Journal of Eating Disorders

RESEARCH Open Access

Development and validation of the Lebanese Orthorexia Nervosa Inventory (LONI)

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Abstract

Background Unlike eating disorders (ED) that are officially recognized and focusing on the quantity of food, Orthorexia Nervosa (ON) revolves around an unhealthy fixation on the quality of food eaten. Existing ON scales differ in how these conceptualize and define ON, ensuing inconsistency in assessments that not only affects the validity and reliability of ON related research, but also impacts the ability of healthcare professionals to identify and provide support for individuals struggling with ON.

Objective Create the first Eastern locally validated tool that considers the cultural nuances and specificity of the Lebanese general population's eating attitudes and their social context, addresses the limitations of existing scales and thereby provides a valid instrument that can be used in Lebanon and culturally-similar countries.

Methods Data were collected between September 2023 and February 2024, enrolling 320 participants for the exploratory factor analysis and 658 for the confirmatory analysis.

Results Starting from an initial pool of 25 items, the exploratory-confirmatory (EFA-CFA) factor analyses retained 13 items. The LONI showed a unidimensional factor structure, and satisfactory convergent and concurrent validity with a composite reliability (ω and α) of 0.90 providing clear evidence of its high reliability, supporting the stability and consistency of LONI scores across different subsamples. The structural characteristics, factor loadings, and item intercepts of the LONI remained consistent regardless of gender, affirming the tool's stability and reliability in measuring ON traits across diverse populations.

Conclusion The LONI is a valid tool for assessing ON, particularly in accounting for Lebanese and culturally similar populations. The scale's unidimensional structure allows for straightforward calculation of the score, making it practical for both clinical and research applications, while offering a unique advantage in considering regional dietary patterns compared with existing ON screening tools due to its cultural specificity and psychometric strengths. The ON prevalence was high in the present sample, underscoring the significance of sociocultural and behavioral factors in its manifestation.

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Plain English summary

Orthorexia Nervosa (ON) is an eating condition characterized by an unhealthy focus on the quality of food rather than its quantity, differentiating it from officially diagnosed eating disorders (ED). Current assessment tools for ON often differ in how they define and conceptualize the disorder, leading to inconsistencies that affect research validity and the ability of healthcare professionals to identify and support individuals with ON. This study aimed to develop the first Eastern culturally specific tool tailored to the Lebanese population's unique eating attitudes and social context, addressing the limitations of existing scales. Data were collected between September 2023 and February 2024. Starting with 25 items, the analysis resulted in a 13-item Lebanese Orthorexia Nervosa Inventory (LONI). The LONI demonstrated a unidimensional factor structure, indicating that all items measured the same underlying construct. It showed high reliability, with composite reliability scores (ω and α) of 0.90, confirming its stability and consistency across different groups, including gender. The LONI is a valid tool for assessing ON. Its unidimensional structure allows for straightforward scoring, making it practical for clinical and research use. Additionally, its cultural specificity provides an advantage over existing ON screening tools, making it a valuable instrument for understanding eating behaviors in culturally similar populations.

Keywords Orthorexia nervosa, Scale validation, Psychometric properties, Cultural differences, Eating habits

Introduction

Orthorexia Nervosa (ON) has captured the attention of researchers and clinicians for its serious potential influence on individuals' health and wellbeing [1–3], despite the fact of not having a universally agreed on clinical diagnosis criteria [4] and not being officially recognized by the most recent *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision* (DSM-5-TR), or the *International Classification of Diseases* (ICD), or the *American Psychiatric Association* [5]. The term "orthorexia nervosa" was first introduced by Dr. Steven Bratman in 1997 [6], deriving from the Greek orthós (correct) and órexis (appetite), referring to an eating pattern that manifests compulsive behaviors and inflexible dietary rules in pursuit of optimal wellbeing through strict eating habits [7]. Unlike other ED that focus on the quantity of food, ON revolves around an unhealthy fixation on the quality of food eaten and the method of food preparation [8].

Individuals with ON may restrain their eating preferences to an extreme degree, avoiding a wide variety of food they deem as unhealthy or impure [8, 9]. This may generate profound frustration when food-related routines are interrupted or hindered, which arises feelings of repulsion along with guilt and dissatisfaction [3], leading to a significant decrease in quality of life triggered by social isolation, anxiety, and self-aversion [8, 9]. Although long-term empirical studies are lacking, literature has shown that this kind of extreme dietary restriction can lead to the same medical complications that one sees with severe Anorexia Nervosa (AN): osteopenia, anemia, hyponatremia, metabolic acidosis, pancytopenia, testosterone deficiency, and bradycardia [3]. In addition, patients with ON were reported to be suffering from the same physical complications as patients diagnosed with malnutrition from AN: nutritional deficiencies, electrolyte imbalances, metabolic acidosis, subcutaneous emphysema, and refeeding syndrome, as seen in recent case reports in 2011 [10]. Other research suggested that both AN and ON can lead to nutritional deficiencies, but the underlying motivations and specific behavioral manifestations are what sets them apart [11].

