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Is orthorexia nervosa a feature of obsessive-compulsive disorder? A multicentric, controlled study

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Short title Overlap between orthorexia and obsessive-compulsive symptoms

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Abstract

Purpose The term Orthorexia Nervosa (ON) was coined to describe altered thoughts and behaviours related to healthy eating. The prevalence of ON was found to scale up to almost 90% among high-risk populations (ballet dancers, athletes, health-workers). ON seem to share psychopathological aspects with both Eating Disorders (ED) and Obsessive-Compulsive Disorder (OCD). The aim of the study was to analyse the frequency and intensity of ON symptoms among subjects diagnosed with OCD, hypothesising that they would be higher than in two control groups (subjects with anxiety-depressive disorders and general population).

Methods We conducted a multi-centre, observational, controlled study. Subjects filled in a socio-demographic questionnaire including questions related to life-style and two psychometric instruments: ORTO-15, for ON symptoms, and OCI-R, for OCD symptoms. Post-hoc analysis of the dataset was performed using the revised version of ORTO-15, the ORTO-R.

Results In the final sample of 328 subjects, the overall prevalence of ORTO-15-ON was 59.5%, mean score 37.9±4.2. The mean score at the ORTO-R was 16.6±4.6. No statistically significant differences were found in the prevalence of ON or in the mean ORTO-15 score among OCD patients and the two control groups, and this was confirmed by the multiple regression analysis. At the ORTO-R re-scoring, OCD patients scored significantly lower than the two clinical subgroups (p=.0005) and a lower ORTO-R score was associated to positivity at the OCI-R, confirming the initial hypothesis of the study.

Conclusions ON symptoms do seem to be more prevalent among subjects suffering from OCD. The psychometric properties of tools available to calculate ON symptoms, namely ORTO-15 vs. ORTO-R, play a relevant role in explaining such finding. ORTO-R seems to be a valid alternative able to overcome such difficulties, though further studies are needed to confirm this.

Declarations

Introduction

The term "Orthorexia" was coined by the American physician Steven Bratman in 1997.

Inspired by anorexia nervosa, the etymology comes from the Greek words "orthos" meaning "proper, correct" and "orexis" meaning "appetite". Orthorexia Nervosa (ON) indicates an 'obsession' for proper nutrition. Affected individuals are typically concerned about the quality, as opposed to the quantity, of food, and are prompted by the need to promote their physical health. Their typical daily routine is characterized by excessive preoccupations about planning of meals, accurate selection of products avoiding food considered impure and unhealthy, spending considerable time controlling and scrutinizing sources, processing and packaging (for example: use of pesticides, hormone supplementation, preservative addition, artificial flavouring, carcinogenic compounds). Furthermore, meal preparation and consumption must strictly respect the principles of healthy eating and satisfaction/frustration rely on the adherence/violations of all these self-imposed rules. Nutritional deficiencies due to elimination of entire food groups, severe weight loss or other medical complications may develop. Educational or occupational impairment and social isolation may also be observed, as a consequence of self-exclusion from social contexts prompted by keeping control of healthy eating [1-7].

After various proposals for ON criteria [1, 4, 8-10], the most recent have been conceptualized by Dunn & Bratman (2016) [11]. Consistently, several psychometric tools were developed to measure ON: the Bratman's Orthorexia Test (BOT) [1], a 10-item questionnaire in a yes/no format, was the first, further developed into the ORTO-15 [12]. Other tools, based upon different conceptualizations of ON were also developed, such as the EHQ (Eating Habits Questionnaire), the DOS (Dusseldorf Orthorexia Scale), the BOS (Barcelona Orthorexia Scale) and the TOS (Teruel Orthorexia Scale): these were applied on specific populations and only fragmented validations were performed. Most of these methodological weaknesses seemed to be influenced by the disagreement around ON conceptualization [13]. ORTO-15, despite being up to now the most accounted, translated, validated and used tool to measure ON in the world [14-17], was criticized for its low specificity and poor internal consistency, together with other flaws such as unclear terminology or inverse scoring, and the lack of adequate assessment of OC traits [18]. The ORTO-15 is described more in details in the Methods section of the present paper. A few adapted and modified versions of the ORTO-15 are available in different languages: the ORTO-11 in Turkish [14], the POLISH-ORTHO-15 in Polish [15], the ORTO-9-GE in German [16] and the ORTO-11-Hu in Hungarian [17].

Because of these limitations, only very recently a revised version of the ORTO-15 was developed, the ORTO-R. It consists of only 6 of the 15 original items (n. 3-4-7-10-11-12), considered to be the best markers of ON and allowing a better cross-cultural reliability [18].

