ORIGINAL ARTICLE

Orthorexia nervosa: replication and validation of the ORTO questionnaires translated into Greek in a survey of 848 Greek individuals

Konstantinos Gkiouras[1,2] · Maria G. Grammatikopoulou[1,3,4] · Tsampika Tsaliki[3] · Laurette Ntwali[3] · Meletios P. Nigdelis[4] · Alexandros Gerontidis[2] · Eleftheria Taousani[4,5] · Christos Tzimos[6] · Radosław Rogoza[7] · Dimitrios P. Bogdanos[1] · Lorenzo M. Donini[8] · Dimitrios G. Goulis[4]

Abstract

Purpose The present study aimed to validate the ORTO-15 questionnaire for orthorexia nervosa (ON), translated by our group into the Greek language, and replicate the findings of the recently proposed 6-item ORTO-R.

Methods The tool was translated into the Greek language (ORTO-15-GR) using the forward–backward–forward method. A total of 848 adults participated in the validation study by filling in the questionnaires and providing general characteristics (age, gender, educational level, body weight, and height). The internal consistency of the tool was assessed by the omega (ω) coefficient, and confirmatory factor analyses (CFA) examined its factorial structure. Using the original six items of the ORTO-15 tool, a separate CFA model examined the factorial structure of the proposed ORTO-R tool. Furthermore, regression models tested the association of ORTO-R with study variables.

Results For ORTO-15-GR, the omega coefficient was 0.70 and for the ORTO-R 0.65. For the latter, the CFA revealed acceptable goodness-of-fit (standardized factor loadings from 0.36 to 0.64); however, all ORTO-15 models were characterized by a poor fit. In addition, there was a negative association between ORTO-R score and female gender, body mass index (BMI), and having a nutrition-related health problem.

Conclusion The replication of ORTO-R indicates that it is a reliable tool in the field of ON. Therefore, the use of a 6-item questionnaire for ON assessment appears promising in research and clinical settings.

Keywords Eating disorders · Healthism · Disordered eating · Eating behavior · Healthy eating · Body image

Konstantinos Gkiouras, Maria G. Grammatikopoulou and Tsampika Tsaliki contributed equally.

✉ Dimitrios G. Goulis
   dgg@auth.gr

1 Department of Rheumatology and Clinical Immunology, Faculty of Medicine, School of Health Sciences, University of Thessaly, Larissa, Greece

2 Medical School, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece

3 Department of Nutritional Sciences & Dietetics, Faculty of Health Sciences, International Hellenic University, Alexander Campus, Thessaloniki, Greece

4 Unit of Reproductive Endocrinology, 1st Department of Obstetrics and Gynecology, Medical School, Aristotle University of Thessaloniki, Thessaloniki, Greece

5 Department of Midwifery, Faculty of Health Sciences, International Hellenic University, Alexander Campus, Thessaloniki, Greece

6 Northern Greece Statistics Directorate, Hellenic Statistical Authority, Thessaloniki, Greece

7 Cardinal Stefan Wyszyński University in Warsaw, Warsaw, Poland

8 Medical Pathophysiology, Food Science and Endocrinology Section, Food Science and Human Nutrition Research Unit, Experimental Medicine Department, Sapienza University, Rome, Italy

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Introduction

The prevalence of eating disorders (EDs) and unspecified feeding and eating disorders (USFED) is constantly increasing globally. Approximately one in five women and one in seven men under the age of 40 years experience some form of USFED [1]. Among the latter [2], orthorexia nervosa (ON) is characterized by an obsession with "healthy" eating patterns [3] and adherence to a strict diet, comprising "clean," "healthy," or "pure" foods. It is particularly prevalent among college and university students [4–7], specifically those majoring in health and nutritional sciences [8, 9], as well as among health professionals [10]. ON is often precipitated by such initiating events as a break-up or a chronic disease diagnosis, although a high level of health-related education is also a baseline risk factor for its development [8, 11]. It has been associated with perfectionism [12], muscle dysmorphia [7], body image [13], a chronic disease diagnosis [14], increased social media use and pseudoscience posts [11, 15], organic food consumption [16], and level of physical activity and exercise addiction [17, 18], as well as sports participation at the elite level [19].

