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Abstract

Purpose: This study represents a first attempt to explore the typology of female adults from a large non-clinical sample based on healthy orthorexia (HO) and pathological orthorexia (orthorexia nervosa, ON). **Methods:** 1245 female adults (Mage = 38.04, SD = 9.73) completed a set of questionnaires assessing orthorexic behaviors, intuitive eating, self-esteem, perceived social support as well as eating disorders, depressive and anxiety symptoms. **Results:** Cluster analysis based on HO and ON scores yielded 4 distinct groups: "Healthy orthorexia cluster (HO), "Orthorexia Nervosa cluster" (ON), "Low Orthorexia cluster" (LO) and "In-between Orthorexia cluster" (IBO). The HO and ON clusters represented individuals with, respectively, healthy and pathological interest in healthy diet. The LO cluster represented those with no particular interest in healthy eating and the IBO cluster showed that ON and HO behaviors can be associated in some individuals. Among all clusters, the ON cluster displayed highest levels of ED, anxiety and depressive symptoms. Inversely, the HO cluster displayed highest levels of intuitive eating, self-esteem and perceived social support. **Conclusion:** Altogether, findings from this study support the bidimensional structure of orthorexic eating behavior and further suggest that ON and HO behaviors can be associated in some individuals. Our findings further provide evidence for the assumption that ON and HO could be seen, respectively, as maladaptive and protective eating behaviors.

Level of evidence Level V, descriptive study.

Keywords: Orthorexia nervosa, Healthy orthorexia, Eating disorders, Cluster analysis

1.Introduction

Healthy eating has various positive outcomes such as reduced risk of depression [1, 2], cancer and heart diseases [3, 4]. However, extreme focus on healthy eating has been suggested as a potential pathological condition, called orthorexia nervosa (ON), leading to dietary restrictions [5], impaired social life, reduced psychological well-being [6] and severe malnutrition [7]. Yet, a recent study [8] pointed out that the interest in healthy eating could not be ranged from not interest at all to a pathological level without passing through a middle point of adaptive interest in healthy eating. In this regard, Barrada and Roncero [8] proposed to distinguish between orthorexia nervosa (i.e., pathological preoccupation with rigid healthy diet) and healthy orthorexia (HO) (i.e., healthy interest in healthy eating) and suggested that orthorexic eating behavior should be considered as a bidimensional construct.

Since, several differences between ON and HO were identified; ON was found to be associated with negative affect and ED symptomatology [8], weight control and affect regulation-related dietary choices [9]. HO, on the other hand, was found to be inversely associated with negative affect and ED symptomatology [8] and for HO the main motive for dietary choices was health-related consequences of what's eaten [9]. Depa, Barrada and Roncero [9] thus suggested that ON represented a maladaptive eating behavior motivated by weight control whereas HO reflected an adaptive interest in healthy food motivated by health-related concerns.

Yet, prior to this recent conceptualization of bidimensional orthorexic eating behavior, the literature mainly focused on ON behavior and further identified its other important risk factors and correlates such as depressive and anxiety symptoms [10] low levels of intuitive eating [11, 12] (i.e., an adaptive eating behavior and a protective factor against disordered eating [13]), and low self-esteem [14,15]. Together, these findings further supported and provided information on the maladaptive nature of ON behavior.

However, although HO is thought to be an adaptive and potentially protective eating behavior [8,16] its association with previously mentioned important correlates of ON behavior remains uninvestigated. Moreover, there is a considerable amount of empirical evidence on the association between ON and ED symptomatology (e.g., body image disturbances, body dissatisfaction, drive for thinness and bulimia) [14, 17, 18, 19], yet, only one study addressed the difference between ON and HO regarding their associations with ED symptomatology [8], thus this important finding could benefit from more empirical support. Additionally, poor social support is known to be a risk factor for the disruption of intuitive eating patterns [20] and the development of anxiety and eating disorders [21]. Yet, again, the question whether ON and HO differed from each other regarding their association with social support remains unexplored.

These research questions could be addressed using variable-centered methods (e.g., correlation, regression or other analyses aimed to describe the associations between variables). As it can also be seen in previously mentioned studies, these methods are commonly used in orthorexia literature.

Exploring the association of HO with these important correlates and risk factors of ON using variable-centered methods could further provide useful information regarding the presumed adaptive nature of HO. However, when it comes to understand the behavior of a group or a person, these methods display significant limitations [22].