As ON started gaining attention over the years, several ON scales have been developed to assess and quantify the severity of orthorexic behaviors, each with varying degrees of reliability and validity. The various scales and inventories assessing ON developed across different countries, shared a common focus on the emotional, psychological, and social implications of rigid dietary practices and were all developed exclusively in Western countries (Orthorexia Nervosa Scale (ONS) [12], Bratman Orthorexia Test (BOT) [13], Burda Orthorexia Risk Assessment (B-ORA) [14], Eating Habits Questionnaire (EHQ) [15] and the Orthorexia Nervosa Inventory (ONI) [16]: United States; ORTO-15 [17] and ORTO-R [18]: Italy; Teruel Orthorexia Scale (TOS) [19]: Spain; Dusseldorf orthorexia scale (DOS) [20]: Germany). Overall, while these assessments overlap in their focus on the psychological and emotional dimensions of orthorexia, they each offer unique perspectives on specific aspects such as appearance, social relationships, and the impact of dietary rigidity on overall quality of life. These measures are accessible in multiple languages, making them useful in a variety of cultural contexts; yet they differ in how they conceptualize and define ON, ensuing inconsistency in assessing results and difficulty in distinguishing between healthy eating practices and pathological eating obsessions [16, 21]. For instance, given the complex relationship between culture and ON, and the serious gap in the existing assessment tools that have not been validated across different cultural settings, a study conducted on a Lebanese sample in 2019 showed a much higher prevalence of ON (75.2%) using the ORTO-15 [22] than

a study conducted a year later (8.4%) using the DOS [23]. The diagnosis of ON is still hindered by the definition of ON and agreed-upon diagnostic criteria. In 2022, a consensus document on definition and diagnostic criteria for ON was attained; however, one of its main limitations is the underrepresentation of participants particularly from Asia [24]. This not only affects the validity and reliability of ON-related research but also impacts the ability of healthcare professionals to identify and provide support for individuals struggling with ON [7], and make cross-cultural comparisons [25, 26].

Eating cultures and habits have been shown to differ significantly across countries [27–29], and the complexity of ON appears to be influenced by the cultural context in which it occurs [30]. Traditionally, Lebanon is known for its predominant Mediterranean diet [31], but recent studies showed that the diet of Lebanese adults has shifted towards a Western-style diet, both of which could be impacting the manifestation and perception of ON [32]. Indeed, the health benefits of the Mediterranean diet known for its preventive aspects against various diseases, contrast sharply with the Western diet increasingly being adopted in Lebanon which is characterized by a higher consumption of processed foods [33]. Hence, besides the fact that this dietary shift is contributing to the global trend of increasing obesity [32], the prevalence of ON may be further exacerbated by the psychological impact of the Western diet, where the influx of processed foods fosters a counter-reaction characterized by an unhealthy obsession with food purity and "clean eating", often resulting from extreme dietary restrictions that may begin as an attempt to avoid processed and unhealthy foods commonly found in Western diet [34]. Congruently, findings are suggesting that "western culture" contributes to the establishment of a high-risk environment for the development of orthorectic behaviors [35]. Such changes are also reflected in the rising prevalence and unique characteristics of ON, particularly as Western influences shape health perceptions and dietary behaviors [26].

This paper aims to create the first Eastern locally validated tool that considers the cultural nuances and specificity of the Lebanese population's eating attitudes and their social context, addressing the limitations of existing scales and providing a valid instrument that can be used by clinicians and researchers to better understand and screen for orthorexic tendencies in Lebanon and culturally-similar countries with respect to health preoccupation and eating habits. Accordingly, the LONI scale sets itself apart from other assessments by focusing on the Lebanese population's extreme preoccupation with health, nutrition, and supplementation. While other scales emphasize disturbed eating attitudes and the resulting frustration, guilt, and social isolation, the LONI highlights how this obsession prevents individuals from trusting established health guidelines, leading them to rely on misleading social media information. Additionally, it addresses previously overlooked issues, such as a preference for controlled industrialized foods over fresh produce and a fear of consuming anything that is not beneficial to their health. Hypochondria is also prevalent, with individuals constantly seeking to immune themselves against diseases. Overall, the LONI aims to provide a unique perspective on orthorexia shaped by cultural influences and social pressures.

Methods

Sample Procedure

This was a cross-sectional study using an online survey. Data collection was conducted between September 2023 and February 2024. Participants were eligible when they were 16 years or older, holders of a Lebanese nationality, residing in Lebanon, and had access to the Internet to complete the survey. Participants were recruited using a snowball sampling technique. The study was administered online via the Qualtrics platform and invitations to participate were disseminated via emails and social media platforms reaching out to communities and university students to disseminate on their platforms and each person reached was asked to pass the questionnaire on. Questionnaire took around 20 min to complete and no remuneration was provided.