Individuals suffering from ON tend to exhibit a pathological personality pattern and difficulty in regulating emotions [20], similarly to other EDs [21]. In order to control their dietary intake, patients often avoid eating with others, leading to social isolation [11, 22, 23]. Their diets are restrictive, with low-fat, low-sugar, vegetarian, or low-gluten being the most commonly adopted regimes [11]. These dietary constraints often lead to nutritional deficiencies, malnutrition, and tiredness [11], while inability to access the desired food groups can trigger mental distress, self-punishment, and guilt [24].

Due to its increasing prevalence [25], a pledge to establish a consensus definition for ON and the use of validated tools to assess ON tendencies has been made [25–27], with the ORTO-15 scale [26, 28] being used to identify ON tendencies [29, 30]. Recently, authors of the original ORTO-15 [28] provided a shorter (6-item), updated version of the questionnaire, ORTO-R [31], with improved factorial structure.

Due to the lack of established criteria, the use of thresholds to diagnose ON has been deemed "unsafe" and should be avoided [31]. Moreover, the ORTO-15 questionnaire was scrutinized for overestimating the prevalence of ON, since it identifies healthy dieting as potentially harmful without verifying any underlying pathology [32]. To correct this, ORTO-R was developed, aiming at presenting orthorexic tendencies as a continuous scale outcome instead of using a threshold value for diagnostic purposes.

The aim of the present survey was to validate the ORTO-15 scale, translated into the Greek language by our group, in a large, representative sample of Greek individuals. Furthermore, this study aimed to isolate the original six items of the ORTO-15 and to replicate the findings of the factorial structure of ORTO-R.

Methods

Components of the two questionnaires

The initial ORTO questionnaire, ORTO-15 [28], consists of 15 questions, each with four possible Likert answers (always, often, sometimes, and never), receiving a score ranging between 1 and 4. In the initial publication, a threshold value of 35 (calculated by summing all item scores) was proposed for the diagnosis of ON [28].

In the revised version of the questionnaire, ORTO-R [31], six questions are included from the original version, and the possible answers for each question are five (never, rarely, sometimes, frequently, and always). Total scoring ranges between 1 and 30, with each question receiving between 1 and 5 points, depending on the answer. In this version, a threshold is not suggested for the diagnosis of ON, but instead, total scoring is used in a scale format to indicate more or fewer ON tendencies [31]. A proposed translation of ORTO-R in the Greek language can be found in Supplementary Fig. 3, and its English format is available on https://osf.io/8zv7q/.

It should be clarified that the original questions of ORTO-15 were used in the analyses presented herein for the replication of the factorial structure of ORTO-R.

Translation of the questionnaire

For the translation and cross-cultural adaptation of ORTO-15 [28], a four-step process proposed by Guillemin et al. [33] was applied (Supplementary Fig. 1). For the translation of the questionnaire, an expert committee was formed, including experienced bilingual authors (DGG and DPB) and the main developer of both tools (LMD).

In the first step (forward translation), the initial questionnaire was translated from English into the Greek language by two independent translators (MPN and MGG), native speakers of both languages. This resulted in two versions of the questionnaire in the Greek language (ORTO-15-GRa and ORTO-15-GRb). Each translator was asked to report issues of concern regarding the selected use of words or possible deviations from the exact word-to-word translation (compared with the original questionnaires).

In the second step, a unanimous translation in the Greek language (ORTO-15-GR-ab) was developed after discussion between the two bilingual translators (MPN and MGG) and

the expert committee, using the versions developed in the previous stage.

