not fully fill the 3-d DR (*n* 45)		
	n	%	*n*	%	*n*	%	*P*
Age (years)							0·495*
Median	14·00		14·00		14·00		
IQR	4		4		4		
School group							
Westernmost	76	41·1	53	37·9	23	51·1	0·116†
Easternmost	109	58·9	87	62·1	22	48·9	
Sex							
Male	74	40·0	53	37·9	21	46·7	0·294†
Female	111	60·0	87	62·1	24	53·3	
Education level (attended)							
5th or 6th school year	46	24·9	34	24·3	12	26·7	0·087*
7th, 8th or 9th school year	71	38·4	48	34·3	23	51·1	
10th, 11th or 12th school year	68	36·8	58	41·4	10	22·2	
Father's education level							
Primary school graduate	103	55·7	77	55·0	26	57·8	0·022*
High school graduate	52	28·1	42	30·0	10	22·2	
University graduate	18	9·7	17	12·1	1	2·2	
Missed cases	12	6·5	4	2·9	8	17·8	
Mother's education level							
Primary school graduate	78	42·1	55	39·3	23	51·1	0·013*
High school graduate	57	30·8	44	31·4	13	28·9	
University graduate	40	21·6	36	25·7	4	8·9	
Missed cases	10	5·4	5	3·6	5	11·1	
Total household monthly income							
0–499€	8	4·3	4	2·9	4	8·9	0·343*
500–999€	33	17·8	21	15·0	12	26·7	
1000–1499€	45	24·3	36	25·7	9	20·0	
1500–1999€	23	12·4	21	15·0	2	4·4	
≥2000€	21	11·4	20	14·3	1	2·2	
Do not know/Do not want to answer	55	29·7	38	27·1	17	37·8	
Number of household members (including the student)							0·272*
Median	4·00		4·00		4·00		
IQR	2		1		2		

* Mann–Whitney *U* test.
† χ^2 test.

if $0{\cdot}6 \leq |\rho| < 0{\cdot}8$ or very strong if $0{\cdot}8 \leq |\rho| \leq 1$[38] – and to access the agreement in categories between the two methods, Kappa statistics was used. Additionally, de-attenuated Pearson's correlation coefficients were calculated to remove within-person variance (i.e. day-to-day variation)[39].

Results

Sample characterisation

Table 2 shows that the 185 participants were aged between 10 and 19 years, were mostly female (60 %) and 58·9 % belonged to the easternmost school group. Exactly 24·9 % were in the 5th or 6th school years, 38·4 % were in the 7th, 8th or 9th school years and 36·8 % were in the 10th, 11th or 12th school years.

Regarding the socio-economic context of the adolescents, it can be inferred, through the parent's education, that they belonged to a medium-low socio-economic level, since only 9·7 % and 21·6 % of fathers and mothers, respectively, were university graduate. It can also be inferred, dividing by 4·03 (average number of household members) the minimum and maximum limit of the range corresponding to the most selected total household monthly income (with the exception of the option 'Don't know/Don't want to answer'). Through this numerical calculation, we obtained a range between €248·14 and €371·96 per person per month. These values are lower than €438·81, that corresponds to the Social Support Index of 2020 (the 'Indexante dos Apoios Sociais' in Portugal), under the terms of 'Portaria n.º 27/2020', of 31 January.

Students who did not fully fill the 3-d DR showed statistically significant differences only in relation to the Father's Education Level (*P*-value = 0·022) and the Mother's Education Level (*P*-value = 0·013), which were lower when compared with students who fully filled the 3-d DR.