In fact, variable-centered approaches underestimate the heterogeneity of individuals and propose general findings that might be inaccurate considering the fact that they result from the examination of samples combining dissimilar groups of individuals [23, 24]. Put differently, using variable-centered methods may not provide sufficient answers to the question whether individuals with ON and HO behaviors, respectively, would indeed differ from each other regarding their behavioral patterns, psychopathological features or other characteristics.

On the other hand, person-centered approaches, typological studies and the use of cluster analysis for example, overcome the reductionism of the variable-oriented approaches as they identify and distinguish between naturally occurring homogenous groups of individuals with similar characteristics or behavioral patterns [23, 24]. Thus, they may further reveal group-specific relations between variables that are masked or ignored by variable-centered approaches [23]. To our knowledge, only three typological studies using cluster analysis were conducted in orthorexia literature. Brytek-Matera, Staniszewska and Hallit [25] demonstrated distinct profiles of individuals (i.e., in terms of eating behaviors, physical activity, ED or obsessive-compulsive disorder (OCD) symptoms) with, without and at risk of ON, respectively. Yakın, Raynal and Chabrol [26] demonstrated the existence of naturally occurring distinct groups of individuals with ON, ED and OCD, respectively, with significantly different body image attitudes. Another study [27] demonstrated the naturally occurring distinct groups of individuals with different definitions of "healthy eating" and with significant differences regarding their tendencies towards ON, ED and OCD. Overall, these studies provided important information regarding the profiles of individuals with ON behavior, which may further be useful for development of potential diagnostic criteria and preventive measures.

Yet, to our knowledge, no person-centered studies have been conducted in order to identify homogeneous groups of individuals based on ON and HO behaviors. Using typological approach and cluster analysis to fill this gap would also allow to investigate whether individuals with ON and HO could be classified into natural occurring distinct groups. This would further allow to confirm the recently conceptualized bidimensional structure of orthorexic eating behavior. Moreover, these analyses would be useful to investigate whether subgroups of individuals with these orthorexic eating behaviors would differ from each other in terms of behavioral patterns, psychological or psychopathological features (i.e., intuitive eating, self-esteem, perceived social support, ED, depressive and anxiety symptoms.). Overall, this approach can deepen our understanding of the differences between ON and HO behaviors and allow us to better distinguish between pathological and non-pathological aspects of healthy eating. In terms of clinical implications, being enabled to better identify and distinguish between individuals with pathological eating behavior and those that

are simply health-conscious with healthy eating patterns, might further contribute to development of prevention or treatment strategies.

Starting from these considerations, the aims of this study were (a) to explore the typology of female adults from a large non-clinical sample based on ON and HO behavior (b) to investigate whether these profiles differed from each other regarding their levels of intuitive eating, self-esteem, perceived social support, ED, anxiety and depressive symptoms. Based on previous studies reporting higher prevalence of orthorexic eating behavior among women [19, 28] a non-clinical population of adult women was preferred in this study. Following previous research on eating behaviors [29], we recruited adult females aged between 18 to 55. As there is neither former study nor model on the typology of individuals with ON and HO behaviors, we used an exploratory approach and avoided formulating hypothesis on clusters. Yet, based on previously mentioned findings on maladaptive and adaptive natures of ON and HO behaviors, respectively, we expected clusters characterized by higher levels of HO, compared to those with higher levels of ON, to be associated with higher levels of intuitive eating, self-esteem, perceived social support and lower levels of psychopathology.

2. Method

2.1 Participants and Procedure

The data were collected through an online survey (created via Limesurvey) that was distributed on Facebook, in groups specifically dedicated to healthy eating and health-related contents (i.e., groups encouraging healthy eating and/or sharing “healthy” recipes). The link to this online survey contained a message presenting the aims of the study and the anonymity of the collected responses. Participants’ personal identifiers, email or IP addresses were not collected. All participants agreed to give their free and informed consent prior to completing the study. Individuals who were < 18 or > 55 years of age were excluded from the study. Bots and multiple entries were identified through usernames (participants were asked to provide only first letters of their name and last name and last two numbers of their year of birth) and time signatures (time taken to complete the questionnaire by each participant). Participants were all female (N = 1245), their mean age was 38.04 (SD = 9.73) and their average BMI was 25.34 (SD = 6.12). The study followed the World Medical Association Declaration of Helsinki. The study protocol was approved by the local ethics committee (Comité d’Éthique de la Recherche of Toulouse University).

2.2 Measures

First, participants completed a set of demographic questions (age, sex, educational level) and then the following questionnaires.