In the third step, the backward translation of the questionnaire was conducted. The Greek version of the tool was back translated into the English language by two independent translators, experienced speakers of both languages (KG and ET). This resulted in two versions of each questionnaire in the English language (ORTO-15-GR-ENa and ORTO-15-GR-ENb). Each translator was asked to report any concerns regarding the translation, where there were points that possibly obscured the meaning of the questions produced and might possibly hinder understanding of the produced questions.

In the fourth step, the expert committee and all four bilingual translators (MGG, KG, MPN, and ET) studied and discussed the translated versions and the reports of all four individual translators: they explained the rationale for the use of specific words, solved discrepancies, and produced the final ORTO-15-GR questionnaire.

Sample recruitment

The ORTO-15-GR questionnaire was made available in an online Google form in order to collect data. An adult sample was recruited through social media posts, and the participants were asked to provide consent and complete the online survey lasting approximately 10 min. Online details concerning the study were provided before obtaining consent. Ethical permission for the study was granted by the Bioethical Committee of the Medical School, Aristotle University of Thessaloniki, Greece. Data identifying the individuals were not collected. Apart from the ORTO-15-GR questionnaire, sociodemographic data were reported, including gender and age (in years), height (in cm), body weight (in kg), and professional status (student, unemployed, public sector employee, private sector employee, housewife, business owner, and an open-ended choice, "other," which was examined and grouped based on the response) as well as the level of educational attainment (secondary education, vocational school, university degree, master's degree, or doctoral degree).

Body mass index (BMI) was calculated for each participant based on the reported height and weight data as body mass (kg) divided by height (expressed in m) squared. Weight status was assessed using the BMI World Health Organization (WHO) thresholds [34] for underweight ($BMI < 18.5 \ kg/m^2$), normoweight ($18.5 \leq BMI < 25 \ kg/m^2$), overweight ($25 \leq BMI < 30 \ kg/m^2$), and obese ($BMI \geq 30 \ kg/m^2$).

Two participants did not provide consent and were removed from the sample, and two were not adults; therefore, the final sample consisted of 848 participants. No missing values were recorded. Characteristics of the sample are presented in Table 1. All data were collected during the year 2020.

Statistical analyses

The Jamovi project (version 1.2.27.0), PASW Statistics 21.0 (IBM SPSS Inc., Hong Kong), and the *R* language [35] (packages lavaan [36] and semTools [37, 38]) were used for the statistical analyses. The level of significance was set at alpha = 0.05. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test and the Shapiro–Wilk test. Descriptive data are presented as medians with their respective interquartile ranges (IQR) (25th–75th) for non-normally distributed variables and for normally distributed variables as means ± standard deviations (SD). Group comparisons were performed with the ANOVA and the Student's *t* test for normally distributed variables and the Kruskal–Wallis or the Mann–Whitney *U* tests for non-normally distributed variables. Correlations among continuous variables were assessed with Spearman's rho (ρ) coefficient, and the internal consistency of the instruments was assessed with the omega (ω) coefficient [31, 38].

A multiple linear regression analysis was conducted, with those variables having a significant association ($P \leq 0.200$) in the aforementioned univariable tests. Regression assumption of normality and homoscedasticity were assessed on the residuals, and multicollinearity was assessed via the calculation of the variance inflation factor and tolerance. Due to the presence of heteroscedasticity, the linear regression model was run with the wild bootstrap method [39, 40].

Table 1 Participant characteristics

Male/female (*n*)	291/557
Age (years)	35.4 ± 12.1 (33, 24–45)
Body mass index (kg/m²)	25.7 ± 5.2 (24.8, 22.1–28.1)
Weight status (underweight/normoweight/overweight/obese) (*n*)	18/422/272/136
Educational level (secondary education/technical school/university/post-graduate degree) (*n*)	129/111/450/158

SD, standard deviation

Note: for quantitative variables, values are means ± standard deviations and medians with their interquartile ranges (in parentheses) and for qualitative variables are frequencies (*n*)