Reproducibility study

Table 3 shows that from the total of sixteen questions, only three presented significant differences between the two applications of the KIDMED Index: question 5, where 7·7 % less of the participants reported having regular fish, crustaceans and mollusks consumption on the second application (*P*-value = 0·024);

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Table 3. Differences and agreement of the Mediterranean Diet Quality Index (KIDMED Index) questions between applications (Mean values and standard deviation; Numbers and percentages, *n* 182)

		Test								
		Yes		No		Total		McNemar test (*P*)	κ	95 % CI
	Retest	*n*	%	*n*	%	*n*	%			
Question 1 (fruit)	Yes	117	87·3	17	12·7	134	73·6	0·458	0·603	0·473, 0·733
	No	12	25·0	36	75·0	48	26·4			
	Total	129	70·9	53	29·1	182	100			
Question 2 (second fruit)	Yes	43	69·4	19	30·6	62	34·1	0·281	0·610	0·487, 0·733
	No	12	10·0	108	90·0	120	65·9			
	Total	55	30·2	127	69·8	182	100			
Question 3 (vegetables)	Yes	137	90·7	14	9·3	151	83·0	1·000	0·429	0·255, 0·602
	No	15	48·4	16	51·6	31	17·0			
	Total	152	83·5	30	16·5	182	100			
Question 4 (second vegetables)	Yes	51	62·2	31	37·8	82	45·1	0·341	0·395	0·261, 0·529
	No	23	23·0	77	77·0	100	54·9			
	Total	74	40·7	108	59·3	182	100			
Question 5 (fish/seafood)	Yes	103	91·2	10	8·8	113	62·1	0·024	0·587	0·464, 0·709
	No	24	34·8	45	65·2	69	37·9			
	Total	127	69·8	55	30·2	182	100			
Question 6 (fast-food restaurants)	Yes	18	69·2	8	30·8	26	14·3	0·210	0·536	0·370, 0·702
	No	15	9·6	141	90·4	156	85·7			
	Total	33	18·1	149	81·9	182	100			
Question 7 (pulses)	Yes	110	88·7	14	11·3	124	68·1	0·392	0·558	0·426, 0·689
	No	20	34·5	38	65·5	58	31·9			
	Total	130	71·4	52	28·6	182	100			
Question 8 (pasta or rice)	Yes	146	93·6	10	6·4	156	85·7	1·000	0·551	0·377, 0·726
	No	10	38·5	16	61·5	26	14·3			
	Total	156	85·7	26	14·3	182	100			
Question 9 (cereal or cereal products for breakfast)	Yes	127	90·1	14	9·9	141	77·5	0·845	0·598	0·458, 0·737
	No	12	29·3	29	70·7	41	22·5			
	Total	139	76·4	43	23·6	182	100			
Question 10 (nuts)	Yes	26	61·9	16	38·1	42	23·1	0·856	0·528	0·380, 0·676
	No	14	10·0	126	90·0	140	76·9			
	Total	40	22·0	142	78·0	182	100			
Question 11 (olive oil)	Yes	171	98·3	3	1·7	174	95·6	1·000	0·608	0·320, 0·900
	No	3	37·5	5	62·5	8	4·4			
	Total	174	95·6	8	4·4	182	100			
Question 12 (breakfast)	Yes	152	95·6	7	4·4	159	87·4	1·000	0·602	0·444, 0·800
	No	8	34·8	15	65·2	23	12·6			
	Total	160	87·9	22	12·1	182	100			
Question 13 (dairy products for breakfast)	Yes	142	90·4	15	9·6	157	86·3	0·307	0·495	0·321, 0·668
	No	9	36·0	16	64·0	25	13·7			
	Total	151	83·0	31	17·0	182	100			
Question 14 (commercially baked goods or pastries)	Yes	47	79·7	12	20·3	59	32·4	0·047	0·561	0·437, 0·685
	No	25	20·3	98	79·7	123	67·6			
	Total	72	39·6	110	60·4	182	100			
Question 15 (yogurts or cheese)	Yes	53	70·7	22	29·3	75	41·2	0·636	0·543	0·418, 0·667
	No	18	16·8	89	83·2	107	58·8			
	Total	71	39·0	111	61·0	182	100			
Question 16 (sweets and candies)	Yes	11	57·9	8	42·1	19	10·4	0·007	0·315	0·138, 0·492
	No	24	14·7	139	85·3	163	89·6			
	Total	35	19·2	147	80·8	182	100			

question 14, where 7·2 % less of the participants referred having commercially baked goods or pastries for breakfast on the second application (*P*-value = 0·047) and question 16, where 8·8 % less of the participants mentioned taking sweets and candies several times a day on the second application (*P*-value = 0·007).