To date, data on the prevalence of ON are mainly based on study on high risk populations such as residents and medical students, high school students, artists and athletes, dietitians and nutrition students [11]. The lack of a standardized definition of ON and, consequently, the use of different diagnostic criteria, psychometric instruments or alternative cut-offs, account for the high variability of prevalence rates, ranging from a

minimum of 12.8% in dieticians, using BOT [19] to a maximum of 88.7% in nutrition students, using an adaptation of the ORTO-15 [20]. Such a wide variability prevents a proper estimation of ON prevalence. Dunn et al. administered the ORTO-15 to 275 US college students. While the ORTO-15 scores showed a rate of 71%, after classifying students based on their rigidity about healthy eating and on their social/educational impairment or medical complications, the rate dramatically lowered to less than 1%, demonstrating that scoring positively does not imply fulfilling ON diagnostic criteria [21].

In Italy, Donini et al. [12] and Ramacciotti et al. [22] respectively found a prevalence rate of 6.9 and 57.6% in the general population, as measured by ORTO-15, Italian version [12] and assuming a cut-off score of 40. The study by Dell'Osso et al. [23] on a sample of 2130 University students using ORTO-15 with a cut-off score of 35 showed a prevalence of 34.9%.

ON is not (yet) mentioned as such in diagnostic manuals as DSM or ICD, and a fervent debate is ongoing on whether it should be considered as a new independent diagnosis, or a variant/subtype/pre-morbid condition of other disorders. More specifically, ON shares clinical features both with ED, particularly anorexia nervosa, and Obsessive-Compulsive Disorder (OCD), conditions that, moreover, may themselves be highly comorbid the one with the other. Also, ON shares features like perfectionism, excessive devotion, self-discipline, hyper-morality and preoccupation for details and rules with OC personality disorder.

Notably, other clinical conditions may share features with ON, such as somatic symptom disorders, and specifically health anxiety (as a motivation for dietary changes), or schizotypal personality disorder and schizophrenia, with reference to food-related magical thinking or delusions of poisoning and somatic influencing. Moreover, severe nutritional unbalances may trigger psychotic episodes in vulnerable subjects [5]. ON, measured with the Dusseldorf Orthorexia Scale (DOS), was found to overlap with other psychiatric conditions also by Strahler and coll. [24].

As to the overlap between ON and OCD, orthorexic subjects manifest recurrent, intrusive thoughts (similar to obsessions) about food, health contamination and impurity, which cause marked anxiety or distress; repetitive and strong needs (similar to compulsions) to prepare and consume food in a ritualized manner. Moreover, orthorexic ruminations and compulsions are time-consuming and cause clinically significant distress or functional impairment. The two disorders, together with anorexia nervosa, share traits of cognitive rigidity, anxiety traits and an elevated need to control.

However, differences between ON and OCD also exist: in OCD, obsessions and compulsions usually extend beyond food and health; also, the individuals realize their behaviours are excessive and unreasonable (the content of obsessions is basically perceived as ego-dystonic); finally, patients are secretive about their behaviours (as it commonly is in anorexia) and may develop depressed mood. On the contrary, in ON, subjects have flaunted behaviours and limited insight about their own condition (the content of obsessions is per-

ceived as ego-syntonic), features suggesting a psychopathological overlap with overvalued ideas [5,6], described by Wernicke as "a solitary, abnormal belief that is neither delusional nor obsessional in nature, but (…) preoccupying in the extent of dominating the sufferer's life" [25].

Anorexia nervosa differentiates from ON in terms of the focus on food quantity (and not quality), on low weight and thinness (and not health), and on the fear of becoming fat (and not impure or unhealthy), combined to compensatory behaviours such as excessive physical exercise or vomiting.

The clinical and epidemiological overlap between ON and ED has been assessed thoroughly [5]. Segura-Garcia et al. demonstrated and increased prevalence of ON in patients who followed a 3-year treatment course for ED [26]. As to the overlap between ON and disorders of the OC spectrum among clinical populations, most of existing data refer to non-clinical populations or populations at high risk for ON, that were analysed by comparing the concomitant presence of ON and OC symptoms [27, 28]. Barthels and coll. compared in terms of prevalence and features of ON, ED and OCD 3 samples constituted by: 40 patients with ED, 30 patients with OCD and two matched control groups of 33 and 30 subjects. ON was elevated among patients with ED but was similar to that of general population in the OCD patients [29].