Ethical considerations

Study objectives and general instructions were provided in the first page of the questionnaire. The study received ethical approval by the ethics committee from ERCPN from Maastricht University, Netherlands (Reference #: 275_136_12_2023) and the Institutional Review Board (IRB) from Lebanese American University, Lebanon (Reference #: LAU.SAS.RR4.2023.R1.30/Jan/2024). The protocol was registered with Aspredicted on March 2024 before the start of the statistical analysis. After providing participants with an online information letter about the content and the goals of the study, participants gave consent by clicking on the "Accept" button before the start of the online survey. The potential risk of discomfort for individuals with EDs was carefully addressed as participants were informed beforehand about questions regarding their eating patterns and body image (BI), and were advised to refrain from participating or withdrawing from the study if they felt uncomfortable or unable to tolerate potential triggers.

Measures

The first part of the questionnaire assessed the characteristics of the participants, including age, gender, marital

status, academic level, country of residence, profession, and financial situation.

The second part consisted of questionnaires to assess ON:

Lebanese Orthorexia Nervosa Inventory (LONI): The development of the LONI scale followed several steps. First, we extensively reviewed ON scales available in different countries: ORTO-R [18], DOS [20], ONS [12], ORTO-15 [17], TOS [19], BOT [13], B-ORA [14], EHQ [15], ONI [16]. Based on that, ORTO-R and DOS were chosen to be included in the questionnaire for convergent validity of the LONI because they are the most reliable as suggested by the literature [36]. Next, we pooled 25 items for the LONI based on existing literature (ONS [12], TOS [19], DOS [20], B-ORA [14], ONI [16]) and clinical experience. The authors recruited based on their expertise in psychology, psychiatry and dietetics gave their professional opinions based on their practice and clinical experience. The two main co-authors were the Lebanese experts in Nutrition and Psychology. While other scales have been focusing on the disturbed eating attitudes and frustration, guilt, discomfort and self-loathing of individuals when not complying to their own rules and its effect on their mental wellbeing, self-esteem and social isolation, the LONI has been created based on the clinical observation of the different culture of the Lebanese population that is highly focused on health, nutrition and supplementation to an extreme point where their preoccupation is keeping them from being able to trust the general health guidelines or health professionals "I can't trust general nutrition recommendations, I prefer to take extra measures on my own", "Sometimes I don't eat all the food served on my plate at restaurants or received from my diet center because I don't trust their choices regarding my health", " I don't trust the diet plan my dietitian gives me, I prefer to correct it myself " but at the same time could easily believe information taken from the social media influencers "I follow influencers online because they help me come up with my own diet strategy" what could be very misleading and triggering to their orthorexic tendencies even more. Moreover, somethings that did not exist in previous scales was the obsession with the preference of highly industrialized food over fresh raw food "I believe that supplements, bars and shakes are more reliable than raw fresh foods because of their controlled content of nutrients" and the fear of eating anything that is not beneficial to their health "I don't eat a meal that won't add benefits to my health". Hypochondria was also highly present among the Lebanese population who constantly seeks to immune itself against diseases "I have specific nutraceuticals that I regularly add to my diet", "I am convinced that avoiding the food I exclude from my diet is protecting me from getting cancer and other diseases". Items were initially developed in English and then translated to Arabic - the native language spoken by participating individuals in the current study. The items administered and their translations are provided in *Appendix 1.* We avoided lengthy, negatively worded, and double-barreled items. We decided on a Likert format for scaling of the agreement dimension that had five response options: [1] strongly disagree [2], disagree [3], don't disagree nor agree [4], agree [5], strongly agree. We chose the 5-point Likert scale because it is largely used in social science research to study human attitudes and perceptions, it is a common practice widely used in the literature, and we consider that a 5-point reference is a good balance that offers a variety of response options enough to capture the opinions while offering flexibility in data interpretation. Four authors (C.E., S.H., A.M, C.M.) of the research team that are experts on nutrition psychology and clinical psychology evaluated the items for clarity and conciseness. The questionnaire was piloted among 20 individuals from the authors surroundings that has no known eating disorders, we made sure they were not clinical patients of any author to avoid any bias of confusion. We followed the same methodology described for the bigger sample which is sending the link to them without any influence. No analysis was used, we sat as a research team with the translators and we proceeded by agreeing on the way we should move forward. Feedback from the pilot indicated no need for changes, hence tool was finalized.

Potential items are provided in Table 1 below.

Table 1 Potential items of the LONI

Item 8	I can't trust general nutrition recommendations, I prefer to take extra measures on my own
Item 15	Sometimes I don't eat all the food served on my plate at restaurants or received from my diet center because I don't trust their choices regarding my health
Item 16	I don't trust the diet plan my dietitian gives me, I prefer to correct it myself
Item 20	I follow influencers online because they help me come up with my own diet strategy
Item 17	I believe that supplements, bars and shakes are more reliable than raw fresh foods because of their controlled content of nutrients
Item 11	I don't eat a meal that won't add benefits to my health
Item 10	I have specific nutraceuticals that I regularly add to my diet
Item 12	I am convinced that avoiding the food I exclude from my diet is protecting me from getting cancer and other diseases

ORTO-R The ORTO-R, the revised version of ORTO-15, consists of six items scored on a five-point Likert scale (never, rarely, sometimes, often, and always) with higher scores suggesting an increased tendency toward ON [17, 37]. This tool has a high reliability with a Cronbach's α

ranging between 0.71 and 0.82 [36]. Also, the internal consistency and validity of this tool amongst a population of Lebanese young adults was confirmed [18].