At least 70·3 % of participants answered all questions in total agreement, and Cohen's Kappa values showed moderate agreement in almost every question (ranging between 0·429 and 0·608). Question 4, related to the consumption of fresh or cooked vegetables more than once a day, and question 16, about taking sweets and candies several times a day, revealed fair agreement ($\kappa = 0{\cdot}395$ and $\kappa = 0{\cdot}315$, respectively) and questions 1 and 2, both related to the daily consumption of fruits, demonstrated good agreement ($\kappa = 0{\cdot}603$ and $\kappa = 0{\cdot}610$, respectively).

Table 5 displays that globally there was no significant change (*P*-value = 0·201) and moderate agreement ($\kappa_w = 0{\cdot}591$, 95 % CI 0·485, 0·696) in the KIDMED Index classification, between the first and the second application. No participants were classified in opposite categories of MD adherence, and 73·6 % of participants were correctly classified as Low, Moderate or High by the two applications of the KIDMED Index.

Furthermore, the ICC – calculated for the KIDMED Index total scores – was 0·759 (95 % CI 0·690, 0·815), revealing excellent reproducibility (ICC above 0·75).

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Table 4. Agreement between the Mediterranean Diet Quality Index (KIDMED Index) questions and 3-d dietary record criteria (Numbers and percentages, *n* 140)

		KIDMED Index (Test)							
		Yes		No		Total			
	3-d DR criteria	*n*	%	*n*	%	*n*	%	*κ*	95 % CI
Question 1 (fruit)	Yes	51	89·5	6	10·5	57	40·7	0·284	0·157, 0·410
	No	48	57·8	35	42·2	83	59·3		
	Total	99	70·7	41	29·3	140	100		
Question 2 (second fruit)	Yes	15	62·5	9	37·5	24	17·1	0·313	0·141, 0·484
	No	26	22·4	90	77·6	116	82·9		
	Total	41	29·3	99	70·7	140	100		
Question 3 (vegetables)	Yes	46	90·2	5	9·8	89	63·6	0·109	0·011, 0·207
	No	68	76·4	21	23·6	51	36·4		
	Total	114	81·4	26	18·6	140	100		
Question 4 (second vegetables)	Yes	7	77·8	2	22·2	9	6·4	0·114	0·009, 0·218
	No	50	38·2	81	61·8	131	93·6		
	Total	57	40·7	83	59·3	140	100		
Question 5 (fish/seafood)	Yes	68	74·7	23	25·3	91	65·0	0·077	−0·089, 0·244
	No	33	67·3	16	32·7	49	35·0		
	Total	101	72·1	39	27·9	140	100		
Question 6 (fast-food restaurants)	Yes	11	23·4	36	76·6	47	33·6	0·160	0·005, 0·315
	No	9	9·7	84	90·3	93	66·4		
	Total	20	14·3	120	85·7	140	100		
Question 7 (pulses)	Yes	71	82·6	15	17·4	86	61·4	0·285	0·124, 0·446
	No	30	55·6	24	44·4	54	38·6		
	Total	101	72·1	39	27·9	140	100		
Question 8 (pasta or rice)	Yes	98	93·3	7	6·7	105	75·0	0·167	0·004, 0·338
	No	28	80·0	7	20·0	35	25·0		
	Total	126	90·0	14	10·0	140	100		
Question 9 (cereal or cereal products for breakfast)	Yes	65	79·3	17	20·7	82	58·6	0·055	−0·098, 0·208
	No	43	74·1	15	25·9	58	41·4		
	Total	108	77·1	32	22·9	140	100		
Question 10 (nuts)	Yes	5	41·7	7	58·3	12	8·6	0·124	−0·048, 0·297
	No	26	20·3	102	79·7	128	91·4		
	Total	31	22·1	109	77·9	140	100		
Question 11 (olive oil)	Yes	134	95·7	6	4·3	140	100·0	–	
	No	–		–		0	0·0		
	Total	134	95·7	6	4·3	140	100		
Question 12 (breakfast)	Yes	114	92·7	9	7·3	123	87·9	0·445	0·223, 0·666
	No	8	47·1	9	52·9	17	12·1		
	Total	122	87·1	18	12·9	140	100		
Question 13 (dairy products for breakfast)	Yes	115	89·1	14	10·9	129	92·1	0·425	0·208, 0·644
	No	3	27·3	8	72·7	11	7·9		
	Total	118	84·3	22	15·7	140	100		
Question 14 (commercially baked goods or pastries)	Yes	24	47·1	27	52·9	51	36·4	0·167	0·001, 0·334
	No	27	30·3	62	69·7	89	63·6		
	Total	51	36·4	89	63·6	140	100		
Question 15 (yogurts or cheese)	Yes	22	73·3	8	26·7	30	21·4	0·313	0·163, 0·463
	No	35	31·8	75	68·2	110	78·6		
	Total	57	40·7	83	59·3	140	100		
Question 16 (sweets and candies)	Yes	5	19·2	21	80·8	26	18·6	0·017	−0·152, 0·186
	No	20	17·5	94	82·5	114	81·4		
	Total	25	17·9	115	82·1	140	100		