Orthorexic behaviors. The Teruel Orthorexia Scale (TOS) [8] was used to assess two dimensions of orthorexic eating behavior: HO (9 items; e.g., "I mainly eat foods that I consider healthy") and ON (8 items; e.g., "Thoughts about healthy eating do not let me concentrate on other tasks"). Items are scored on a 4-point Likert scale ranging from "0 = Completely disagree" to "3 = Completely agree". This scale was found to have satisfactory internal consistency with Cronbach’s α above 0.80 for both

factors [8]. In this study a French version of this scale was used. The translation for this scale was conducted by our colleagues CL and JC who were fluent in both languages. This translation process was supervised by HC. The cultural differences were also carefully taken into account, as one word or an expression could have different significations in Spanish and in French languages. The options of the scale were also carefully translated to have the same range as the original version. The revised French version of the scale was back translated into Spanish by HC and EY who were less familiar with the questionnaire, independently. The final translated version of the questionnaire was administered to a small group of students to check for the degree of construct overlap, clarity, understanding or spelling issues. As participants were found to be familiar with item formats and rating scales of the TOS there were no further necessary revisions to be made.

Disordered eating behaviors. The French versions of the Drive for thinness, Body dissatisfaction and the Bulimia subscales of the Eating Disorders Inventory-3rd Edition (EDI-3) [30] were used to assess disordered eating behaviors. The Drive for thinness subscale evaluates preoccupation with thinness, dieting and fear of gaining weight (7 items, e.g., "I am very afraid of gaining weight"). Body dissatisfaction subscale measures dissatisfaction with various areas of one's body (10 items, e.g., "I think my thighs are too large") and the Bulimia subscale evaluates the frequency of disturbed eating behaviors (7 items, e.g., "I eat moderately in front of others and stuff myself when they are gone"). Items are rated on a 6-point Likert scale ranging from "0 = Never" to "6 = always and recoded as 0, 0, 1, 2, 3, 4. The French version of the EDI-3 previously demonstrated satisfactory internal consistency with subscale Cronbach's alphas ranged between .68 and .89 in French populations [26, 30, 31] and it demonstrated significant correlations with ED-related variables (e.g., negative body image attitudes and low levels of motivation to change ED behaviors) [26, 30, 31].

Intuitive eating. The French version of The Intuitive Eating Scale-2 (IES-2) [32] was used to assess the intuitive eating and its three dimensions: Eating for physical rather than emotional reasons (8 items, e.g., "I find other ways to cope with stress and anxiety than by eating"), Unconditional permission to eat (4 items, e.g., "I do not follow eating rules or dieting plans that dictate what, when, and/or how much to eat" and Reliance on hunger and satiety cues (6 items, e.g., "I trust my body to tell me when to eat"). Items of this scale are rated on a 5-point Likert scale ranging from "1 = Strongly disagree" to "5 = Strongly agree". All items of the scale were summed to form a total intuitive eating score with higher scores indicating greater levels of intuitive eating. The French version of IES-2 was found to be a reliable measure of intuitive eating behaviors (satisfactory internal consistency with Cronbach's $\alpha = .85$ for the whole scale and above 0.70 for three subscales, test–retest reliability = 0.79 over a mean 8-week period) [32]. Its construct validity was supported via its associations with other measures of eating behaviors and psychological well-being (e.g., cognitive restraint, emotional eating, uncontrolled eating, depressive symptoms) [32].

Self-esteem. The French version of the Rosenberg Self-Esteem Scale (RSES) [33] was used to assess global self-esteem. This scale contains 10 items (e.g., "On the whole, I am satisfied with myself") rated on a 4-point Likert scale ranging from "1 = strongly disagree" and "4 = strongly agree". The French version of the RSES was found to be reliable measure of self-esteem (satisfactory internal consistency with Cronbach's α = .83 and test–retest reliability = .84 over a mean 3-week period [33]. Its construct validity was supported via its significant correlations with lower levels of depression and higher levels of life-satisfaction [33].

Anxiety symptoms. The French version of the Generalized Anxiety Disorder-7 (GAD-7) [34] was used to assess anxiety symptoms experienced by individuals in the preceding two weeks. The GAD-7 consists of 7 items rated on 4-point Likert scale ranging from "0 = Not at all" to "3 = Nearly every day". The French version of the GAD-7 [34] was found to be a reliable measure of anxiety symptoms (satisfactory internal consistency with Cronbach's α= 0.89) [35]. Its external validity was supported via its significant associations with worry (core symptoms of GAD) and depression [35].