DOS A 10-item scale using a 4-point Likert-scale from "this applies to me" (4 points) to "this does not apply to me" (1 point). Higher points indicate more pronounced orthorexic behavior with a maximum score of 40 points [38]. As a preliminary cut-off score to indicate presence of ON, a score ≥ 30 is used. A score between 25 and 29 (95th percentile) describes conspicuous eating behavior (indicating risk of ON) [38]. The Arabic version of the scale was validated in Lebanon with good structural validity and high internally consistency (α = 0.85) [39].

The third part consisted of questionnaires to assess characteristics that were reported in the literature to be associated with ON:

The Big Three Perfectionism Scale (BTPS): This 45-item self-report measure assesses multidimensional aspects of perfectionism through three global factors: rigid perfectionism, self-critical perfectionism, and narcissistic perfectionism. These are further divided into 10 core facets including self-oriented perfectionism, self-worth contingencies, concern over mistakes, doubts about actions, self-criticism, socially prescribed perfectionism, other-oriented perfectionism, hypercriticism, entitlement, and grandiosity [40]. The scale was evaluated across several studies, showing strong psychometric properties with exploratory and confirmatory factor analyses confirming its structure. The internal consistency for the global factors was robust, with Cronbach's α ranging from 0.92 to 0.93 [40]. The scale was validated in Lebanon [41].

The 12-item Obsessive-Compulsive Inventory (OCI-12): This is a 12-item measure used to assess obsessive-compulsive disorder (OCD) symptoms by focusing on four core OCD dimensions: washing, checking, ordering, and obsessing [42]. Each item is rated on a scale from 0 (not at all) to 4 (extremely); the scale yields four subscale scores and a total score by summing the responses across all items. We used the Arabic version of the OCI-12. Positive screening is defined as a total score of 11 or higher [42]. It has shown strong psychometric properties in a sample including Lebanese participants with a Cronbach's α of 0.87 and a McDonald's ω of 0.84, indicating good internal consistency and reliability [43].

The body areas satisfaction scale (BASS) This scale is a 10-item subscale of the Multidimensional Body-Self Relations Questionnaire, used to assess satisfaction with specific body areas and overall appearance [44]. It uses a 5-point Likert scale ranging from −2 (dissatisfied) to +2 (satisfied). The areas assessed include face, hair, lower torso, mid-torso, upper torso, muscle tone, height, and weight. The scale does not employ differential item weights, meaning all items are considered equally important in the evaluation of body satisfaction. The BASS has been demonstrated to have good internal consistency, with Cronbach's α values of 0.82 for men and 0.83 for women. This scale was translated into Arabic using reverse translation. The literature has shown that the BASS' test-retest reliability ranges from 0.74 to 0.86, confirming its stability over time [44].

Data Analysis

Sample Size Calculation.

A sample of 250 participants was needed for the exploratory factor analysis based on 10 participants per LONI scale's item [45] whereas a sample of 500 participants was needed for confirmatory based on 20 participants per LONI scale's item [46].

Analytic Strategy.

There were no missing responses in the dataset. We used the exploratory-confirmatory (EFA-CFA) factor analyses technique to examine the factor structure of the LONI [47]. We split the main sample using the random option in SPSS into two subsamples; subsample 1 consisting of 1/3 of the participants used for the EFA (n = 320; 68.1% females; mean age 26.67 ± 9.42 years) and subsample 2 consisting of 2/3 of the participants used for the CFA (n = 658; 62.5% females; mean age 25.99 ± 8.73). There were no significant differences between the two subsamples in terms of mean age, $t(974) = 1.08$, $p = .281$, $d = 0.07$, and genders χ^2 [1] = 3.01, $p = .083$.

Exploratory factor analysis on the first subsample. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Bartlett's statistics were assessed to check the suitability of the data. The Measure of Sampling Adequacy (MSA) at the item level was used to check whether an item needs to be eliminated from the analysis if values were below 0.50 [48]. The residual correlation between two items (referred to as doublets) was assessed via the Expected Residual correlation direct Change (EREC) index, which should be approximately 0. Items that repeatedly appear in different doublets were to be removed [49]. EFA was carried out with a polychoric correlation matrix given the ordinal nature of the variables and the high number of items with kurtosis and skewness values greater than |1 [50]. The method of estimation was Unweighted Least Squares (ULS), as recommended by international guidelines [51]. The Parallel Analysis (PA) was used to assess the number of factors to be retained [52, 53]. Loading factors ≥ 0.33 were considered adequate [54].