Validity study

Table 4 shows slight to moderate agreement (ranging between 0·109 and 0·445) between the KIDMED Index and the 3-d DR for eleven questions. For question 5, regarding regular fish, crustaceans and mollusks consumption, question 9, about eating cereal or cereal products for breakfast, question 10, concerning regular nuts consumption, and question 16, about taking sweets and candies several times a day, the agreement was not significantly better than what would be expected by chance (*P*-value ≥0·05), and for question 11, about olive oil consumption, there was no agreement between the two methods.

Table 5 reveals weak correlation ($\rho = 0{\cdot}317$; *P*-value <0·001) and slight agreement ($\kappa_w = 0{\cdot}167$, 95 % CI 0·071, 0·262) between the KIDMED Index classification and the 3-d DR-derived KIDMED score. Almost 50 % of participants were classified into the same category of MDP adherence.

Table 5 also reveals moderate correlation ($\rho = 0{\cdot}423$; *P*-value <0·001) and fair agreement ($\kappa_w = 0{\cdot}344$, 95 % CI 0·202, 0·486) between the terciles of the KIDMED Index score and the MAI score. Almost 50 % of participants were classified into the same terciles of scores, while 11·43 % were misclassified into the opposite terciles of scores by the two methods.

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Table 5. Differences and agreement of the Mediterranean Diet Quality Index (KIDMED Index) classification between applications (*n* 182) and correlation and agreement between the KIDMED Index classification and the 3-d dietary record (DR)-derived KIDMED score and the Mediterranean Adequacy Index score (Numbers and percentages, *n* 140)

	KIDMED Index classification* – Retest										
	Low		Moderate		High		Total				
KIDMED Index classification* – Test	*n*	%	*n*	%	*n*	%	*n*	%	McNemar–Bowker Test (*P*)	κ_w	95 % CI
Low	4	44·4	4	4·2	0	0·0	8	4·4	0·201	0·591	0·485, 0·696
Moderate	5	55·6	77	81·1	25	32·1	107	58·8			
High	0	0·0	14	14·7	53	67·9	67	36·8			
Total	9	4·9	95	52·2	78	42·9	182	100			

	3-d DR-derived KIDMED score†											
	Low		Moderate		High		Total					
KIDMED Index classification*	*n*	%	*n*	%	*n*	%	*n*	%	ρ	*P*	κ_w	95 % CI
Low	3	75	1	25·0	0	0·0	4	2·9	0·317	<0·001	0·167	0·071, 0·262
Moderate	24	30·0	53	66·3	3	3·8	80	57·1				
High	8	14·3	36	64·3	12	21·4	56	40·0				
Total	35	25·0	90	64·3	15	10·7	140	100				