Depressive symptoms. The French version of the Patient Health Questionnaire-9 (PHQ-9) [36], was used to assess depressive symptoms in the 2 past weeks. This scale contains 9 items (e.g., "having little interest or pleasure in doing things") rated on a 4-point Likert scale "0 = not difficult at all " to "3 = extremely difficult" with higher scores indicating greater severity of depressive symptoms. The French version of this scale was reported to have a good internal reliability with Cronbach's α above .80. [36]. Its criterion validity was measured against psychiatrist's DSM-IV diagnosis and it demonstrated good sensitivity and specificity in detecting all depressive disorders (65% and 76%, respectively) [36].

Perceived social support. The French version of the Multidimensional Scale of Perceived Social Support (MSPSS) [37] was used to assess perceived social support. This scale contains 12 items (e.g., "There is a special person in my life who cares about my feelings") rated on a 7-point Likert scale ranging from "1 = completely disagree" to "7 = strongly agree" with higher scores indicating higher perceived social support. The French version of the MSPSS was found to be a reliable measure of perceived social support (excellent internal consistency with Cronbach's α= 0.92 and acceptable test–retest reliability = .54 over a mean 12-week period) [37]. The divergent validity of this measure is confirmed by its significant negative correlation with depressive symptoms [37].

Body mass index. Participants were requested to provide their height and weight. BMI was calculated as kg/m^2.

2.3. Statistical Analysis

First, a confirmatory factor analysis was conducted on French version of the TOS to test the factorial structure found in the original study [8]. Cronbach's alpha reliability analyses were conducted to assess the internal consistency of two subscales of the TOS. Then, a hierarchical cluster analysis was conducted (Ward's method with Euclidean distance) on the whole sample to identify distinct groupings of participants based on their standardized scores for HO and ON. The

agglomeration schedule and dendrogram were used to identify the number of clusters. K-means clustering was then used to assign each individual to the identified clusters. Cluster group differences regarding studied variables were tested using one-way ANOVA for each variable. Tukey post hoc tests were conducted to determine which clusters were statistically different on each scale. Statistical analyses were performed using STATISTICA 11.

3. Results

3.1. Assessment of orthorexic behaviors with TOS

A two-factor confirmatory analysis was conducted to test the factorial structure of the TOS found in the original validation study [8]. As this scale uses a 4-point Likert scale, following the original validation study [8], we used Weighted Least Squares with Mean and Variance (WLSMV) estimation method which is more appropriate for ordinal data [38]. Confirmatory factor analysis was conducted in RStudio (Version 1.4.1103 for Macintosh), using the Lavaan and semTools packages. As recommended [39], we reported fit indices suitable for large samples: Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA). The two-factor solution showed a significant CFI of 0.91 and a GFI of .97 and a relatively low but acceptable SRMR of .09 and RMSEA of .09 (90% CI of RMSEA [.08, .09]). Values greater than .90 and .95 for the CFI and represent an adequate model fit [41]. Values closer to 1.00 for the GFI indicate a better model fit [40]. Values at or below 0.08 for the RMSEA and 0.06 for the SRMR represent a good model fit, when values for these indices below 1.00 are considered acceptable [41]. The Cronbach's α for the French versions of HO and ON subscales of the TOS showed good internal consistency (Cronbach's $\alpha = 0.86, 0.75$, respectively).

3.2. Cluster Analysis

Based on the dendrogram and the agglomeration schedule, a four-cluster solution was identified. The agglomeration schedule showed a sudden increase in linkage distance when four clusters were merged to three clusters (from 49.41 to 82.64). This indicated that the passage from four to three clusters would have more impact on the heterogeneity of the clusters than previous stages of the analysis. Therefore, the four-cluster solution was the most appropriate. A discriminant analysis showed clear differences between the four clusters (Wilks' $\lambda = 0.09$, $p < 0.001$) with 98.15% of cases correctly classified.

Data revealed a first group ($n = 298$ [24%]) characterized with mean score on ON that was above the sample mean by half standard deviation (SD) and with mean score of HO below the sample mean by half SD (Fig. 1). Thus, this group was called "Orthorexia nervosa" (ON) cluster. A second group ($n = 320$ [26%]) had a mean score on HO above the sample mean by more than half SD value and with score on ON above the sample mean by half SD value. This group was called "Healthy orthorexia" (HO) cluster. A third group ($n = 217$ [17%]) was characterized with mean scores on ON and HO that were both above the sample means by more than one SD value. Thus, this group was labelled "In-Between orthorexia" (IBO) cluster. A fourth group ($n = 410$ [33%]) had mean scores on

ON and HO that were both below the sample means by one SD value. Thus, this group was labelled "Low orthorexia" (LO) cluster.