Confirmatory factor analysis on the second subsample. CFA was conducted via SPSS AMOS v.29 software. Parameter estimates were obtained using the maximum likelihood method. The model adequacy was verified via

several fit indices: the normed model chi-square (χ^2/df) (≤5), the Steiger-Lind root mean square error of approximation (RMSEA) (≤0.08), standardized root mean square residual (SRMR) (≤0.05), the Tucker-Lewis Index (TLI) and the comparative fit index (CFI) (both ≥0.90) [55]. Multivariate normality was not verified (Bollen-Stine bootstrap p=.002); therefore, we performed non-parametric bootstrapping procedure.

Gender invariance. To examine gender invariance of the LONI, we conducted multi-group CFA using the total sample [56]. Measurement invariance was assessed at the configural, metric, and scalar levels [57]. We accepted ΔCFI≤0.010 and ΔRMSEA≤0.015 or ΔSRMR≤0.010 as evidence of invariance [56].

The remaining analysis was done via SPSS software v.26. Composite reliability was assessed using McDonald's ω and Cronbach's α, with values greater than 0.70 reflecting adequate reliability. Normality of the LONI total score was verified since the skewness (=−0.232) and kurtosis (=0.372) values varied between −1 and +1 [58]. Consequently, the Pearson test was used to correlate two continuous variables, and the Student t test to compare two means. P<.05 was deemed statistically significant.

Results

Exploratory Factor Analysis (subsample 1)

None of the items of the LONI was suggested to be removed because of low MSA. However, three items were removed because of low communalities (1, 2, and 14) and the doublets identified through the EREC index led to the removal of items 3, 5, 7, 8, 9, 14, 19, 24 and 25, as they appeared the most frequently in the doublets. Another factor analysis was then conducted with the final 13 items. The KMO index (KMO=0.93) and Bartlett's test (p≤.001) confirmed the adequacy of the data for the factor analysis. The parallel analysis indicated an adequate fit to a unidimensional structure supported by the GFI (GFI=0.99) being greater than 0.95, the explained variance of 44.02%, the CFI of 0.99, the following indices: UniCo (UniCo=0.99) greater than 0.95, the I-ECV (I-ECV=0.90) greater than 0.85 and MIREAL (MIREAL=0.17) lower than 0.30.

Confirmatory Factor Analysis (subsample 2)

CFA results showed that the unidimensional structure of the LONI was acceptable: χ^2/df=301.68/65=4.64, RMSEA=0.074 (90% CI 0.066, 0.083), SRMR=0.044, CFI=0.926 and TLI=0.912. The loading factors resulting from the EFA and CFA are summarized in Table 2.

Table 2 Loading factors of the LONI from the EFA and standardized loading factors from the CFA

	EFA	CFA
4. When someone asks me to go out to eat, I start feeling anxious because I worry about having to make excuses to not eat unhealthy foods.	0.60	0.67
6. My food restrictions have led me to lose more weight than people would say is good for me.	0.65	0.63
10. I have specific nutraceuticals that I regularly add to my diet.	0.67	0.65
11. I don't eat a meal that won't add benefits to my health.	0.74	0.68
12. I am convinced that avoiding the food I exclude from my diet is protecting me from getting cancer and other diseases.	0.58	0.59
13. I can't trust general nutrition recommendations, I prefer to take extra measures on my own.	0.59	0.58
15. Sometimes I don't eat all the food served on my plate at restaurants or received from my diet center because I don't trust their choices regarding my health.	0.61	0.71
16. I don't trust the diet plan my dietitian gives me, I prefer to correct it myself.	0.60	0.65
17. I believe that supplements, bars and shakes are more reliable than raw fresh foods because of their controlled content of nutrients.	0.62	0.62
20. I follow influencers online because they help me come up with my own diet strategy.	0.62	0.64
21. I have an online presence on social media because I want to help other people by influencing them with what I eat and believe.	0.62	0.64
22. I take my own food along when eating away from home.	0.62	0.63
23. Sometimes I wish that I was less concerned about "unpure" foods I have consumed.	0.62	0.62

Note. LONI: Lebanese Orthorexia Nervosa Scale; EFA: Exploratory Factor Analysis; CFA: Confirmatory Factor Analysis

The composite reliability was good in subsample 1 (ω=0.89 / α=0.89), subsample 2 (ω=0.90 / α=0.90) and the total sample (ω=0.90 / α=0.90).

Gender invariance

All indices suggested that configural, metric, and scalar invariance was supported across gender (Table 3). No significant difference was found between males and females in terms of LONI scores (34.62±9.45 vs. 35.08±8.58, t(976)=−0.77, p=.442, d=0.05.