	Tercile of MAI score											
	(0·23–0·80)		(0·81–1·44)		(1·45–4·80)		Total (%)					
Tercile of KIDMED Index score	*n*	%	*n*	%	*n*	%	*n*	%	ρ	*P*	κ_w	95 % CI
(0–6)	27	51·9	15	28·8	10	19·2	52	37·1	0·428	<0·001	0·344	0·202, 0·486
(7–7)	13	40·6	12	37·5	7	21·9	32	22·9				
(8–12)	6	10·7	20	37·5	30	53·6	56	40·0				
Total	46	32·9	47	33·6	47	33·6	140	100				

MAI, Mediterranean Adequacy Index.
* Low adherence to the MDP (≤3 points); moderate adherence to the MDP (4–7 points); high adherence to the MDP (≥8 points).
† Low adherence to the MDP (≤3 points); moderate adherence to the MDP (4–7 points); high adherence to the MDP (≥8 points) according to the 3-d DR-derived KIDMED score.

Pearson's correlation coefficient between the KIDMED Index total score and the 3-d DR-derived KIDMED score was 0·388 (*P*-value <0·001) and between the KIDMED Index total score and the MAI score was 0·333 (*P*-value <0·001). After de-attenuation of data, Pearson's correlation coefficients were 0·625 and 0·661, respectively, revealing strong correlations.

Discussion

In the present study, the Portuguese version of the KIDMED Index revealed as an appropriate, reliable and valid instrument for assessing adherence to the MDP among adolescents, in alignment with the few studies investigating psychometric properties of this index in other countries.

Reproducibility studies

The differences and the agreement between the test and retest were analysed for each question and for the KIDMED Index score. For questions 5, 14 and 16 of the KIDMED Index, the responses were in agreement, but showed significant differences between the two applications. In questions 5, 14 and 16, respectively, 7·7 %, 7·2 % and 8·8 % of the adolescents changed their answer from YES (test) to NO (retest).

A 2-week period between the two applications of the KIDMED Index does not seem to be a considerable time to observe major changes in the eating habits of adolescents – especially without any intervention in order to change them – so these three questions did not reveal data collection precision. However, the remaining thirteen questions (81·25 % of the questions) and the KIDMED Index score showed no significant differences (*P*-value ≥ 0·05) between the two applications, and a moderate agreement was revealed in almost every question and in the final score ($\kappa_w = 0{\cdot}591$, 95 % CI 0·485, 0·696), suggesting acceptable reproducibility of the Portuguese version of the KIDMED Index when repeated over a 2-week interval.

Our results are in alignment with previous studies. In the Croatian study[26], which included university students (19·70 (SD 1·32) years), there were no significant changes in question responses between the first and second occasion (after a 2-week period), with the exception of question 8, regarding the consumption of pasta or rice almost daily; and kappa statistics showed moderate to excellent agreement in each question and moderate agreement ($\kappa = 0{\cdot}597$; *P*-value <0·001) in the KIDMED Index score. In the Colombian study[27], which included schoolchildren from a private institution (12·9 (SD 3·1) years), there were significant changes in question responses, between the first and second application (after 7 d), in questions 1 and 2, regarding the daily consumption of fruits, and question 15, regarding the daily consumption of yogurt and cheese. However, kappa statistics showed good agreement in almost every question and in the KIDMED Index score ($\kappa = 0{\cdot}665$; 95 % CI = 0·459, 0·772). Finally, in the Brazilian study[28], it only evaluated the agreement of the final score, on two occasions (after 7–10 d), in children (5·29 (SD 2·03) years) and adolescents (14·33 (SD 1·96)), from public

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and private schools, covering the capital and inland of the state, and the ICC showed excellent reproducibility in both groups (ICC = 0·893; 95 % CI = 0·812, 0·939 in children and ICC = 0·998; 95 % CI = 0·997, 0·999 in adolescents).