Therefore, the aim of the present study was to analyse the prevalence and intensity of symptoms of ON as measured by the ORTO-15 among subjects diagnosed with OCD, and compare them to the same parameters among two control groups: one composed by patients suffering from other psychiatric conditions, specifically anxiety or depressive disorders; and the other composed by subjects with no psychiatric morbidity. We expected to find more ON symptoms among individuals with OCD, as a confirmation that, in a psychopathological perspective, ON shares significant features with disorders of the OC spectrum.

Materials and Methods

Study Design

Observational, multicentric, controlled study.

Population

It consisted of three groups, described as follows.

The first group (the OCD group) consisted of patients with a DSM-5 primary diagnosis of OCD consecutively referred to the psychiatric outpatient service of the San Luigi Gonzaga University Hospital (Turin, Italy) or to the community mental health centres of the Department of Mental Health of Modena, Italy.

The second group (the control group #1) consisted of patients with an established psychiatric diagnosis in the anxiety-depressive spectrum disorder, recruited at various services of the Department of Mental Health of Modena, Italy.

The third group (the control group #2) consisted of people without any psychiatric disorder, recruited as healthy volunteers from the University of Modena and Reggio Emilia (students and employees) and in other non-clinical contexts (e.g. public meetings) in Turin, Modena and Bologna (north of Italy).

Exclusion Criteria

Subjects could not be enrolled if they were:
- aged < 18 or > 70 years;
- suffering from severe psychiatric conditions affecting the understanding of the study or the ability to provide consent or presenting with acute and severe symptoms (such as psychosis, dementia or suicidal ideation) or not fulfilling the conditions to be included in one of the above mentioned research groups;
- insufficient or no understanding of the spoken and written Italian language.

Inclusion Criteria

Subjects could be enrolled:
- in the OCD group, if they had received a primary diagnosis of OCD according to the DSM-5 criteria;
- in the control group #1, if they had received a diagnosis of an anxiety and/or depressive disorder according to the DSM-5 criteria, but not of OCD;
- in the control group #2, if they declared not having received any psychiatric formal diagnosis and/or not receiving any active treatment for that;
- if they provided an informed, written consent to be involved in the study.

Measures

Subjects providing consent to be involved in the study were administered the following measuring tools:
- **Socio-demographic questionnaire**: a questionnaire developed *ad hoc*, including information on age, sex, marital status and living situation, education, occupation, place of residence and domicile, weight, height, level of physical activity, habits related to smoke, alcohol consumption and eating;
- **ORTO-15**: a self-administered questionnaire consisting of 15 items on a 4-point Likert scale ("always", "often", "sometimes" and "never"), in the Italian validated version [12]. A total score < 40 may suggest the presence of ON [20, 30], while scores higher than 40 predict normal eating behaviour [31], though the use of a more restrictive cut-off of 35 was suggested.
- **ORTO**-R: this is a reviewed version of ORTO-15, consisting of six of the original 15 items, and specifically items n. 3-4-7-10-11-12, to be scored according to the same 4-point Likert scale. Authors advise the use of the final score as a dimension, rather than to calculate prevalence. The ORTO-R proved to overcome some of the main limitations of ORTO-15 [18].

- **OCI-R**: a self-administered questionnaire consisting of 18 items on a 5-point Likert Scale, in its validated Italian version [32, 33]. The questionnaire aims at rating symptoms of OCD. It provides both a total and subscales scores, related to six different clinical components of OCD: washing, obsessing, hoarding, ordering, checking and mental neutralizing. A total score ≥ 21 may suggest the presence of OCD [33]. OCI-R was proved to show adequate psychometric properties and may be used also as an outcome measure, considering its sensitivity to treatment effects [34, 35].

[*The questionnaires are available upon request to the corresponding author*].

The questionnaires were distributed in anonymous paper versions during clinical outpatient visits, teaching sessions and other meetings; they required about 15 minutes to be filled in. Data collection occurred between October 2016 and December 2017. The ORTO-R score was calculated post-hoc, after recruitment had been completed, since this new version was not yet available when the study was originally designed.

Data from the questionnaires were subsequently included in an electronic database. The paper questionnaires as well as the signed forms for informed consent were stored appropriately.

The study was conducted according to the Good Clinical Practice principles, the Helsinki Declaration's statements and the current legislation regarding observational studies. The study was approved by the local ethics committee (Comitato Etico AVEN, Regione Emilia Romagna, Italy, Cod. 146/16, date of approval 9.9.2016).