Table 3 Measurement invariance of the LONI across gender in the total sample

Model	CFI	RMSEA	SRMR	Model Comparison	ΔCFI	ΔRMSEA	ΔSRMR
Configural	0.926	0.052	0.046				
Metric	0.926	0.050	0.049	Configural vs. metric	<0.001	0.002	0.003
Scalar	0.926	0.048	0.049	Metric vs. scalar	<0.001	0.002	<0.001

Note. CFI=Comparative fit index; RMSEA=Steiger-Lind root mean square error of approximation; SRMR=Standardized root mean square residual

Convergent and concurrent validity

The LONI scores correlated significantly with higher ORTO-R (r=.57; p<.001), DOS (r=.70; p<.001), OCD (OCI-12) (r=.34; p<.001) and perfectionism (BTPS) (r=.43; p<.001) scores, but not with body appreciation (BASS) (r=−.01; p=.764).

The Table 4 shows the final LONI inventory consisting of 13 items.

Discussion

Development of the scale

A variety of scales have been developed despite the fact that no consensus definition nor standardized diagnosis for ON has been reached, although multiple authors have proposed diagnostic criteria for ON and made a case to formally recognize ON as an ED many theoretical papers have been published [24].

The aim of this study was to develop the LONI with a focus that is distinct from other scales that typically address the disturbed eating behaviors and the feelings of frustration, guilt or self-loathing that individuals experience when they do not adhere to their self-imposed rules, affecting their mental well-being, self-esteem and social isolation. While food habits are mainly related to social behavior [59], the LONI was specifically tailored to the unique cultural context of the Lebanese population, which places an intense emphasis on health, nutrition, and supplementation.

The first specific objective of this study was to analyze the original 25 items suggested by the experts. Item analysis revealed that 12 items had to be removed based on their low communality that did not exceed 0.3. Also, the EREC index showed that some items were linked with more than an item indicating a cross-loading that required their removal to keep every item independent and not linked with more than an item. Out of the 13 items that have been kept from the initial 25 items, only items 4 and 6 were inspired from other scales, the BORA and ONI scales respectively, whereas all remaining items selected were from our experts' customized additions based on their thorough clinical observations. This highlights how tailored the LONI is, ensuring its relevance and accuracy for the Lebanese culture, consolidating the purpose of the study to incorporate items reflecting the Lebanese eating habits, acknowledging the culturally-specific nature of problematic eating behaviors.

Health information sharing and exchange via social media is increasing in the Arabic speaking world [60]. Despite being highly involved in their health matters, studies are showing that the dietary knowledge of the Lebanese population is somehow low which is indicative that they lack intervention in terms of healthy eating habits [61, 62]. In addition, a recent scoping review showed that higher nutrition education levels lead to lower orthorexic tendencies [63], and this could be explaining how the strong focus on wrong health information might be potentially leading to the exacerbation of orthorexic tendencies. And while social media use was associated with an increased risk for EDs among a sample of Lebanese students [64], this might be potentially linked to the fact that the Lebanese population relies mostly on social media to attain nutrition information [65] and to be more

Table 4 Lebanese Orthorexia Nervosa Inventory (LONI)

	Strongly disagree	Disagree	Don't disagree nor agree	Agree	Strongly agree
3. *When someone asks me to go out to eat, I start feeling anxious because I worry about having to make excuses to not eat unhealthy foods.*					
4. *My food restrictions have led me to lose more weight than people would say is good for me.*					
5. *I have specific nutraceuticals that I regularly add to my diet.*					
6. *I don't eat a meal that won't add benefits to my health.*					
7. *I am convinced that avoiding the food I exclude from my diet is protecting me from getting cancer and other diseases.*					
8. *I can't trust general nutrition recommendations, I prefer to take extra measures on my own.*					
9. *Sometimes I don't eat all the food served on my plate at restaurants or received from my diet center because I don't trust their choices regarding my health.*					
10. *I don't trust the diet plan my dietitian gives me, I prefer to correct it myself.*					
11. *I believe that supplements, bars and shakes are more reliable than raw fresh foods because of their controlled content of nutrients.*					
12. *I follow influencers online because they help me come up with my own diet strategy.*					
13. *I have an online presence on social media because I want to help other people by influencing them with what I eat and believe.*					
14. *I take my own food along when eating away from home.*					
15. *Sometimes I wish that I was less concerned about "unpure" foods I have consumed.*					

prone to be influenced by social media [66] that could be potentially spreading misleading information with a paralleled insufficiency of national health recommendations that hinders the Lebanese's ability to trust general health guidelines or professionals.

When it comes to eating behaviors, a different dynamic comes at play. While literature emphasized the role of Western culture, societal transitions, and cultural ideas in the establishment of a high-risk environment for the development of orthorexic behaviors [35], the Lebanese diet has been shown to be shifting towards a more Western-style diet [22]. Drifting from the Mediterranean eating habits might be playing a role in triggering orthorexic tendencies as a study showed that the main reason behind the parent's drive to give their children supplementation is their feeling that their child does not eat fruits, vegetables, and a well-balanced diet anymore. All of which has been caused by the shift from a Mediterranean diet to a more Westernized and industrialized diet that has been proven to be increasingly causing more chronic diseases [67]. In fact, a study showed that 70% of the Lebanese adult population consumes dietary supplements [68], what consolidates the findings of the obsession of replacing food nutrition by dietary supplementation.

