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Research Paper

Validation of an Italian questionnaire on knowledge and perceived effects on health of Mediterranean Diet and other dietary patterns: the NUTRIDIET questionnaire

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ABSTRACT

Background and aims: Unhealthy dietary patterns are a major contributor to non-communicable diseases. The Mediterranean Diet (MD) proved health benefits, but its adherence has declined in Italy. Nutrition knowledge (NK) significantly influences dietary behavior, but no validated tool exists to assess NK and perceptions of the MD and other dietary patterns. This study aimed to develop and validate the NUTRIDIET questionnaire among the Italian population.

Methods and results: A prospective observational study was conducted on 438 Italian adults (18–65 years). The NUTRIDIET questionnaire consisted of 30 items across two sections: knowledge of dietary patterns and perceptions of their health impacts. The total score ranges 0–30 points. Reliability was assessed via internal consistency (Cronbach's alpha) and test-retest reliability. Construct validity was examined by comparing scores between participants with and without nutritional background. The questionnaire exhibited good internal consistency (Cronbach's alpha = 0.792) and test-retest reliability ($R = 0.650$, $p < 0.001$). Construct validity was confirmed by higher scores in participants with nutritional background (26.9 ± 2.8) compared to those without (21.1 ± 5.4, $p < 0.001$). Most items were of moderate difficulty and had a good discrimination index, distinguishing between individuals with different NK levels.

Conclusion: The NUTRIDIET questionnaire is a valid and reliable tool for assessing NK and health-related perceptions of the MD and other diets in the Italian population, particularly among young adults and women. This instrument can aid in identifying knowledge gaps and programming targeted interventions to improve dietary adherence and public health outcomes.

1. Introduction

The relationship between eating habits and human health is well-established in the scientific literature. The Global Burden of Disease (GBD) study revealed that, in 2024, millions of deaths and disability-adjusted life years (DALYs) were attributed to unhealthy lifestyles. Particularly, 763 million (95 % uncertainty intervals 650–865) DALYs were attributable to behavioural risks, 476 million were attributable to metabolic risks, and 416 million were attributable to environmental and occupational risks [1]. As for dietary risk factors, diets high in sodium, low in fruit and whole grains were confirmed to be among the top ranking risk factors, especially for those aged 50–69 years [1]. Therefore, unhealthy diets represent a major risk factor for the development of several non-communicable diseases, including obesity, diabetes, cardiovascular diseases and some forms of cancer. These findings highlight the critical role of dietary patterns in public health outcomes.

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Traditionally, the term "diet" referred to nourishment or a way of life, focusing on the intake of appropriate macro- and micronutrients through a balanced variety of foods. However, in recent years, the term has become more associated with specific dietary regimens, particularly those aimed at weight loss or body composition modifications. Among these, the Mediterranean Diet (MD) stands out for its consistent and strong evidence supporting its beneficial effects on body composition and cardiometabolic health [2]. Other dietary approaches include those based on macronutrient modulation (e.g., low-fat, low-carb or high-protein diets), caloric restriction methods like intermittent fasting, and therapeutic diets like the Dietary Approaches to Stop Hypertension (DASH diet). Despite the health benefits of the MD, adherence to this dietary pattern is declining in Italy, possibly due to the rise of new dietary trends or increased consumption of animal-based products [3,4]. Understanding the reasons behind this shift is critical, and exploring the population's level of knowledge about the MD is central to this task.

Nutrition knowledge (NK) is recognized as a fundamental factor influencing dietary behaviors. NK encompasses not only factual knowledge about food and nutrients but also a deeper understanding of how diet affects health outcomes. Individuals with higher NK are more likely to make healthier food choices, follow dietary guidelines, and engage in long-term health-promoting behaviors [5–8]. NK includes awareness of nutrient sources, recommended dietary patterns, and the relationship between diet and disease. However, a gap exists in the literature regarding specific tools designed to assess both the knowledge and perceptions about the health benefits related to the MD and other dietary patterns, such as vegetarian, DASH, or low-carbohydrate diets. Based on these premises, this study aimed to develop and validate, among the Italian population, the NUTRIDIET questionnaire to assess both NK and the perception on health-related implications of the MD, as well as other dietary patterns. The tool was designed to capture comprehensive insights into NK across diverse groups, including individuals with and without formal nutritional training.