Statistical Analysis

Statistical analysis was performed using STATA® software version 14 (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP). Descriptive statistics were presented for baseline demographic clinical characteristics for the entire group, as well as for the three subgroups. Continuous variables were presented as the number of patients (N), mean, standard deviation (SD), range (min-max) and compared between subgroups using Unpaired Student's t test for two groups or Anova for more than two groups; categorical variables were presented as frequency (N, percentage [%]) and compared using Pearson's chi-squared test.

A multivariate logistic regression model was carried out using a stepwise selection method to identify the prognostic factors between groups, and specifically the risk to being positive for ON, assuming it to be higher among subjects diagnosed with OCD. In the first step, the intercept-only model was fitted and individual score statistics for the potential variables were evaluated. A significance level of $p<0.05$ was used to allow a variable into the model. In stepwise selection, an attempt was made to remove any insignificant variables from the model before adding a significant variable to the model. Hosmer and Lemes how test was used to evaluate "goodness of fit" in the selection model. Data from the univariate and multivariate logistic

regression analyses were expressed as odds ratio (OR) and 95% confidence interval (CI). A p<0.05 was considered statistically significant.

Pearson correlations coefficients were used to look at the associations between ORTO-R and ORTO-15 scores and demographic variables, R >70% values were considered significant correlations.

Results

Description of the sample

A total of 345 people accepted to take part to the study and filled in the questionnaires, of which 50 in the OCD group, 42 in the control group #1 and 253 in the control group #2. Seventeen subjects of the latter group declared to suffer from a psychiatric disorder and were excluded, resulting in a control group #2 of 236 subjects and in a final sample of 328 people.

Table 1 describes the most relevant characteristics of the total sample and of each group separately, including the scores at the three psychometric tools, ORTO-15, ORTO-R and OCI-R (further details as collected by the socio-demographic questionnaire and not included in the table for brevity are available upon request from the authors).

Include table 1 about here

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As table 1 describes, the prevalence of ON as from a score <40 at the ORTO-15 was similar in the three groups. When considering the mean and SD of the ORTO-15 score comparatively in the three subgroups, the OCD patients scored lower, suggesting a higher ON symptomatology, though without statistical significance. When repeating this but with the ORTO-R, a statistical significance of the differences was found (p=.0005).

The three groups showed statistically significant differences for the following variables: sex (*p*<0.001), marital status (*p*=0.008), living situation (*p*<0.001), career (*p*=0.040), physical activity (*p*=0.017), alcohol consumption (*p*<0.001), the person who prepares the meals (*p*<0.003).

Features of the total 133 subjects with a negative ORTO-15 score were compared to those of the total 195 subjects with a positive ORTO-15 score. The orthorexic group showed a mean ORTO-15 score of 35.2 ± 3.2 (range 23-39), while the mean score of the non-orthorexic group was 41.8±1.8 (range 40-50). No statistically significant differences between the two groups emerged for any of the collected variables. Results of this analysis are included in *Table 2*.

Insert table 2 about here

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Logistic regression analysis

Table 3 displays the results of the multivariate logistic regression performed for the outcome "ON".

No statistically significant association was found between the risk to score positive at the ORTO-15 and being in any of the three subgroups of subjects. In other words, OCD patients, non-OCD patients and healthy controls did not differ for the risk to have ON symptoms. Among the remaining variables examined, only those who declared to follow a restrictive diet for weight control and those living with a roommate were found to have an increased risk to also suffer from ON (respectively OR 2.39, IC 1.18-4.82, p=.014; OR 2.90, IC 1.32-6.37, p=.008).

Insert table 3 about here

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Finally, variation of both the ORTO-15 and ORTO-R scores in the whole sample and, comparatively, in the three sub-groups was analysed by means of Anova and t-test.

The ORTO-15 score variation was associated to civil status of respondents in the whole sample and in control group #1 (non-OCD patients), with widowers showing more ON symptoms than subjects with partner or separated/divorced (Anova, p = .0250 and .0170 respectively). The ORTO-R score variation was associated to degree of education and intensity of physical activity in the whole sample, with ON symptoms more frequent in less educated subjects (p = .0043) and in those practicing high-frequency physical activity (p = .0341); lower education was associated to more ON symptoms also among OCD patients (p = .0105).

Both ORTO-15 and ORTO-R variations were associated with statistical significance to both positivity at the ORTO-15 (scoring 40 or less) (t-test, p = .000 and .000, respectively) and concurrent positivity at the ORTO-15 and the OCI-R (t-test, p = .000 and .000, respectively).

The ORTO-R variation, finally, was also associated to the OCI-R score, more specifically a positive OCI-R score was associated to a lower ORTO-R score (t-test, p = .0266).

(Detailed results of these analyses are available upon request to the corresponding author).