3.3. Analysis of Variance

Using one-way analysis of variance and Tukey's HSD posthoc tests (Table 2), we compared the four clusters based on intuitive eating and its dimensions, self-esteem, perceived social support, ED symptoms, anxiety and depressive symptoms, as well as some sociodemographic variables.

In comparison with all other clusters, the ON clusters displayed greater scores in ED and depressive symptoms. Both ON and IBO displayed greater scores on anxiety symptoms compared to HO or LO clusters. In comparison with all other clusters, the HO cluster displayed greater scores in intuitive eating, ERP, RHSC, self-esteem, perceived social support and educational level. The LO cluster displayed greater scores in UPE compared to all other clusters.

Age differed between only between ON and LO clusters. These 2 clusters had higher BMI compared with the HO and IBO clusters. The HO cluster had higher educational level compared to ON and LO cluster. The effect sizes for these differences were below .04.

4. Discussion

It was recently suggested that orthorexic eating behavior should be considered as a bidimensional construct [8]. Yet, to our knowledge, no previous study to date has employed a typological approach to assess ON and HO behaviors and to investigate whether individuals with these behaviors could be classified into natural occurring distinct groups. The aim of the current study was, therefore, to use cluster analyses in order to identify the typology of French female adults from a large non-clinical sample based on ON and HO scores and further explore between group differences regarding their level of intuitive eating, self-esteem, perceived social support as well as ED, anxiety and depressive symptoms.

Cluster analysis yielded 4 distinct groups. A first group called HO represented individuals with a healthy interest in healthy eating while the ON group represented those with a pathological preoccupation with rigid healthy diet. LO represented individuals with no particular interest in healthy diet whereas the fourth group called IBO, characterized with high scores on both HO and ON, represented individuals who have both pathological and healthy behaviors in regard to a healthy diet (i.e., experiencing self-punishment when violating restrictive eating rules along with trying to convince people to follow a healthy eating). These clusters were quite similar in size, but they displayed significant differences on virtually all variables.

First, compared to all other clusters, the ON cluster displayed greater scores in body dissatisfaction, bulimia and depressive symptoms, and both the ON and IBO clusters displayed greater scores in drive for thinness and anxiety symptoms compared to other 2 clusters. These findings suggest that individuals with a pathological preoccupation with rigid healthy diet are more likely to develop ED, depressive and anxiety symptoms compared to those with HO or those who have no particular interest in healthy eating. These findings further support the assumption that ON

represented a maladaptive eating behavior associated with ED, depressive and anxiety symptoms [8, 10, 19].

On the other hand, the HO cluster, which showed the lowest levels of psychopathological features mentioned above, displayed greater scores on intuitive eating and its 2 dimensions: Eating for physical rather than emotional reasons and Reliance on hunger and satiety cues. These results suggest that compared to individuals with ON or to those with no particular interest in healthy eating, individuals with HO are more likely to 1) eat intuitively, 2) to eat because they are physically hungry rather than to cope with emotional distress and 3) to trust and use their body's internal hunger and satiety cues to determine when and how much to eat. Additionally, this cluster showed the highest levels of perceived social support and self-esteem. Together, these findings are in line with previous studies suggesting that individuals who eat intuitively had greater self-esteem, lower levels of preoccupation over food, body image disturbance and disordered eating [13].

It is important to note that intuitive eating is considered as a protective factor against disordered eating [13] and that poor social support is known to be a risk factor for the disruption of intuitive eating patterns and for the development of anxiety and eating disorders [21]. Thus, our findings on the between-group differences regarding their levels of intuitive eating and perceived social support can further explain in part the differences between HO and ON clusters regarding their levels of ED, anxiety and depressive symptoms. In fact, high levels of these psychopathological features in ON cluster may be due to the lack of perceived social support and intuitive eating.

Interestingly, compared to all other clusters, the LO cluster showed higher scores on the unconditional permission to eat, while the HO cluster showed higher scores on this subscale compared to ON and IBO clusters. This finding suggests that, while individuals with no particular interest in healthy eating allow themselves to eat unconditionally, selective and restrictive eating is present among individuals with HO and it increases significantly among individuals with ON. This result is in line with previous findings on the differences between HO and ON clusters regarding their associations with restrictive eating [8]. This result may be explained in part by different motives for dietary choices that were found to be associated with HO and ON. In fact, results from a recent study suggested that ON was related to weight control and affect regulation whereas, for HO, the main motive was health-related consequences of what's eaten [9]. For example, these motives may lead to elimination of processed food with negative health and environmental consequences in the case of HO, and in the case of ON, they may lead to elimination of foods that contain higher calories to help for weight-loss or -management. Of note, inter-group differences regarding age, educational level and BMI were found to be statistically significant but negligible in terms of effect size ($\eta^2 < .04$).