2. Methods

A prospective observational study was conducted to validate the NUTRIDIET questionnaire. Ethical approval was obtained by the San Matteo Ethical committee (protocol number 20200069192, date: August 04, 2020). The validation process followed several steps: (i) questionnaire ex novo creation (including items creation, collection and final selection), (ii) questionnaire administration, (iii) items analysis and (iv) reliability and validity evaluation.

2.1. Questionnaire development

No previous questionnaire about NK on various dietary patterns and their perceived effects on health has been validated and published in literature. For that reason, it was not possible to gather and select pertinent items from existing tools. Indeed, the ex novo questionnaire creation was required. A panel of 20 nutrition experts referring to the Italian Society of Human Nutrition was invited to participate in the project, with 7 of them agreeing to collaborate in the questionnaire development. We applied an evidence-based approach to decide the dietary patterns included in the questionnaire considering only the regimens with a consolidated literature background. Dietary patterns were selected drawing on our previous umbrella review on the effects of popular diets on cardiometabolic health [2]. The rationale behind this approach was to include in the questionnaire dietary regimens that have been consistently investigated in the scientific literature. The final selection included the Mediterranean diet, Vegetarian and Vegan diets, Paleolithic diet, Low Glycemic Index diet, DASH diet, (Very) Low-Carbohydrate diet, Ketogenic diet, Nordic diet, Intermittent Fasting, Low-Fat diet, and (Very) Low-Calorie diet. An initial pool of items was created with the following criteria: (i) to investigate the knowledge or health benefits perception, (ii) to be related to at least one of the previously mentioned regimens (also comparison questions were accepted), (iii) to be multiple choice questions with one "I don't know" option. Forty-eight items were generated and evaluated by each expert, who was asked to state whether the question was "essential" or "not essential" to the operationalization of a theoretical construct. Then, the content validity ratio was calculated, yielding values that ranged from +1 to −1. Positive values indicate that at least half of the experts rated the item as essential. Using this approach, the final questionnaire was made up of 30 items, equally distributed into two sections. The first one investigated the "knowledge" about the dietary patterns composition or the difference(s) between two of them (e.g. *which features are common to Mediterranean and Vegetarian diets?*). The second construct contained the items related to the perceived effects on health of one or more regimens (e.g. *In your opinion, which of the following diets is better for glycemic control purposes?*). All the items had 4 possible options, including the "I don't know" one and only one correct answer. For each correct answer, a +1 point was given while no points (0 points) were attributed when a wrong or "I don't know" option was selected. Based on this procedure, each section score could vary between 0 (no correct answers) to 15 (all correct answers), with the total score ranging between 0 and 30 points. The questionnaire is available in the Supplementary Material (Appendix 1 and 2).

2.2. Questionnaire administration

After development, the questionnaire was firstly tested on a pilot sample of 50 participants (including nutrition experts and non experts on a 1:1 ratio), to verify its feasibility and comprehensibility. No item modification was needed, thus the questionnaire was subsequently extended to a broader population. Administration was performed electronically through Google Forms and in the same circumstances. Informed consent was obtained prior to the NUTRIDIET fulfillment. Recruitment was carried out between January 2021 and June 2024. As the aim of this study was to validate the NUTRIDIET questionnaire among the general population, no strict inclusion/exclusion criteria were established. The inclusion criteria were: (i) age between 18 and 65 years and (ii) speaking Italian to ensure the questionnaire comprehension capability. No additional criteria were applied. A brief section about demographic (i.e. age, sex, highest degree, rural/urban residence) and anthropometric information (self-reported weight and height) was introduced before the first construct. Participants were asked to indicate their region and location of residence and subsequently categorized into "rural" ($\leq$300 inhabitants/km^2) or "urban" residence (>300 inhabitants/km^2), according to the Italian Institute of Statistics indications [9]. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters for each participant. Participants were categorized according to standard BMI ranges: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), and obesity ($\geq$30 kg/m^2). Auto-reported levels of adherence to the Mediterranean diet ("poor", "medium", "high") and nutritional background were also evaluated. Nutritional background was defined as having a bachelor's degree, master's degree, specialization (for physicians only) or doctorate in the field of nutrition (i.e. dietetics, human nutrition, food science). The whole items' completion was required in order to include the questionnaire in the analysis. A subsample of participants (n = 291) was asked to fulfill the questionnaire twice, within a mean of 4 weeks interval (from 2 to 6), to check its reproducibility. This interval was considered to be long enough to avoid recall biases [10] but reasonably short to not be influenced by any NK modification.