Discussion

The present study was designed with the purpose to investigate the prevalence and intensity of symptoms of ON in patients diagnosed with OCD, in comparison to subjects with disorders of the anxiety-depression spectrum and healthy controls.

The main finding of the study was that subjects with OCD show a higher amount of ON symptoms, but only after refining the methodology of measurement, introducing the revised version of the ORTO-15, the ORTO-R. This result seem to support the concept that a correlation may exist not only between ON and ED, but also between ON and OCD. This is in contrast with what observed in the work of Barthels and coll., where the

association between ON and OCD was disconfirmed, while they discovered a high prevalence of orthorexic symptoms in subjects with ED [29], whereas Strahler and coll. found a correlation between ON symptoms and OCD, though less strong than with pathological eating (30 vs. 78%) [24]. In our sample, we found more ON symptoms among subjects who declared to follow a restricted dietary regime for weight control. Finally, when studying the variation of the score of ORTO-R, a lower ORTO-R, suggesting more ON symptoms, was associated to a positive OCI-R score. This association did not reach statistical significance when using the ORTO-15.

ON symptoms were also more common among subjects not living with family members but with roommates were found at higher risk for ON: though this was not also true for subjects living alone, it may be argued that life in a familial context may be more protective as to having healthy – but not excessively healthy – alimentary habits.

A high prevalence of ON symptoms was found in our sample: this is in line with previous research [20, 22, 36-38]. Dell'Osso and colleagues [23] found a prevalence of ON of 34.9%, lower than the ones calculated in our sample. This is attributable to the choice of 35 as a cut-off score, which is more restrictive: in a study conducted by Ramacciotti and coll., the prevalence of ON dropped from 57.6% to 11.9% when shifting from the 40- to the 35-cut-off [22], raising the concern that a cut-off of 40 is associated with false ON positivity.

The very high prevalence of ON found in our study, therefore, contributes to the debate on the psychometric properties of the ORTO-15, and particularly its specificity when used in the general population rather than on high-risk groups [10, 15, 16, 39]. The ORTO-R was developed also with the aim to overcome this limitation, and our results confirmed that ORTO-R may support a better diagnostic definition than ORTO-15: the difference in mean score among the three subgroups in the present study, that did not reach statistical significance when using the ORTO-15, did so when switching to ORTO-R. Also, only variations in ORTO-R, and not in ORTO-15, were associated to a positive score at the OCI-R, supporting the hypothesis that ORTO-R allows a better definition of OC-related features of ON, as suggested by its developers [18]. ORTO-R is still a very recent development, its larger scientific and clinical use in the next future will hopefully provide further confirmation of this.

Previous prevalence studies of ON in the general population revealed contradictory results also when discussing the role of age, gender, marital status, education level, BMI, smoking and alcohol consumption [8, 40-43]. In the original version of the present study, when using ORTO-15 to calculate prevalence of ON, no significant associations were found between positivity to ORTO-15 and the different socio-demographic variables analysed. Many authors have advised that the ORTO-15 and ORTO-R scores should be used as dimensions rather than as categorical variables: when studying our sample in these terms, a better definition of different features associated to score variation was found, both in the whole sample and in the three sub-groups, in some cases confirming the role of risk factors, such as intense physical activity, in some other with more contrasting results (e.g. more ON symptoms in less educated subjects).

Limitations of the study

Some limitations of the present study have to be acknowledged, as they might have an impact on generalizability of results. The first was, as just mentioned, the relatively small sample size of 328 subjects. Considering the increasing impact of ON-related 'styles' and behaviours in the general population, anyway, we hope that the present study may contribute to prompting further clinical research on this topic, on larger samples.

Secondly, the sample was not completely homogenous, with differences about socio-demographic variables, despite our efforts to minimize disparities between the subgroups. One significant discrepancy was already acknowledgeable during recruitment, since most of the OCD subjects were recruited at the Psychiatric Clinic in Turin, where a highly-specialized outpatient clinic for OCD is run. The role of cultural context, e.g. living in big cities vs. in rural surroundings, or level of education, is known to be relevant in the epidemiology and features of ON [10, 38], and further studies should better control this potential bias. Also, data on educational level and occupation of many subjects in the control subgroup were not available and not included in the analysis, resulting in potential partial alteration of findings.

A further limitation may be the choice to use the ORTO-15 questionnaire as a measure for ON symptoms, as already discussed above. The ORTO-15 was chosen in a stage of development of the research project when no other significant options were available, and also because, being by far the most used psychometric tool in ON-related scientific literature, its use would have allowed comparison to the majority of existing data on ON. Moreover, a re-analysis of the sample by means of the ORTO-R, subsequently introduced, consented the overcoming of this limitation.