Confirmatory factor analysis

Confirmatory factor analysis (CFA) models were constructed to evaluate both ORTO-15 and ORTO-R factorial structure. The methodology by Rogoza and Donini [31] was followed in an attempt to replicate their findings and confirm or reject the CFA model of ORTO-R (with the original six questions of the ORTO-15 questionnaire) [31]. In further detail, first, a CFA model included all items of ORTO-15 loaded on a single-factor model. Subsequently, a three-factor model was analyzed by including the three hypothesized factors of ORTO-15: cognitive–rational (items 1, 5, 6, 11, 12, and 14), clinical (items 3, 7, 8, 9, and 15), and emotional (items 2, 4, 10, and 13) [28]. Moreover, the factorial structure of ORTO-R was examined in a CFA model, including items 3, 4, 7, 10, 11, and 12. Since this model failed to provide a good fit, a method factor was introduced as an orthogonal latent factor which included items 10, 11, and 12 with their factor loadings constrained to be equal. The rationale of the latter CFA model was based on the special wording of items 10, 11, and 12 (all three beginning with the phrase "Do you think…"), which might elicit a different response by the participants as compared to items 3, 4, and 7 [31]. Finally, a two-factor CFA model was tested for the factorial structure of ORTO-R by loading on the first factor the items 3, 4, and 7 and, on the second factor, the items 10, 11, and 12 to examine the hypothesis if the poor fit of ORTO-R was based on the presence of two factors rather than method bias [31]. In addition to these analyses, it was hypothesized that this model might be miss-specified, since the three-factor CFA model of the original ORTO-15 had a non-positive definite matrix. A re-specification took place by constructing the ORTO-12 model as follows. First, items 5, 8, and 15 were excluded because of having standardized factor loadings close to zero. Second, by examining the inter-factor correlations, it was found that the factor "emotional" had high correlations with the factors "cognitive–rational" (0.959) and "clinical" (0.978); therefore, the factor "emotional" was removed from the respecified model. Third, the "emotional" factor items were assigned to the remaining two factors by inspecting their residuals in the ORTO-15 model.

For all models, CFA analyses were implemented with the weighted least squares with the mean and variance (WLSMV) adjusted estimated method, and the goodness-of-fit was evaluated with the calculation of the chi-square statistic, the standardized root mean square residual (SRMR) (with values closer to zero indicating a good fit and > 0.10 a poor fit), the root mean square error of approximation (RMSEA) and its 90% confidence intervals (CI) with low values of the RMSEA (or its upper CI less than 0.10) indicating a good fit, and the comparative fit index (CFI) (with values closer to 1.0 indicating the best result) [31, 41, 42].

Results

Comparisons and correlation of ORTO-R and ORTO-15-GR with study variables

The produced translation of ORTO-15 in the Greek language is provided in Supplementary Fig. 2. Moreover, selected questions adopted in ORTO-R are presented in Supplementary Fig. 3. Overall, the sample's mean age was 35.4 ± 12.1 years, with the majority of the participants being female (66%), normoweight (50%), and having obtained a university or postgraduate degree (72%) (Table 1). Table 2

Table 2 ORTO-R-GR and ORTO-15-GR scores among participants of different categories

Categories		ORTO-15-GR	P value	ORTO-R-GR	P value
Gender	Female (n = 557)	36 (34–38)	0.571[a]	15 (13–16)	≤ 0.001[a]
	Male (n = 291)	36 (33.5–38)		16 (14–18)	
Age group	< 25 years old (n = 248)	36 (33.3–38)	0.006[b]	14 (12–16)	0.013[b]
	25–34.9 years (n = 195)	36 (34–39)		15 (13–17)	
	35–44.9 years (n = 191)	36 (34–38)		15 (13–17)	
	45–54.9 years (n = 154)	37 (34–39)		15 (14–17)	
	≥ 55 years old (n = 60)	35 (33–37)		15 (13–17)	
Educational level	Secondary education (n = 240)	36 (33.3–38)	0.975[b]	15 (13–17)	0.822[b]
	Tertiary education (n = 450)	36 (34–38)		15 (13–17)	
	Postgraduate level (n = 158)	36 (34–38)		15 (13–17)	
Weight status	Underweight (n = 18)	37 (34–39.3)	0.742[b]	17 (13.8–19)	≤ 0.001[b]
	Normoweight (n = 422)	36 (34–38)		15 (13–17)	
	Overweight (n = 272)	36 (34–38)		15 (12.3–17)	
	Obese (n = 136)	35 (33–38)		14 (12–16)	