2.3. Items analysis and internal consistency

Item analysis was carried out through item difficulty index and discrimination index calculation. The item difficulty index is calculated as a percentage of the total correct responses of the test item on the total

answers (both exact and wrong). The higher the percentage, the easier the question. The ideal item difficulty index values should range between 20 and 80 % [11–13]. When the difficulty index value is lower than 20 %, the item is considered "difficult", whereas when the index value is above 80 %, it can be considered "easy". The item discrimination index measures how well an item discriminates between high and low knowledge subjects. Item discrimination was assessed using a point-biserial correlation between the scores obtained on a given item and the total questionnaire scores. These correlation indices range from −1 to 0 to +1, with values < 0.2 identifying items to be discarded or revised [14]. The total questionnaire score percentiles were also investigated and analyzed according to the different nutrition backgrounds.

The internal consistency was assessed by calculating Cronbach's alpha for the whole questionnaire and for each section, considering a minimum value of 0.60 as recommended for internal consistency [15].

2.3.1. Statistical analysis

The sample size was calculated according to the rule of thumb (n:p), i.e. the ratio between the number of subjects (n) and the number of items in the questionnaire (p) should be 10. As the questionnaire consists of 30 items, at least 300 subjects should be included in the study.

The main characteristics of the participants were explored using descriptive analysis. Quantitative variables were described as means and standard deviations, whereas qualitative variables were described as frequencies (%). Individual questions were analyzed using the item difficulty index and the item discrimination index. The item difficulty index was also performed for the population divided into nutrition background groups (with/without). A two-sample Welch *t*-test was used to examine construct validity by looking for differences in the scores between participants with and without a nutritional background on the first administration of the questionnaire. Pearson's correlation coefficients were calculated as a measure of stability over time (test-retest reliability) for the whole questionnaire and for each section and each item. All statistical analyses were performed using the Statistical Package for Social Science (IBM SPSS Statistics for Macintosh, version 28.0, IBM Corp., Armonk, NY, USA), with significance set at $p < 0.05$.

3. Results

3.1. Participants' characteristics

Out of 480 participants who gave their consent to participate in the project, 42 did not complete the questionnaire (total completion rate: 91 %). A total of 438 participants were included in the study, of whom 115 (26 %) had a background in nutrition and 323 (74 %) did not. Their baseline characteristics are presented in Table 1. Briefly, the overall sample consisted of 75 % females and 25 % males. The mean age of participants was 33 ± 13 years. BMI (mean value 22.5 ± 3.7 kg/m^2) was within the normal range for 75 % of participants. The sample was almost equally distributed between those with urban (59 %) and rural (41 %) residence. Of the total participants, 61 % were graduates or postgraduates. Similar characteristics were observed among the sub-group of participants (66 %) who completed the questionnaire twice.