Albeit self-rated tools are more feasible, their use could have limited the reliability of data [44], particularly considering the tendency to secrecy or self-over/under-estimation of behaviours like the ones here investigated, known for being socially criticized or appreciated (attention to the choice of food, to physical shape, to weight, and so on…). For example, habits related to physical activity are overestimated, whereas weight and risk behaviours are underestimated [41, 45]. This bias may have concerned in particular controls in the #2 group, who were defined not suffering from mental conditions only on the basis of self-declaration. Finally, we were unable to control for treatment adherence and effectiveness of both subjects with OCD and subjects with anxiety and depression disorders. Nevertheless, the aim of the assessments employed in this study was to focus on stable, persistent traits and beliefs that may be less influenced by medications.

What is already known on this subject?

- The psychopathology of ON as a clinical condition is under study

- The most frequently used psychometric tool to measure ON is the ORTO-15

- ON shares psychopathological features with ED and disorders in the OC spectrum

- A dimensional use of ON symptomatology as measured by psychometric tools should be preferred to prevalence calculation

What this study adds?

- The ORTO-R, but not the ORTO-15, allows differentiating clinical and not clinical populations in terms of overall ON symptomatology and OC features of ON
- Elements supporting a psychopathological connection of ON to disorders of the OC spectrum were found, but only when using ORTO-R

Conclusions

Bratman himself, the author who introduced the term "orthorexia" about 20 years ago, declared to be surprised of the increased attention from researchers for ON. The number of scientific papers dedicated to ON, as recently searched on PubMed using the key-word "orthorexia" raised from 57 to 135 in the last 3 years, suggesting the growing interest of the scientific community over this topic, with specific reference to the status, or not, of ON as a full-blown syndrome. The ORTO-R was recently introduced, with the aim to support further the most correct clinical definition of ON [18].

Existing literature and clinical observation have suggested that ON may share significant characteristics with both ED and OCD [24]. ORTO-R, though not ORTO-15, was found to be associated to concomitant OC symptoms and ORTO-15 and ORTO-R mean scores were lower among patients diagnosed with full-blown OCD, though with a statistical significance only with ORTO-R. This confirms the evidence that the psychometric properties of these tools are relevant in explaining these findings, with ORTO-R as a possible more reliable alternative, for both research and clinical use.

Future studies are needed to better understand the underlying psychopathological mechanisms of ON, and to confirm the relevance and reliability of raising this set of behaviours to the status of a bona fide mental disorder.

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TABLES

Table 1: Socio-demographic description of the sample.

		OCD group N=50		Control group #1 N=42		Control group #2 N=236		Total N=328		*p*-value
		Mean±SD (range)								
Age		38.3±12.7 (19-69)		46.2 ±13.7 (22-69)		34.5 ±13.5 (19-65)		36.5 ±13.8 (19-69)		n.s.
		N	%#	N	%	N	%	N	%	
Sex	M	34	68.0	7	16.7	101	42.8	142	43.3	<0.001
	F	16	32.0	35	83.3	135	57.2	186	56.7	
Marital status	Single	28	56.0	11	26.2	106	44.9	145	44.2	0.008
	With partner	20	40.0	25	59.5	117	49.6	162	49.4	
	Divorced/separated	2	4.0	3	7.1	9	3.8	14	4.3	
	Widower	0	0.0	3	7.1	2	0.8	5	1.5	
Area of residence	Lowland (<200 mt a.s.l.)	43	86	33	78.6	221	93.6	297	90.5	0.007
	Hill (200-600 mt a.s.l.)	7	14	8	19	11	4.7	26	7.9	
	Mountain (>600 mt a.s.l.)	0	0	1	2.4	4	1.7	5	1.5	
Living situation	With parents	24	48.0	9	21.4	92	39	125	38.1	<0.001
	With partner/children	16	32	24	57.1	72	30.5	112	34.1	
	Alone	9	18	8	19	28	11.9	45	13.7	
	With roommates	1	2	1	2.4	44	18.6	46	14	
Degree of study	Middle school	12	24	9	21.4	Missing		21	6.4	n.s
	High school	25	50	22	52.4			47	14.3	
	Bachelor's degree	3	6	3	7.1			6	1.8	
	Graduation degree	7	14	5	11.9			12	3.7	
	Post-graduation degree	2	4	2	4.8			4	1.2	
Occupation	Full-time job	21	42	22	52.4	Missing		43	13.1	0.040
	Part-time job	4	8	6	14.3			10	3	
	Student	8	16	4	9.5			12	3.7	
	Housewife	4	8	5	11.9			9	2.7	
	Unemployed	10	20	0	0			10	3	
	Disable	0	0	0	0			0	0	
	Retired	1	2	4	9.5			5	1.5	
	Other	1	2	1	2.4			2	0.6	
		Mean ± SD (range)								
BMI		25.2 ±4.7 (0-36.3)		24.2 ±4.9 (17-38.1)		23.5 ±4.8 (16.3-57.7)		23.8 ±5.0 (0-57.7)		n.s.
		N	%	N	%	N	%	N	%	
Satisfied with own physical condition?	Yes	22	44.0	19	45.2	137	58.1	178	54.3	0.088
	No	28	56.0	23	54.8	99	41.9	150	45.7	
Practicing physical activity?	Yes	21	42.0	21	50	147	62.3	189	57.6	0.017
	No	29	58.0	21	50	89	37.7	139	42.4	
Smoking	Yes (less than 10 cigarettes)	2	4.0	4	9.5	34	14.4	40	12.2	n.s.
	Yes (10-20 cigarettes)	4	8.0	4	9.5	22	9.3	30	9.1	
	Yes (more than 20 cigarettes)	1	2.0	0	0,0	1	0.4	2	0.6	
	No	43	86.0	34	81	179	75.8	256	78	
Alcohol consumption	Yes (every day or almost every day)	6	12.0	5	11.9	20	8.5	31	9.5	<0.001