Furthermore, Lebanon ranked first among Western Asian countries in cancer incidence per population, with a rate of 242 cases per 100,000 citizens in 2018, according to the International Agency for Research on Cancer [69]. And while a study revealed significant knowledge gaps in cancer prevention and screening [70], the Lebanese population seems to be highly concerned with the prevention of the incidence of cancer and could be potentially seeking refuge in orthorexic tendencies translated by extreme food avoidance and amplified supplementation.

Psychometric properties of the LONI

We conducted a preliminary validation to establish psychometric properties of the LONI. For factorial validity, both EFA and CFA were conducted. Results suggested that the remaining 13 items can be regarded as a unidimensional construct. The high internal consistency, as indicated by composite reliability, with a Cronbach's α value of 0.90 and a McDonald's ω value of 0.90, provide clear evidence of its high reliability, supporting the stability and consistency of LONI scores across different subsamples. Utilizing composite reliability coefficients offers a valuable means to measure the reliability of scales with multiple dimensions [71]. This is beneficial as it permits a comprehensive analysis of a measure's psychometric properties [72]. Moreover, the structural characteristics, factor loadings, and item intercepts of the LONI remained consistent regardless of gender, affirming the scale's stability and reliability in measuring ON traits across diverse populations.

In addition, the findings demonstrated satisfactory correlations between LONI and DOS, suggesting similar validity. Specifically, the correlation with ORTO-R was moderate, while the correlation with DOS was strong. Also, LONI showed correlation with measures of perfectionism and OCD, consistent with previous findings linking ON with these variables [73]. However, LONI scores did not correlate with body appreciation, showing that the LONI focuses solely on ON traits rather than views of BI. In fact, this finding aligns with existing literature suggesting that ON focuses primarily on the purity and quality of food rather than BI or weight loss, which are central to AN and Bulimia Nervosa (BN) [36]. Furthermore, another study demonstrated that while individuals with AN and BN exhibit significant concerns with body size and shape, influencing their self-esteem and eating patterns, those with ON are typically preoccupied with health implications of food, without the direct influence on their body satisfaction [15]. In addition, ON has been shown to be sharing similarities with AN, particularly regarding restrictive eating patterns and food-related preoccupations, distinguishing between the two conditions rely on the absence of BI distortion and the primary focus on food quality and purity in ON [34]. This distinction is crucial for clinical assessments and interventions, as it highlights the need for different therapeutic approaches, as the focus in the case of ON is not on altering BI perceptions but rather on addressing the compulsive behaviors and cognitive distortions related to "healthy eating patterns" [11]. Additionally, a study explored the relationship between ON and EDs, revealing that in patients with EDs, orthorexic behaviors are less frequent with increased EDs pathology, indicating a complex interplay where ON might either precede or develop from the traditional EDs that we know [74]. With this in mind, our findings may second that ON is distinct from other EDs such as AN and BN which include negative and disturbed evaluations of weight and shape.

Overall, the findings suggest that the LONI is a valid tool for assessing ON, particularly in accounting for Mediterranean and Western influenced eating patterns within a Lebanese sample, irrespective of gender differences. The scale's unidimensional structure allows for straightforward calculation of the score, making it practical for both clinical and research use [41], while offering a unique advantage in considering regional dietary patterns compared with existing ON screening scales.

Study implications and research perspectives

Introducing the LONI as a screening tool could enhance early detection and intervention. Routine screening for ON should be advocated across healthcare settings. The culturally-specific LONI showed potential advantages over existing scales due to its good psychometric

properties and brevity. This carries substantial implications for the detection and intervention of ON, not only in Lebanon but also in other neighboring regions. Moreover, longitudinal studies utilizing the LONI could enrich our comprehension of ON within specific cultural and dietary landscapes, thereby guiding the development of targeted interventions. Given its good psychometric properties, the LONI could benefit from checking its test-retest reliability to study whether it performs in the same way on the long run. The LONI would also benefit from assessing its suitability across diverse cultural settings and using different languages. An additional venue to further validate the LONI would be an Ecological Momentary Assessment (EMA) [75] study focusing on rigid eating patterns including obsessing about the health and purity of food in relation to the LONI scores. In other words, a study that asks for people's actual thoughts, emotions, food choices and eating behaviors in the moment of their occurrence for a relatively long period of time, while relying less on people's memories. By registering states and behaviors at the moment they occur, investigating whether their LONI scores are predictive for their actual cognitions, affects, thoughts and behaviors could add valuable information to the literature.

A follow-up study with expert psychiatrists for the LONI cut-off clinical validation could be a very perceptive addition to the literature by validating ON against a gold standard diagnostic assessment."