3.2. Questionnaire item analysis

The item difficulty and discrimination indices for the 30 questions in the questionnaire are shown in Table 2. The percentage of correct answers per item (item difficulty) varied from 48 % to 99 %, with most items being of moderate difficulty. The item discrimination indices ranged from 0.225 to 0.624, with at least 48 % of participants giving the correct answer. All the items had an ideal item difficulty index, with only one question ("*In your opinion, for which reason following a diet is advisable?* (a) just to lose weight, (b) to improve your health, (c) only if affected by a specific pathology, (d) I don't know") achieving a poor correlation ($r < 0.2$) between the score on that question and the total score. However, it was considered extremely important for the topic by the expert panel and was retained in the final version of the questionnaire. All correlations were statistically significant ($p \leq 0.005$),

Table 1
Participants' characteristics.

	Total participants (n = 438)	Participants with nutrition background (n = 115)	Participants with no nutrition background (n = 323)	Participants who completed the questionnaire twice (n = 291)
Sex				
Female	75 %	83 %	72 %	75 %
Male	25 %	17 %	28 %	25 %
Age (years)	33 ± 13	33 ± 10	34 ± 14	35 ± 12
Weight (kg)	64 ± 13	61 ± 10	65 ± 13	65 ± 13
Height (cm)	168 ± 12	168 ± 9	168 ± 13	169 ± 9
BMI (kg/m^2)	22.5 ± 3.7	21.6 ± 2.6	22.8 ± 3.9	22.7 ± 3.8
BMI categories				
Underweight	9 %	6 %	9 %	8 %
Normal weight	72 %	87 %	67 %	69 %
Overweight	14 %	5 %	18 %	17 %
Obesity	5 %	2 %	6 %	6 %
Educational level				
Pre-graduate	39 %	5 %	50 %	33 %
Graduated	50 %	80 %	40 %	55 %
Postgraduate	11 %	15 %	10 %	12 %
Residence				
Rural	41 %	33 %	44 %	38 %
Urban	59 %	67 %	56 %	62 %

Values for age, weight, height, and BMI are reported as mean ± standard deviation.

Table 2
Item analysis for the 30 questions of the questionnaire.

Item	"I do not know" answer (%)	Item difficulty (% correct answers)	Item discrimination (r value)[a]
Section 1			
1	0.9 %	96.3 %	0.284
2	0.9 %	95.4 %	0.225
3	17.6 %	68.7 %	0.369
4	13.2 %	73.1 %	0.441
5	18.5 %	66.7 %	0.555
6	11.0 %	75.1 %	0.434
7	14.8 %	65.3 %	0.453
8	10.3 %	81.7 %	0.455
9	18.0 %	66.2 %	0.424
10	4.1 %	87.2 %	0.380
11	15.3 %	55.0 %	0.447
12	11.6 %	73.3 %	0.304
13	14.8 %	62.3 %	0.312
14	1.4 %	96.6 %	0.301
15	8.7 %	76.7 %	0.500
Section 2			
16	0.2 %	99.1 %	0.134
17	11.0 %	79.7 %	0.515
18	21.5 %	48.2 %	0.544
19	21.9 %	69.6 %	0.624
20	25.3 %	68.3 %	0.611
21	7.1 %	84.9 %	0.435
22	19.2 %	65.8 %	0.519
23	16.9 %	55 %	0.595
24	3.7 %	84.9 %	0.238
25	17.1 %	70.3 %	0.539
26	15.3 %	74.0 %	0.561
27	4.6 %	89.7 %	0.489
28	10.0 %	77.9 %	0.615
29	10.3 %	86.5 %	0.342
30	10.7 %	71.7 %	0.512

[a] Pearson's correlation test. All correlations are significant ($p \leq 0.005$).

indicating that the items were effective in distinguishing between participants with different levels of nutrition knowledge. Therefore, all 30 questions were retained in the final version of the questionnaire, as excluding any item would not have improved the reliability of the questionnaire. The different item difficulty indices based on nutrition background were also analyzed and are presented in Supplemental Table S1. As expected, the percentages of correct answers were generally higher in the group with nutritional background than in the group without nutritional background.

3.3. Questionnaire reliability and validity

Table 3 shows the reliability and validity of the questionnaire. Reliability analysis showed acceptable internal consistency, with Cronbach's alpha values of 0.792 for the total questionnaire, 0.690 for Section 1, 0.666 for Section 2.