Together these findings have several implications. First and foremost, they demonstrate the existence of naturally occurring distinct groups of individuals with ON and HO behaviors, respectively. This finding further confirms and provides additional empirical evidence for the recently conceptualized bidimensional structure of orthorexic eating behavior. Moreover, our findings on the

existence of distinct IBO cluster suggest that these behaviors can also be associated among some individuals, which further implies the existence of another orthorexic profile characterized by an interest towards healthy eating that has both pathological and healthy aspects. This information can help clinicians and researchers to, not only better identify and distinguish between individuals with pathological eating behavior and those that are simply health-conscious with adaptive eating patterns, but also be aware of the existence of an "In-between" orthorexic group of individuals. This group, with the help of appropriate screening and intervention techniques, may serve as a starting point in early prevention or treatment of ON behavior. Our findings on between-group differences regarding important psychological and eating-related features, providing novel information on adaptive nature of HO, can be further useful at this point (e.g., establishing interpersonal interventions in order to enhance social support systems or promotion of intuitive eating and self-esteem to enhance HO and prevent the development or the maintenance of ON).

However, this study has several limitations. First, it was conducted with a non-clinical sample of French female adults who was recruited online. Thus, findings from this study cannot be generalizable beyond French population, to clinical or male populations. Moreover, the online survey was shared on different Facebook groups dedicated to healthy eating and health-related contents. Thus, individuals who are not interested or familiar with these concepts were not particularly reached out. Thus, the study may contain a selection bias due to the familiarity with the subject under investigation and therefore possible greater sensibility and tendency towards orthorexic behaviors. Further, the exploratory (rather than hypothesis or theory-driven), descriptive and cross-sectional nature of this study limits our ability to explain the causal interactions between findings or whether the identified profiles are stable over time or whether individuals may switch from one group to the other. While the use of confirmatory techniques could be helpful to replicate and confirm the profiles explored in the current study, longitudinal studies are needed to better analyze these issues. Future studies should also consider latent class analysis or latent class regressions as useful alternative techniques to explore, identify and distinguish between subgroups of individuals with similar characteristic. More importantly, this study did not conduct measurement invariance analysis to compare the French and the original versions of the TOS. Thus, it cannot assure whether the TOS is measurement equivalent across cultures. To our knowledge, no cultural adaptation studies of orthorexia measures conducted this analysis in order to investigate whether the translated questionnaire assessed the same construct as its original version. An investigation of orthorexia measures, including the TOS, measurement equivalence across cultures has yet to be conducted, this would make such cultural adaptations more meaningful. Finally, it is also important to note that ON cluster does not reflect ON patients and cannot provide information regarding the ON prevalence. Thus, the results from this study should be interpreted accordingly.

What is already known on this subject?

Orthorexic eating behavior was proposed recently as a bidimensional construct and several differences between its dimensions were identified using variable-centered methods (i.e., different motives for dietary choices, association with negative affect and ED symptomatology). Yet, to date no person-centered studies were conducted to assess profiles and distinguishable behavioral patterns of individuals with ON and HO behaviors.

What this study adds?

This study is the first to explore the typology of individuals based on ON and HO behaviors. Observed distinct clusters support the bidimensional structure of orthorexic eating behavior and further suggest that ON and HO can be associated in some individuals. This finding further implies the existence of an "In-between" orthorexic profile. Between group differences provide novel information on adaptive and potentially protective nature of HO.

5. Conclusion

To our knowledge this study is the first to identify the typology of female adults based on HO and ON behaviors. Our results document distinct group of individuals with HO, ON and with no particular interest towards healthy eating. Additionally, the IBO group suggests that ON and HO behaviors can be associated in some individuals. Together, these naturally occurring groups support the bidimensional structure of orthorexic eating behavior and further suggest that its two distinct dimensions can be experienced together by some individuals. Our results also document between group differences regarding several important psychological and psychopathological features. Overall, ON was found to be related with greater levels of ED, anxiety and depressive symptoms. Inversely, HO appeared to be associated with greater levels of intuitive eating and its components (i.e., eating for physical rather than emotional reasons and reliance on internal hunger and satiety cues) self-esteem and perceived social support. These findings offer support for the assumption that ON and HO could be seen, respectively, as maladaptive and protective eating behaviors.

Declarations

Funding

No funding was provided for this study.

Conflicts of interest

The authors have no conflicts of interest to declare.