	Sometimes (max 1-2 times a week)	14	28.0	10	23.8	131	55.5	155	47.3	
	Never or almost never	29	58.0	27	64.3	84	35.6	140	42.7	
	Missing values	1	2.0	0	0	1		2	0.6	
Who prepares your meals?	You	22	44.0	30	71.4	160	67.8	212	64.6	<0.003
	Others	28	56.0	12	28.6	75	31.8	115	35.1	
Dietary regime	Free	40	80.0	34	81	172	72.9	246	75	n.s.
	Controlled (lose weight)	5	10.0	7	16.7	36	15.3	48	14.6	
	Controlled (other causes)	5	10.0	1	2.4	28	11.9	34	10.4	
OCI-R total score	Positive (≥ 21)	30	60.0	18	42.9	56	23.7	104	31.7	**<0.001**
	Negative	20	40.0	24	57.1	180	76.3	224	68.3	
ORTO-15 total score	Positive (<40)	32	64.0	24	57.1	139	58.9	195	59.5	n.s.
	Negative	18	36.0	18	42.9	97	41.1	133	40.5	

		Mean ± SD (range)				
OCI-R total score		26.9±15.7(0-59)	19.7±10.4 (5-48)	14.9±9.7 (0-55)	17.3±11.7 (0-59)	**<0.05**
	OCI-R hoarding	3.5±3.4 (0-12)	4.5±3.0 (0-11)	3.5±2.6 (0-12)	3.6±2.8 (0-12)	n.s.
	OCI-R checking	5.2±3.8 (0-12)	2.6±2.4 (0-12)	2.3±2.2 (0-12)	2.8±2.7 (0-12)	**<0.05***
	OCI-R ordering	4.1±3.5 (0-12)	3.7±2.9 (0-12)	3.3±2.7 (0-12)	3.5±2.9 (0-12)	n.s.
	OCI-R mental neutralizing	2.8±34 (0-12)	1.0±1.5 (0-6)	0.8±1.5 (0-9)	1.1±2.1 (0-12)	**<0.05****
	OCI-R washing	3.7±3.5 (0-11)	2.1±2.5 (0-12)	1.8±2.3 (0-12)	2.1±2.6 (0-12)	**<0.05*****
	OCI-R obsessing	7.4±3.5 (0-12)	5.5±3.3 (0-12)	2.9±2.9 (0-12)	3.9±3.6 (0-12)	**<0.05**
ORTO-15 total score		36.8±5.5 (23-45)	38.1±5.1 (25-50)	38.1±3.7 (28-47)	37.9±4.2 (23-50)	n.s.
ORTO-R total score		14.8±6.1 (6-23)	15.2±5.0 (6-24)	17.2±4.0 (6-24)	16.6±4.6 (6-24)	**<0.05*******

sums of frequencies not equal to 100 are due to missing values

* p<0.005 for controls #1 vs OCD and OCD vs controls #2

**p<0.005 for controls #1 vs OCD and OCD vs controls #2

*** p<0.005 for controls #1 vs OCD and OCD vs controls #2

**** p<0.005 for controls #2 vs both OCD and controls #1

Table 2: Comparison between subjects with a positive vs. negative ORTO-15 score.