Participants with a nutrition background scored significantly higher than those without a nutrition background on both questionnaire sections and the total score. Specifically, the mean scores for Section 1 were 13.3 ± 1.5 for participants with a nutrition background and 10.7 ± 2.7 for those without ($p < 0.001$). For Section 2, the mean scores were 13.7 ± 1.9 and 10.4 ± 3.2 ($p < 0.001$) for the 2 groups, respectively. The mean total scores were 26.9 ± 2.8 for participants with a nutrition background and 21.1 ± 5.4 for those without ($p < 0.001$), demonstrating a significant difference in NK based on educational background. This finding was also confirmed by the total questionnaire score percentiles presented in Table S2. Significantly higher proportions of NK (50th percentile or above) were observed in the nutrition background group for both Section 1, Section 2 and total score, while participants without a nutrition background were classified in the lower percentiles of NK.

Test-retest reliability was assessed in a subset of the total population consisting of 291 participants who completed the questionnaire twice (Table 4). The correlation between the baseline (T1) and the second administration (T2) was good for the total score ($R = 0.650$, $p < 0.001$), as well as for individual sections ($R = 0.621$ for Section 1 and $R = 0.622$ for Section 2, both $p < 0.001$). The high correlation coefficients indicate good stability of the questionnaire over time, confirming its temporal reliability.

4. Discussion

This study led to the development and validation of the NUTRIDIET questionnaire, a novel tool to assess both NK and perceived health effects of the Mediterranean Diet and other dietary patterns in the Italian population. To our knowledge, this is the first instrument designed specifically for this dual purpose, offering a comprehensive assessment of both objective and subjective dimensions of nutrition literacy.

NK has long been recognized as a critical determinant of dietary behavior, influencing food choices, adherence to specific dietary patterns, and ultimately, health outcomes [5–7,16]. However, recent evidence [17] suggests that perceptions of a diet's health benefits may be even more influential than factual knowledge. Individuals frequently rely on perceived benefits, particularly in contexts saturated with conflicting nutritional information from media and public discourse. For this reason, combining factual knowledge and health-related perceptions in the NUTRIDIET questionnaire represents a major methodological advancement.

The questionnaire demonstrated good psychometric properties, including acceptable internal consistency and test-retest reliability, indicating stability over time. It also showed strong construct validity, as participants with a nutrition-related background scored significantly higher across all sections (total mean score 26.9 ± 2.8 vs 21.1 ± 5.4; $p < 0.001$). This trend has been confirmed by several other studies [18–20]. This difference is not only a validation metric but also highlights the real-world implications of educational exposure on diet-related knowledge and perceptions. Most items showed moderate difficulty, with correct response rates ranging from 48 % to 99 %. Nevertheless, three items (11, 18, and 23), focusing on fat content in low-fat diets vs. the MD, the goals of low-fat diets, and triglyceride management, had relatively low correct response rates (48–55 %). These results suggest knowledge gaps or confusion related to dietary fat, likely reflecting broader public uncertainty amid growing interest in high-fat diets like ketogenic regimens.

Only one item failed to meet the discrimination threshold ($r < 0.2$) [13,14]. This item, assessing motivations for following a diet (weight loss, health, medical need), was retained based on expert judgment. In fact, although not highly discriminatory, it provides valuable insights into public attitudes toward the purpose of dieting. Indeed, NK encompasses not only factual understanding of food composition and nutrient function but also the ability to interpret and apply dietary guidelines and evidence-based recommendations to everyday eating habits. The association between NK and adherence to healthy dietary patterns, particularly the MD, is well documented. Several studies have shown that individuals with higher NK are more likely to adhere to healthier diets [5–7,16]. For example, Bonaccio et al. [21] reported a 62 % increase in the likelihood of high Mediterranean diet adherence among individuals with high NK. Similarly, Bottcher et al. (2017) [22] and Aureli and Rossi [5] confirmed significant associations between NK and Mediterranean diet adherence across diverse populations. Additionally, in a systematic review exploring the relationship between nutrition knowledge and food consumption patterns, significant positive but weak ($r < 0.5$) associations between higher nutrition knowledge and higher quality dietary intake or pattern were found in a majority of the studies [23].