Ethics approval

The study protocol was approved by the local ethics committee (Comité d'Éthique de la Recherche of Toulouse University).

Consent to participate

All participants agreed to give their free and informed consent prior to completing the study.

Consent for publication

All participants were informed that the results from this study were going to be published in scientific journals or congress.

Availability of data and material

The authors do not have permission to share data.

Code availability

Not applicable.

Authors' contributions

EY, HC and PR designed the study and wrote the protocol. EY conducted literature searches, provided summaries of previous research studies and conducted the statistical analysis. HC and EY participated in the back-translation of the TOS. EY wrote the first draft of the manuscript, HC and PR supervised the writing process. All authors contributed to and have approved the final manuscript**.**

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Fig.1 K-means clustering: Graph of means or four-cluster solution based on standardized scores for Healthy Orthorexia and Orthorexia Nervosa

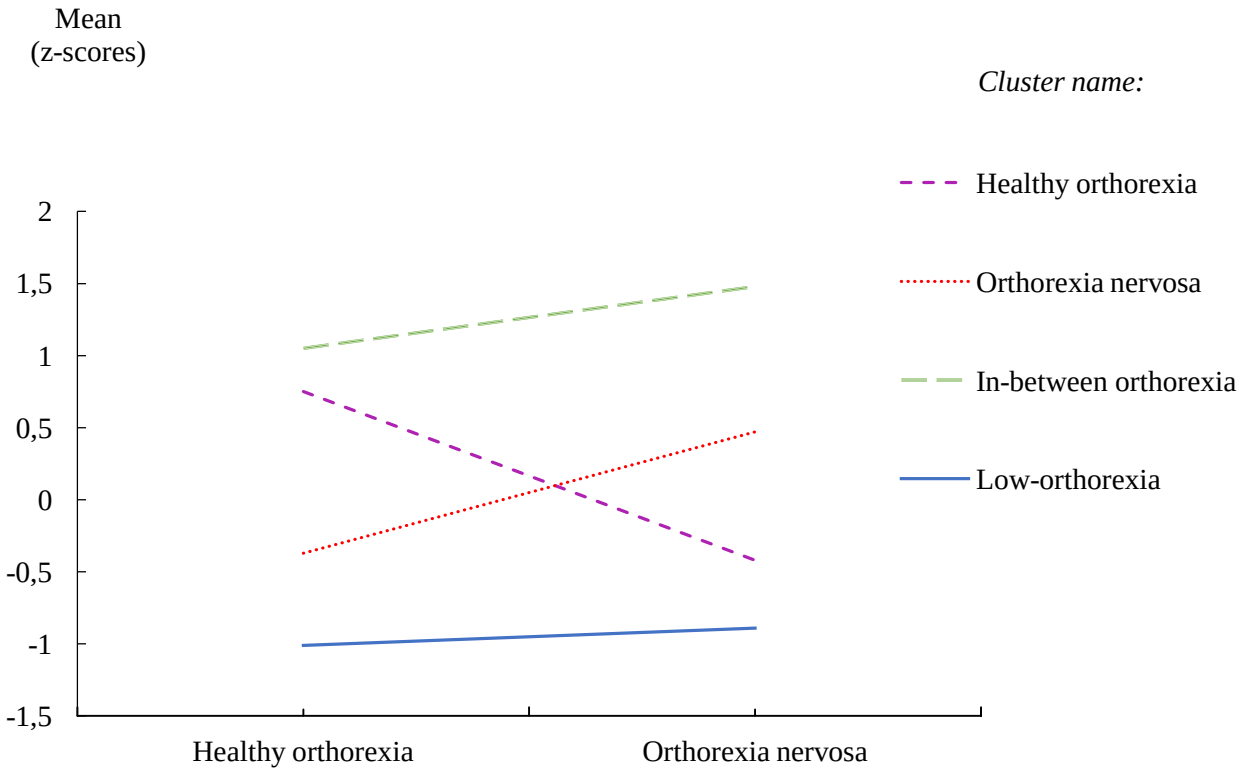

Table.1 Descriptive statistics and reliabilities for all variables

	Sample N = 1245 M (SD)	Range	α	MIC
Healthy orthorexia	13.59 (6.08)	0-27	.86	.41
Orthorexia nervosa	5.41 (4.13)	0-24	.75	.29
Intuitive eating	3.1 (.7)	1-5	.87	.28
EPR	3.07 (1.04)	1-5	.93	.62
RHSC	3.4 (.9)	1-5	.85	.49
UPE	2.69 (.83)	1-5	.55	.23
Self-esteem	29.4 (6.38)	11-40	.9	.48
Perceived social support	20.83 (6.19)	4-28	.95	.83
Body dissatisfaction	20.95 (9.05)	0-36	.87	.43
Drive for thinness	11.21 (7.38)	0-28	.84	.42
Bulimia	3.64 (4.18)	0-25	.79	.37
Anxiety symptoms	8.45 (5.81)	0-21	.92	.61
Depressive symptoms	8.87 (5.99)	0-27	.87	.43
Age	38.04 (9.73)	18-55	n.a	n.a
BMI	25.34 (6.12)	14.87-56.64	n.a	n.a
Educational level	3.14 (2)	1-7	n.a	n.a

Note. α = Cronbach's alpha. MIC = mean interitem correlation; n.a = not applicable; EPR, Eating for physical rather than emotional reasons; RHSC, Reliance on hunger and satiety cues; UPE, Unconditional permission to eat, measured with Intuitive Eating Scale-2.