		ORTO-15				*p*-value
		Negative **N = 133**		**Positive** **N = 195**		
		Mean ± SD (range)				
Age		37.2±14 (19-69)		36.1±13.9 (19-49)		n.s.
		N	%#	N	%	
Sex	M	58	43.6	84	43.1	
	F	75	56.4	111	56.9	
Marital Status	Single	60	45.1	85	43.6	n.s.
	With partner	65	48.9	97	49.7	
	Divorced/separated	7	5.3	7	3.6	
	Widower	0	0.0	5	2.6	
Area of residence	Lowland (< 200 mt a.s.l.)	122	91.7	175	89.7	n.s.
	Hill (200-600 mt a.s.l.)	9	6.8	17	8.7	
	Mountain (> 600 mt a.s.l.)	2	1.5	3	1.5	
Living situation	With parents	55	41.4	70	35.9	n.s.
	With partner/children	49	36.8	63	32.3	
	Alone	18	13.5	27	13.8	
	With roommates	11	8.3	35	17.9	
	Other (specify)	0	0.0	0	0.0	
Degree of study	Middle school	6	4.5	15	7.7	n.s.
	High school	18	13.5	2	1.0	
	Bachelor's degree	5	3.8	1	0.5	
	Graduation degree	4	3.0	8	4.1	
	Post-graduation degree	2	1.5	2	1.0	
Occupation	Full-time job	18	13.5	25	12.8	n.s.
	Part-time job	2	1.5	8	4.1	
	Student	4	3.0	8	4.1	
	Housewife	5	3.8	4	2.1	
	Unemployed	5	3.8	5	2.6	
	Disable	0	0.0	0	0.0	
	Retired	2	1.5	3	1.5	
	Other	0	0.0	2	1.0	
		Mean ± SD (range)				
BMI		23.9±4.8 (0-41)		23.8±5.2 (0-57.7)		n.s.
		N	%	N	%	
Satisfied with own physical condition?	Yes	76	57.1	102	52.3	n.s.
	No	57	42.9	93	47.7	
Practicing physical activity?	Yes	80	60.2	109	55.9	n.s.
	No	53	39.8	86	44.1	
Smoking	Yes (less than 10 cigarettes)	15	11.3	25	12.8	n.s.
	Yes (10-20 cigarettes)	16	12.0	14	7.2	
	Yes (more than 20 cigarettes)	1	0.8	1	0.5	
	No	101	75.9	155	79.5	
Alcohol consumption	Yes, every day or almost every day	13	9.8	18	9.2	n.s.
	Sometimes (max 1-2 times a week)	68	51.1	87	44.6	

	Never or almost never	51	38.3	89	45.6	
Who prepares your meals?	You	80	60.2	132	67.7	n.s.
	Others	53	39.8	62	31.8	
Dietary regime	Free	107	80.5	139	71.3	n.s.
	Controlled (lose weight)	13	9.8	35	17.9	
	Controlled (other causes)	13	9.8	21	10.8	
		Mean ± SD (range)				
OCI-R total score		16.5±10.9 (0-53)		17.9 ±1.3 (0-59)		n.s.
	OCI-R hoarding	3.4±2.6(0-11)		3.7±2.9(0-12)		n.s.
	OCI-R checking	2.6±2.7(0-12)		2.9±2.7(0-12)		n.s.
	OCI-R ordering	3.1±2.5(0-12)		3.7±3.1(0-12)		0.069
	OCI-R mental neutralizing	1.2±2.0(0-11)		1.1±2.1(0-12)		n.s.
	OCI-R washing	2.1±2.5(0-12)		2.2±2.7(0-12)		n.s.
	OCI-R obsessing	3.8±3.5(0-12)		4.0±3.6(0-12)		n.s.
ORTO-15 total score		41.8±1.8 (40-50)		35.2±3.2 (23-39)		**<0.001**

[#] sums of frequencies not equal to 100 are due to missing values

Table 3: multivariate logistic regression for the outcome "ON (= score at ORTO-15<40)".

Variable	Multivariate analysis		
	OR	95% CI	p-value
OCD group vs. control group #2	1.51	0.79-2.90	0.211
Control group #1 vs. control group #2	1.09	0.54-2.19	0.806
Age (years)	0.99	0.97-1.02	0.940
Sex, Male	1.18	0.73-1.92	0.492
Living with roommates	**2.90**	**1.32-6.37**	**0.008**
Being on a controlled dietary regime (to lose weight)	**2.39**	**1.18-4.82**	**0.014**