As shown in other research, NK is influenced by factors such as sex, age, education, and socioeconomic status [23,24]. Our study confirmed

Table 4
Test-rest reliability (n = 291).

NK Score	Baseline NK Score (T1)	Follow-up NK Score (T2)	Correlation (Total score) R	Correlation (Total score) p-value[a]	Correlation (Individual score) R	Correlation (Individual score) p-value[a]
Section 1	11.7 ± 2.5	11.8 ± 3.0	0.621	<0.001	0.479	<0.001
Section 2	11.7 ± 3.1	11.8 ± 3.2	0.622	<0.001	0.520	<0.001
Total	23.4 ± 5.1	23.6 ± 5.8	0.650	<0.001	0.500	<0.001

Data are reported as mean ± standard deviation.
[a] Pearson's correlation test.

Table 3
Questionnaire reliability and validity.

NK Score	Cronbach's Alpha	Total participants (n = 438)	Nutrition background (n = 115)	No nutrition background (n = 323)	p value[a]
Section 1	0.690	11.4 ± 2.6	13.3 ± 1.5	10.7 ± 2.7	<0.001
Section 2	0.666	11.3 ± 3.3	13.7 ± 1.9	10.4 ± 3.2	<0.001
Total	0.792	22.7 ± 5.5	26.9 ± 2.8	21.1 ± 5.4	<0.001

Data are reported as mean ± standard deviation.
[a] Independent samples Welch *t*-test between nutrition background and no nutrition background groups.

significantly higher NK among females, as also observed in China [25] and Turkey [26] Age also plays a role and NK tends to increase with age, as seen in both the Hendrie et al. (2008) [27] and Bhawra et al. (2023) [23,24] studies. Participants aged 35 years and older scored significantly higher NK than the younger age group [27]. Similar results were obtained in the 2018 International Food Policy Study where the oldest age group (>60 years) scored significantly higher on the food processing knowledge score (FoodProK) than the youngest age group (18–29 years) ($p = 0.002$) [19]. Respondents aged 30–44 years ($p < 0.001$) and 45–59 years ($p = 0.002$) had significantly lower FoodProK scores than those in the 60+ years category [23,24]. Educational background, especially in nutrition, was a key predictor of performance in our study. Participants with formal training in nutrition (26.2 % of the sample) had significantly higher scores across all sections. These findings are consistent with validation studies from Kuwait [18], Romania [20], Uganda [28], and Italy.

Some limitations should be considered. First, certain dietary patterns may be unfamiliar to segments of the population, potentially affecting response accuracy. Second, while several regimens were included, others, particularly emerging or culturally specific diets, were not, limiting the questionnaire's generalizability. Additionally, the sample was predominantly female and aged 20–45, reflecting possible selection bias linked to the online administration method and gender-based interest in diet-related topics [18,19]. Importantly, no data were collected on household income, a key determinant of NK and dietary behavior. Although its exclusion was due to practical and ethical considerations (e.g., reluctance to disclose financial information), this limits our ability to examine the role of socioeconomic status in shaping NK. The NUTRIDIET questionnaire also has some strengths. It is the first validated tool assessing both NK and perceived health impacts of various diets in an Italian context. Its high completion rate (91 %) suggests strong acceptability, likely due to its concise structure. Moreover, its inclusion of multiple dietary patterns enhances its applicability across varied population groups and dietary practices.

5. Conclusions

The NUTRIDIET questionnaire is a validated, user-friendly tool that provides a robust measure of nutrition knowledge and health-related perceptions of diverse dietary patterns. It offers a valuable resource for both researchers and public health practitioners seeking to assess and improve nutritional literacy, particularly among younger adults and women. Future research should expand its application to other population groups, explore links with actual dietary behavior and health outcomes, and consider broader social determinants such as income and cultural background.