[a]Based on the Mann–Whitney U test; [b]based on the Kruskal–Wallis test

Note: values are medians with their respective interquartile ranges

presents the ORTO-15-GR and ORTO-R scores of different participant groups. No differences were noted for ORTO-15-GR and distinct participant categories, except for age. On the other hand, the ORTO-R scores were significantly higher among men compared with the women participants ($P \leq 0.001$). Moreover, different ORTO-R scores were noted in distinct age groups and weight status tiers ($P = 0.013$ and $P \leq 0.001$, respectively). In addition, participants with a nutrition-related health issue demonstrated lower ORTO-R scores (median, 14; IQR, 12–17) compared with the rest of the sample (median, 15; IQR, 13–17) ($P = 0.007$). The ORTO-R scores did not differ between dietetics/healthcare students ($n = 30$, 14.17 ± 2.84) and university students of other disciplines ($n = 140$, 14.46 ± 3.27) ($P = 0.644$). Participants within a distinct educational level ($P = 0.478$) or professional status ($P = 0.233$) tiers did not demonstrate different ORTO-R scores. On the other hand, weak positive correlations were noted for ORTO-R and participant age (rho $= 0.101$, $P = 0.003$) and a negative one with the sample's BMI (rho $= -0.156$, $P \leq 0.001$).

Multiple linear regression of ORTO-R with study variables

The multiple linear regression model revealed a negative association of ORTO-R-GR score with female gender ($\beta = -1.37$; 95% CI, -1.80 to -0.94; $P \leq 0.001$), BMI ($\beta = -0.13$; 95% CI, -0.17 to -0.08; $P \leq 0.001$), and having a nutrition-related health problem ($\beta = -0.66$; 95% CI, -1.22 to -0.022; $P = 0.021$). On the other hand, ORTO-R score was positively associated with age ($\beta = 0.04$; 95% CI, 0.02 to 0.06; $P \leq 0.001$).

Factor analysis and reliability assessment

The one-factor model of ORTO-15-GR had standardized factor loadings ranging from -0.02 to 0.71 (Table 3) and did not provide a good fit (Table 4). Furthermore, the three-factor ORTO-15-GR was characterized by a non-positive define matrix. These models had three items (5, 8, and 15) that yielded standardized factor loadings close to zero. Items 2 and 13 had the highest residuals with the "clinical" factor items and items 4 and 10 with the "cognitive–rational" factor. Thus, the respecified ORTO-12 model had only two factors by reassigning these items accordingly. However, ORTO-12 also failed to provide an acceptable fit.

On the other hand, the ORTO-R model's standardized factor loadings ranged from 0.36 to 0.64 (Fig. 1), and the introduction of the method factor loaded by the items 10, 11, and 12, which begin with the same prompt sentence "Do you think…", enhanced the ORTO-R model's fit (Table 4). The ORTO-R model with two factors produced similar results. However, due to the "parsimony principle" [41], the less parsimonious one-factor model can be selected to

Table 3 Standardized factor loadings of ORTO-15 and ORTO-12 in confirmatory factor analyses