Table 2. Typology of individuals based on Healthy Orthorexia and Orthorexia Nervosa. Cluster comparison using ANOVA and post-hoc test.

	Cluster *M (SD)*						
	Healthy orthorexia *n* = 320 (25.7%)	Orthorexia nervosa *n* = 298 (23.93%)	In-between orthorexia *n* = 217 (17.42%)	Low orthorexia *n* = 410 (32.93%)	*F*	η^2	significant comparisons
Healthy orthorexia	18.58 (3.06)	11.53 (3.03)	20.36 (3.62)	7.67 (3.23)	1047.58**	.72	IBO > HO > ON > LO
Orthorexia Nervosa	3.81 (1.95)	7.41 (2.12)	11.69 (3.2)	1.88 (2.58)	1073.39**	.72	IBO > ON > HO > LO
Intuitive Eating	3.41 (.61)	2.76 (.65)	2.98 (.71)	3.15 (.69)	50.38**	.11	HO > LO > IBO > ON
EPR	3.53 (.9)	2.69 (.99)	3.01 (1.06)	3 (1.04)	36.12**	.08	HO > LO > ON,IBO
RHSC	3.71 (.82)	3.05 (.91)	3.5 (.91)	3.33 (.86)	29.86**	.07	HO > LO, IBO > ON
UPE	2.71 (.8)	2.44 (.65)	2.13 (.68)	3.18 (.77)	107.48**	.20	LO > HO > ON > IBO
Body dissatisfaction	17.03 (8.2)	23.96 (7.97)	21.48 (9.77)	21.5 (9.04)	33.01**	.07	ON > LO, IBO > HO
Drive for thinness	8.5 (5.45)	14.74 (7.82)	14.36 (8.1)	9.14 (6.35)	68.16**	.13	ON,IBO > LO,HO
Bulimia	2.27 (2.76)	5.38 (5.23)	4.24 (4.54)	3.15 (3.62)	32.87**	.07	ON > IBO > LO > HO
Self-esteem	31.86 (5.87)	27.18 (6.17)	28.8 (6.69)	29.41 (6.1)	29.55**	.06	HO > LO > ON, IBO
Perceived social support	22.47 (5.53)	19.71 (6.16)	20.34 (6.83)	20.72 (6.11)	11.09**	.04	HO > ON,LO, IBO
Anxiety Symptoms	6.09 (5.03)	10.47 (5.91)	9.89 (6)	8.12 (5.5)	36.18**	.07	ON,IBO > LO > HO
Depressive symptoms	5.77 (4.35)	11.36 (6.12)	10.02 (6.19)	8.91 (5.8)	53.03**	.11	ON > LO, IBO >HO
Age	38.25 (9.46)	39.64 (9.52)	37.41 (9.62)	36.71 (9.9)	5.42*	.01	ON > LO
Educational level	3.50 (2.02)	3 (1.97)	3.37 (1.94)	2.88 (2)	7.06*	.01	HO > ON,LO
BMI	23.89 (5.33)	26.25 (5.67)	24.14 (5.29)	26.37 (7.07)	14.76**	.03	ON,LO > IBO, HO

Note. Degrees of freedom for all tests: 3.0; HO = "Healthy Orthorexia" cluster; ON= "Orthorexia Nervosa" cluster; IBO = "In-Between Orthorexia" cluster, LO = "Low Orthorexia" cluster. EPR, Eating for physical rather than emotional reasons; RHSC, Reliance on hunger and satiety cues; UPE, Unconditional permission to eat measured with Intuitive Eating Scale-2.

**p <.001, *p <.05