Author contributions

MG and DM: conceptualization. MG, CF, DM, MD and AR: methodology. MG, CF, DM, MD, SF and AR: investigation. MG, SF, CF and AR: data curation. MG, CF, DM, MD, SF and AR: writing – original draft preparation. MG, CF, DM, MD, SF and AR: writing – review and editing. CF and DM: supervision. All authors contributed to the article and approved the submitted version.

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Declaration of competing interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.numecd.2025.104264.

References

[1] GBD 2021 Risk Factors Collaborators. Global burden and strength of evidence for 88 risk factors in 204 countries and 811 subnational locations, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. Lancet 2024;403:2162–203. https://doi.org/10.1016/S0140-6736(24)00933-4.

[2] Dinu M, Pagliai G, Angelino D, Rosi A, Dall'Asta M, Bresciani L, et al. Effects of popular diets on anthropometric and cardiometabolic parameters: an umbrella review of Meta-analyses of randomized controlled trials. Adv Nutr 2020;11:815–33. https://doi.org/10.1093/advances/nmaa006.

[3] Damigou E, Faka A, Kouvari M, Anastasiou C, Kosti RI, Chalkias C, et al. Adherence to a Mediterranean type of diet in the world: a geographical analysis based on a systematic review of 57 studies with 1,125,560 participants. Int J Food Sci Nutr 2023;74:799–813. https://doi.org/10.1080/09637486.2023.2262781.

[4] Lotti S, Napoletano A, Tristan Asensi M, Pagliai G, Giangrandi I, Colombini B, et al. Assessment of Mediterranean diet adherence and comparison with Italian dietary guidelines: a study of over 10,000 adults from 2019 to 2022. Int J Food Sci Nutr 2024;75:336–43. https://doi.org/10.1080/09637486.2024.2313979.

[5] Aureli V, Rossi L. Nutrition knowledge as a driver of adherence to the mediterranean diet in Italy. Front Nutr 2022;9:804865. https://doi.org/10.3389/fnut.2022.804865.

[6] Scalvedi ML, Gennaro L, Saba A, Rossi L. Relationship between nutrition knowledge and dietary intake: an assessment among a sample of Italian adults. Front Nutr 2021;8:714493. https://doi.org/10.3389/fnut.2021.714493.

[7] Carbonneau E, Lamarche B, Provencher V, Desroches S, Robitaille J, Vohl M-C, et al. Associations between nutrition knowledge and overall diet quality: the moderating role of sociodemographic characteristics-results from the PREDISE study. Am J Health Promot 2021;35:38–47. https://doi.org/10.1177/0890117120928877.

[8] Ren Z, Hao Z, Cao J. The association between dietary knowledge based on the Chinese Dietary Guidelines and adherence to healthy dietary habits: a large-scale cross-sectional study. Front Psychol 2024;15:1453815. https://doi.org/10.3389/fpsyg.2024.1453815.

[9] (ISTAT) II of S. Urban grade glossary n.d. https://www.istat.it/classificazioni-e-strumenti/glossario?term=urbanizzazione (accessed May 14, 2025).

[10] Feren A, Torheim LE, Lillegaard ITL. Development of a nutrition knowledge questionnaire for obese adults. Food Nutr Res 2011;55. https://doi.org/10.3402/fnr.v55i0.7271.

[11] Mitra NK. The levels of difficulty and discrimination indices in type A multiple choice questions of pre-clinical semester 1 multidisciplinary summative tests. IeJSME 2009; 3 (1): 2-7..

[12] Rosi A, Ferraris C, Guglielmetti M, Meroni E, Charron M, Menta R, et al. Validation of a general and sports nutrition knowledge questionnaire in Italian early adolescents. Nutrients 2020;12. https://doi.org/10.3390/nu12103121.

[13] Kline P. Handbook of psychological testing. second ed. 2000.