Item[a]	One factor	Three factors[b]	Two factors[c]
1. When eating, do you pay attention to the calories of the food?	0.37	0.44	0.42
2. When you go to a food shop, do you feel confused?	0.43	0.41	0.46
3. In the last 3 months, did the thought of food worry you?	0.70	0.79	0.75
4. Are your eating choices conditioned by your worry about your health status?	0.52	0.50	0.57
5. Is the taste of food more important than the quality when you evaluate food?	0.04	−0.02	NI
6. Are you willing to spend more money to have healthier food?	0.22	0.30	0.29
7. Does the thought about food worry you for more than 3 h a day?	0.40	0.44	0.43
8. Do you allow yourself any eating transgressions?	0.003	0.04	NI
9. Do you think your mood affects your eating behavior?	0.52	0.57	0.55
10. Do you think that the conviction to eat only healthy food increases self-esteem?	0.56	0.54	0.64
11. Do you think that eating healthy food changes your lifestyle (frequency of eating out, friends, …)?	0.45	0.51	0.49
12. Do you think that consuming healthy food may improve your appearance?	0.57	0.66	0.63
13. Do you feel guilty when transgressing?	0.71	0.67	0.77
14. Do you think that on the market there is also unhealthy food?	0.25	0.28	0.27
15. At present, are you alone when having meals?	−0.02	−0.02	NI

CFA, confirmatory factor analyses; *NI*, not included

[a]Original questions of the ORTHO-15. Reversed coded responses were 1, 2, 5, 8, 9, and 13

[b]A CFA model including the originally proposed ORTO-15 modeling with the 15 items categorized to three factors as follows: cognitive–rational (items 1, 5, 6, 11, 12, and 14), clinical (items 3, 7, 8, 9, and 15), and emotional (items 2, 4, 10, and 13)

[c]A two-factor CFA model with the following structure: factor 1 (items 1, 4, 6, 10, 11, 12, and 14) and factor 2 (items 2, 3, 7, 9, and 13)

Table 4 Results of model fit statistics of the confirmatory factor analyses

Model	χ^2	df	P value	CFI	RMSEA	90% CI	SRMR	WRMR
One-factor ORTO-15-GR	1170.57	90	<0.001	0.620	0.119	0.113–0.125	0.103	2.642
Three-factor ORTO-15-GR	1079.29	87	<0.001	0.651	0.116	0.110–0.122	0.099	2.536
Two-factor ORTO-12	230.17	53	<0.001	0.925	0.063	0.055–0.071	0.056	1.297
ORTO-R	65.15	9	<0.001	0.931	0.086	0.067–0.106	0.051	1.154
ORTO-R with method factor	13.704	8	0.090	0.993	0.029	0.0–0.054	0.024	0.511
ORTO-R with two factors	13.730	8	0.089	0.993	0.029	0.0–0.054	0.024	0.522

χ^2, chi-square statistics; *CI*, confidence intervals; *CFI*, comparative fit index; *df*, degrees of freedom; *RMSEA*, root mean square error of approximation; *SRMR*, standardized root mean square residual; *WRMR*, weighted root mean square residual
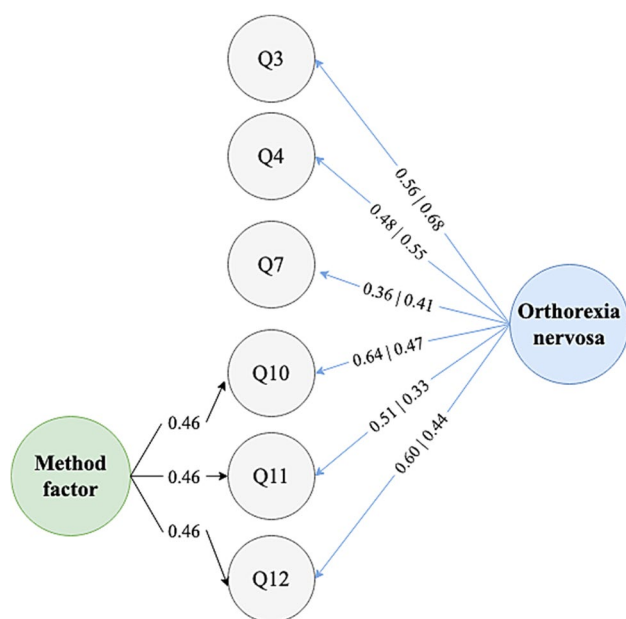