Validity studies

When the validity in reference to the 3-d DR was analysed, eleven questions (68·75 % of the questions) showed slight to moderate agreement (ranging between 0·109 and 0·445) and the KIDMED Index score revealed weak correlation ($\rho = 0{\cdot}317$; *P*-value <0·001) and slight agreement ($\kappa_w = 0{\cdot}167$, 95 % CI 0·071, 0·262). When the KIDMED Index was compared with the MAI, it was found moderate correlation ($\rho = 0{\cdot}423$; *P*-value <0·001) and fair agreement ($\kappa_w = 0{\cdot}344$, 95 % CI 0·202, 0·486) between the two scores, which corroborate the validity of the KIDMED Index assessed with the 3-d DR.

Question 9, about eating cereal or cereal products for breakfast, also proved to be reproducible but not valid, which can be due to the misunderstanding of the term 'cereals for breakfast' as the so-called ready-to-eat 'breakfast cereals' because if the 'breakfast cereals' were included into the criteria to obtain 1 point in question 9 according to 3-d DR data, this question would have been – incorrectly – considered valid ($\kappa = 0{\cdot}219$, 95 % CI 0·034, 0·405). The consumption of this non-Mediterranean food products at breakfast has increased over the last decades, being one of the most frequent breakfast components among children and adolescents[40].

Questions 10 and 11 did not prove to be valid, even though they proved to be reproducible. This fact can be due to limitations of the 3-d DR: in question 10, only 8·6 % of the sample consumed nuts (according to the 3-d DR), which reveals a very infrequent consumption (<10 %) to be evaluated in just 3 d, and in question 11, 100 % of the sample consumed olive oil (according to the 3-d DR) because all recipes considered the use of olive oil, when using the Eat24 Software programme to enter the fully filled DR answers'.

Question 5 and question 16 did not show reproducibility or validity. However, it was found that adolescents who answered YES to question 5 and to question 16 of the KIDMED Index had a higher daily fish, crustaceans and mollusks consumption and a higher daily intake of sweats and candies, respectively, than adolescents who answered NO (20·0 g/d *v.* 18·3 g/d and 12·7 g/d *v.* 9·7 g/d), although without statistical significance (*P*-value = 0·376 and *P*-value = 0·788, respectively).

Still, the validity of each question may be less important than the validity of the score[41] – since diet quality is determined by the collective contribution of the sixteen questions of the KIDMED Index. For this reason, we can assume that the Portuguese version of the KIDMED Index has an acceptable validity.

Our results are in alignment with the previous HELENA study[29] that recommends the use of the KIDMED Index in European adolescents when investigating adherence to the MDP among adolescents because the index showed associations with nutrient and food intakes and nutritional biomarkers, in the hypothesised directions. In this study, they collected 24-h dietary recalls on two non-consecutive days within a period of 2 weeks, Food Frequency and Food Choices and Preferences questionnaires and fasted blood samples to investigate if the adapted KIDMED Index for adolescents (aged 12·5–17·5 years) was associated with better food/nutrient intakes and nutritional biomarkers.

Despite our conclusion, it might be of use that future research would focus on improving the psychometric properties of this MDP adherence score.

Strengths and limitations

Our study is one of the first to have simultaneously addressed the reproducibility and the validity of the KIDMED Index. In Portugal, it is the only one to focus on the psychometric properties of this instrument.

Lack of participation was largely due to failure to return the consent form, but the final sample was the most heterogeneous sample possible because this study included two public school groups, the westernmost and easternmost ones from a northern district of the country, and selected adolescents from different school years, aged between 10 and 19 years. The data were collected via a stratified one-stage cluster sampling – within each school group (stratum), a few classes (clusters) were randomly selected and then all students in a class were included. However, a record of the class to which the student belonged was not kept, making it impossible to study the potential correlations among students within the same class.

The KIDMED Index was self-administered at both times, preventing the introduction of interviewer bias in the data[42], and it was considered a 2-week period between test and retest, avoiding major changes in the eating habits of adolescents – if the time interval was too long, participants could change their actual eating habits – and reducing the possibility of artificially inflate reliability of the instrument– if the time interval was too short, participants could remember their answers from the first occasion and answer the same way the second time to be consistent[43].