Study strengths and limitations

To our knowledge, this is the first ON scale developed according to the cultural context of the MENA region, using a thorough review of the scales available in the literature, and pre-publishing a protocol with AsPredicted before the start of data analyses for transparency purposes. Strengths also include the final items selection to be mainly from the experts' customized additions, acknowledging the culturally-specific nature of problematic eating behaviors of the Lebanese population, highlighting tailored nature of the LONI.

Despite the promising findings, several limitations need to be taken into consideration. The reliance on self-report measures may introduce biases, necessitating further examination of the LONI's diagnostic validity through for example, structured clinical interviews. Additionally, it is imperative to acknowledge that our study utilized a snowball sampling technique for data collection. The reliance on individuals to recruit further participants may have led to a non-random selection process, potentially skewing our sample. This methodological approach, while convenient in certain contexts, may compromise the external validity of our findings. Future research aiming to validate LONI questionnaires, particularly within diverse cultural and linguistic contexts, is strongly encouraged to employ more robust sampling methodologies. Addressing these limitations will strengthen the generalizability and applicability of the LONI in diverse contexts.

Conclusion

This study successfully developed and validated the Lebanese Orthorexia Nervosa Inventory (LONI), a culturally tailored questionnaire designed to measure ON within the context of modern Lebanese dietary patterns. Through rigorous item analysis and validation processes, the LONI emerged as a unidimensional construct with high reliability and validity, suitable for both clinical and research applications. The scale demonstrated robust psychometric properties, including strong internal consistency and convergent validity with established ON measures, as well as its stability across gender differences.

Our findings indicate a high prevalence of ON within the Lebanese population, underscoring the significance of sociocultural and behavioral factors in its manifestation. The study highlights the LONI's potential to pave the way for early detection and intervention strategies for ON, emphasizing its advantages over existing tools due to its cultural specificity and psychometric strengths.

Despite these promising results, the study acknowledges limitations such as potential biases from self-report measures and snowball sampling. Future research should focus on validating the LONI through more rigorous methodologies and exploring its applicability across diverse cultural settings, EMA study focusing on rigid eating patterns including obsessing about the health and purity of food in relation to the LONI scores, and a follow-up study for LONI cutoff clinical validation. Addressing these limitations will further solidify the LONI's role as a reliable and effective tool for assessing ON, not only in Lebanon but also in broader regional contexts.

Abbreviations

LONI	Lebanese Orthorexia Nervosa Inventory
ED	Eating Disorders
ON	Orthorexia Nervosa
DSM	5-TR-Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision
ICD	International Classification of Diseases
APA	American Psychiatric Association
EFA	CFA-Exploratory-Confirmatory Factor Analyses
ω	Composite Reliability Omega
α	Cronbach's Alpha
ONS	Orthorexia Nervosa Scale
ORTO	15-Orthorexia Scale with 15 items
ORTO	R-Revised ORTO-15 Scale
TOS	Teruel Orthorexia Scale
BOT	Bratman Orthorexia Test
B	ORA-Burda Orthorexia Risk Assessment
EHQ	Eating Habits Questionnaire
ONI	Orthorexia Nervosa Inventory
DOS	Dusseldorf Orthorexia Scale
BTPS	Big Three Perfectionism Scale

OCI	12-12-item Obsessive-Compulsive Inventory
BASS	Body Areas Satisfaction Scale
KMO	Kaiser-Meyer-Olkin Measure of Sampling Adequacy
MSA	Measure of Sampling Adequacy
EREC	Expected Residual correlation direct Change
ULS	Unweighted Least Squares
PA	Parallel Analysis
RMSEA	Root Mean Square Error of Approximation
SRMR	Standardized Root Mean Square Residual
TLI	Tucker-Lewis Index
CFI	Comparative Fit Index
BI	Body Image
AN	Anorexia Nervosa
BN	Bulimia Nervosa
EMA	Ecological Momentary Assessment
MENA	Middle East and North Africa

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40337-024-01149-y.

Supplementary Material 1

Acknowledgements
We would like to acknowledge Ms. Rawan Ziab for her assistance with data collection.

Author contributions
ABM, CE, RR, SH, and SO were involved in the conceptualization of the study. CEK, PN, and SH curated the data. Data collection was conducted by ABM, CE, CEK, PN, RR, SH, and SO. The formal analysis was carried out by CE and SH. Methodology was developed by CE, CM, RR, and SH. CM, RR, and SH provided supervision. The original draft of the manuscript was written by CE, CEK, and PN. The manuscript was reviewed and edited by ABM, CM, RR, SH, and SO. All authors read and approved the final manuscript.

Funding
None.

Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study received ethical approval by the ethics committee from ERCPN from Maastricht University, Netherlands (Reference #: 275_136_12_2023) and the Institutional Review Board (IRB) from Lebanese American University, Lebanon (Reference #: LAU.SAS.RR4.2023.R1.30/Jan/2024). The participants gave consent to participate by clicking on the "Accept" button before the start of the online survey.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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Received: 15 August 2024 / Accepted: 5 November 2024
Published online: 18 November 2024

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