Fig. 1 Standardized factor loadings of the measurement model of ORTO-R. Values on the left side of | correspond to the model without the method factor. Abbreviation: Q, question

represent the structure of ORTO-R. Finally, as expected, the correlation of ORTO-R with ORTO-15-GR was positive (rho = 0.602, $P \leq 0.001$). The reliability coefficients (ω) for ORTO-15-GR, ORTO-12, and ORTO-R were 0.70, 0.77, and 0.65, respectively.

Discussion

The present study showed that the ORTO-15 translation in the Greek language is sufficiently reliable, and the items included in the instruments share high covariance, "measuring" the same underlying concept. Furthermore, replication of the ORTO-R analysis conducted by Rogoza and Donini [31] confirmed its factorial structure. Finally, higher

ORTO-R scores were associated with male gender, lower BMI, and not having a nutrition-related health issue.

Previous validation of ORTO-15 in the Greek language, using a smaller sample of participants, with age restriction (120 students), similarly revealed adequate internal consistency (coefficient 0.77) [43]. However, the importance of using representative samples in orthorexia has recently been stressed by Hay [44] with the aim of categorizing ON as a disorder. Translations of ORTO-15 into other languages resulted in Cronbach's α of 0.67–0.80 for the Spanish and Austrian [45–47], 0.62 for the Turkish [48], 0.644–0.9 for the Polish [49, 50], and 0.72 for the German version [51]. On the other hand, a limited number of studies have translated, validated, and used ORTO-R in other languages to date. Translation of ORTO-R in the Arabic language had an internal consistency of 0.785 [52], whereas the use of ORTO-R in the Turkish language [53] failed to report any measures of internal consistency (without adaptation). The ω coefficient's value of 0.65 produced herein for ORTO-R can be "tolerated" considering the large sample size [41].

This study presents and analyzes the structure of a 12-item version of ORTO-15, following the finding of a non-positive definite matrix. Although the causes of this inconvenient matrix characteristic can vary [41], we hypothesized that it emerged due to model misspecification. We mainly based this hypothesis on the fact that the original ORTO-15 structure of three factors was not corroborated by factor analysis. Furthermore, non-positive definiteness was present in the recent re-analysis of the original ORTO-15. In addition, the high inter-factor correlations revealed in our analysis were evident in a previous analysis [47]. Previous CFA on ORTO-15 arrived at a single-factor model [47, 54]. These facts, when taken together, attest that the three-factor model originally proposed cannot easily hold, and a more parsimonious model might be more valid. However, our 12-item, two-factor version of ORTO-15 was constructed on mainly statistical considerations rather than theoretical bases. Therefore, it would be ill-advised to propose it without further corroboration by other samples, especially when

less complex models have been proposed previously or in the light of the good fit of the single-factor ORTO-R.

The present results are consistent with previous research suggesting that women have slightly more orthorexic tendencies than men, as indicated by a lower median ORTO-R score [8, 55–57]. As seen in other studies, younger individuals [8, 58] exhibited increased orthorexic tendencies. Concerning other pathologies, lower ORTO-R scores indicative of greater scores in orthorexic behaviors were observed among participants with a diagnosis requiring nutritional management. Given that many patients with a chronic disease often resort to lifestyle changes and alternative therapies and rely on cherry-picked and even unsupported health evidence [59, 60], the development of ON tendencies among these populations appears inevitable, driven by a desire for extremes of healthism or an overzealous need to adhere to physician recommendations.

According to Boynton [61], the use of questionnaires has been widely "abused" in research in that they are regarded as providing a "quick fix" [62]. Nevertheless, questionnaires, which should be clear, valid, reliable, and succinct [63], are useful aids in diagnosing, recording patient attitudes, and collecting information regarding their beliefs, knowledge, and practices. Today, although the use of Cronbach's α is common practice for the validation of questionnaires, several inconsistencies are apparent concerning its appropriate thresholds [64]. For most studies, a threshold of α = 0.70 is considered to provide evidence of the internal consistency of the examined instrument [64].