The 3-d DR was used to collect dietary data, for the reason that the DR are recognised as the gold standard of the dietary assessment methods and are used as a reference in calibration or validation studies, which employ other less rigorous and less expensive method[30]. On the other hand, the DR requires literate population[30], which helps to clarify the lower parent's education level found in students who did not fully fill the 3-d DR. Other disadvantage of the DR is the fact that it requires multiple records, over several months, to capture usual intake[30]. This helps explain the very infrequent nuts consumption observed. However, using DR with more than a minimum of 3 d would elevate the subject's burden and the staff's cost and burden too[30]. The use of one single database of food composition data – the Eat24 Software programme, based on the information from the Portuguese Food Composition Table, to enter the 3-d DR – avoided the limitations that coincide with the use of various databases of food composition data, but did not avoid the loss of accuracy in dietary information from mixed dishes, such as the inclusion of olive oil in all recipes. To overcome these limitations, fasted blood samples could be considered as in HELENA study, but they were not collected in this school-based study due to an ethical and practical viewpoint, and they would

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not allow to validate each question of the KIDMED Index such as the DR allowed.

The MAI has not been validated in Portugal, but it is a useful tool and it has been used to study the adherence of a country or a population to the MDP, by dividing the energy from the Mediterranean food groups by the energy from the non-Mediterranean food groups[15,19,34,44,45]. This index can be used with dietary data obtained with reliable and valid methods, such as DR[44]; it can be calculated for adults, but appropriate modifications are needed, for example, for children and adolescents[45] – such as the inclusion of all alcoholic beverages into the non-Mediterranean food groups, even wine, a drink whose moderate consumption is promoted in MDP – and MAI values can be calculated using food groups intake expressed as percentages of total energy/d or g/d[44,45] – although, in this case, the MAI will generally be higher than when expressed as a percentage of total energy/d[44] but will have better into account the light/zero/diet food products' contribution, such as the light/zero/diet refrigerants. So, even with these known limitations, in the present study, as in previous studies[15,19], the MAI values were calculated through an adaptation of the MAI defined by Alberti-Fidanza *et al.*[34], allowing us to verify the validity of the KIDMED Index with an extra tool that has also been used to study the adherence to the MDP.

Conclusion

The Portuguese version of the KIDMED Index is an instrument with an acceptable reproducibility and validity for assessing adherence to the MDP among adolescents.

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Annex A: KIDMED Index – Portuguese version

Question 1	Comes uma peça de fruta ou bebes um sumo de fruta natural todos os dias?
Question 2	Comes uma segunda peça de fruta todos os dias?
Question 3	Comes produtos hortícolas frescos (exemplo: saladas) ou cozinhados (exemplo: sopa de legumes) regularmente, uma vez por dia?
Question 4	Comes produtos hortícolas frescos ou cozinhados mais de uma vez por dia?
Question 5	Comes pescado (exemplos: pescada, sardinha, polvo, camarão) com regularidade (pelo menos 2 a 3 vezes por semana)?
Question 6	Vais, uma vez ou mais por semana, a restaurantes de "fast-food" tipo hamburguerias?
Question 7	Gostas e comes leguminosas (exemplos: feijão, ervilhas, grão-de-bico, favas, lentilhas) mais de uma vez por semana?
Question 8	Comes massa ou arroz quase todos os dias (5 dias ou mais por semana)?
Question 9	Comes cereais ou derivados de cereais (exemplos: aveia, pão) ao pequeno-almoço?
Question 10	Comes frutos secos oleaginosos (exemplos: nozes, amêndoas, avelãs) com regularidade (pelo menos 2 a 3 vezes por semana)?
Question 11	Usas azeite em casa?
Question 12	Tomas o pequeno-almoço todos os dias?
Question 13	Comes lacticínios (iogurte, leite, queijo) ao pequeno-almoço?
Question 14	Comes produtos de confeitaria ou pastelaria (exemplos: bolachas, bolos, croissants, lanches, donuts) ao pequeno-almoço?
Question 15	Comes 2 iogurtes e/ou 2 fatias de queijo por dia?
Question 16	Comes, várias vezes ao dia, doces e guloseimas (exemplos: chocolates, gomas, rebuçados)?