[14] Trakman GL, Forsyth A, Hoye R, Belski R. Developing and validating a nutrition knowledge questionnaire: key methods and considerations. Public Health Nutr 2017;20:2670–9. https://doi.org/10.1017/S1368980017001471.

[15] Cronbach LF. Coefficient alpha and the internal structure of tests. Psychometrika 1951;16:297–334.
[16] O'Leary M, Mooney E, McCloat A. The relationship between nutrition knowledge and dietary intake of university students: a scoping review. Dietetics 2025;4:16. https://doi.org/10.3390/dietetics4020016.
[17] Aureli V, Nardi A, Palmieri N, Peluso D, Rossi L. When knowledge is not enough: understanding the barriers to sustainable food choices in Italy. Int J Food Sci Nutr 2025:1–11. https://doi.org/10.1080/09637486.2025.2515109.
[18] Alkaed D, Ibrahim N, Ismail F, Barake R. Validity and reliability of a nutrition knowledge questionnaire in an adult student population. J Nutr Educ Behav 2018; 50:718–23. https://doi.org/10.1016/j.jneb.2018.03.012.
[19] Rosi A, Martini D, Grosso G, Bonaccio ML, Scazzina F, Angelino D. Validation of a nutrition knowledge questionnaire in Italian students attending the University of Parma. Public Health Nutr 2020;23:1527–31. https://doi.org/10.1017/S1368980019004555.
[20] Putnoky S, Banu AM, Moleriu LC, Putnoky S, Şerban DM, Niculescu MD, et al. Reliability and validity of a general nutrition knowledge questionnaire for adults in a Romanian population. Eur J Clin Nutr 2020;74:1576–84. https://doi.org/10.1038/s41430-020-0616-5.
[21] Bonaccio M, Di Castelnuovo A, Costanzo S, De Lucia F, Olivieri M, Donati MB, et al. Nutrition knowledge is associated with higher adherence to Mediterranean diet and lower prevalence of obesity. Results from the Moli-sani study. Appetite 2013; 68:139–46. https://doi.org/10.1016/j.appet.2013.04.026.
[22] Bottcher MR, Marincic PZ, Nahay KL, Baerlocher BE, Willis AW, Park J, et al. Nutrition knowledge and Mediterranean diet adherence in the southeast United States: validation of a field-based survey instrument. Appetite 2017;111:166–76. https://doi.org/10.1016/j.appet.2016.12.029.
[23] Spronk I, Kullen C, Burdon C, O'Connor H. Relationship between nutrition knowledge and dietary intake. Br J Nutr 2014;111:1713–26. https://doi.org/10.1017/S0007114514000087.
[24] Bhawra J, Kirkpatrick SI, Hall MG, Vanderlee L, White CM, Hammond D. Patterns and correlates of nutrition knowledge across five countries in the 2018 international food policy study. Nutr J 2023;22:19. https://doi.org/10.1186/s12937-023-00844-x.
[25] Fu L, Shi Y, Li S, Jiang K, Zhang L, Wen Y, et al. Healthy diet-related knowledge, attitude, and practice (KAP) and related socio-demographic characteristics among middle-aged and older adults: a cross-sectional survey in southwest China. Nutrients 2024;16. https://doi.org/10.3390/nu16060869.
[26] Sanlier N, Kocaay F, Kocabas S, Ayyildiz P. The effect of sociodemographic and anthropometric variables on nutritional knowledge and nutrition literacy. Foods 2024;13. https://doi.org/10.3390/foods13020346.
[27] Hendrie GA, Coveney J, Cox D. Exploring nutrition knowledge and the demographic variation in knowledge levels in an Australian community sample. Public Health Nutr 2008;11:1365–71. https://doi.org/10.1017/S1368980008003042.
[28] Bukenya R, Ahmed A, Andrade JM, Grigsby-Toussaint DS, Muyonga J, Andrade JE. Validity and reliability of general nutrition knowledge questionnaire for adults in Uganda. Nutrients 2017;9. https://doi.org/10.3390/nu9020172.