Concerning ON, given that a consensus on its definition has not yet been reached, none of the tools used to assess orthorexic tendencies will provide ideal results. As already mentioned, a classification of ON is absent from the Diagnostic and Statistical Manual for Mental Disorders (DSM-5) [2] or the International Classification of Disease (ICD-10) [65]. At the moment, ON is accommodated in the DSM-5 under the umbrella categories for Unspecified Feeding and Eating Disorders, Avoidant/Restrictive Food Intake Disorder (ARFID) or Other Specified Feeding and Eating Disorders (OSFED). However, these categories do not fully embrace the pathophysiology of ON, as described by Bratman [66].

The present study results are strengthened by the large sample size; however, due to the COVID-19 restrictive measures, including quarantining, recruitment of participants could only be performed online. Thus, data concerning the anthropometric characteristics of the sample were reported and not measured. To date, none of the published studies [52, 53] has adapted ORTO-R, although all have used items of ORTO-15 to construct ORTO-R without any modifications. Moreover, in the present study, our aim was not to validate the ORTO-R questionnaire but to replicate the analysis conducted by Rogoza and Donini [31], as the different rating scales employed in ORTO-R compared to ORTO-15 indicate the need for additional validation of the items taking into account all the modifications suggested herein and by Rogoza and Donini [31].

The use of valid tools to identify orthorexic tendencies is important for early identification and treatment. Moreover, the translation and cultural adaptation of valid tools in other languages facilitate and expand the use of these tools in additional countries/populations. The present study adds a culturally updated version of ORTO-15 in a large Greek sample and validates the results of the factorial structure of the recently proposed ORTO-R, adding tools for the effective screening of patients with ON.

Among the limitations of the present study is its cross-sectional design, which hinders determination of causation in the examined associations. In addition, it should be stressed that online sample recruitment might not be equivalent to an in-person random sample in terms of the generalizability of its findings. Furthermore, any statistical differences or associations found herein might not be valid in other populations and/or clinical settings and should be interpreted along with the magnitude of their effect estimates (means and coefficients).

Early screening and provision of care for all OSFED could avert 70.5 deaths per 100,000 people under the age of 40 and significantly decrease healthcare expenses [1]. Whether ON is the epiphenomenon of distorted science presented in social media or an extreme form of healthism is at present unknown. In fairness, whatever the etiology driving ON, proper identification of orthorexic traits is likely to aid in prompt management of the phenomenon, defining the fine line between healthy and health-restrictive eating behaviors.

Conclusions

The ORTO-R questionnaire has been validated in this Greek sample, and its factorial structure has been fully replicated in the present analysis. The ORTO-R short version enables easy implementation of the method for assessment of orthorexia nervosa. Although both ORTO-R and ORTO-15 tools have acceptable reliability coefficients, ORTO-15 has not shown an acceptable fit in confirmatory analyses and can no longer be proposed for usage. Finally, orthorexic tendencies were correlated with female gender and younger participants, thus pinpointing a possibly susceptible population who require identification in clinical practice.

the pilot study. KG, CT, DGG, and MGG participated in the statistical analyses. Furthermore, KG, MGG, DGG, DPB, and LMD drafted the manuscript, and, with the rest of the authors (TT, LN, AG, CT, RR, LMD, and ET), revised and corrected subsequent versions. All authors have approved the final manuscript and approved its publication.

Availability of data and material Data are available upon request to the corresponding author.

Declarations

Ethics approval The Bioethical Committee of the Medical School, Aristotle University of Thessaloniki, Greece, approved the study protocol.

Consent to participate Informed consent from all participants was obtained.

Consent for publication All authors have approved the final manuscript and approved its publication.

Conflict of interest The authors declare no competing interests.

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