

Original Research

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Investigating the relationship between orthorexia nervosa and autistic traits in a university population

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Abstract

Background. Orthorexia nervosa (ON) is an emerging condition featuring restrictive eating behaviors on the basis of subjective beliefs about food healthiness. Many authors have stressed the similarities between ON and anorexia nervosa (AN) in both cognitive and behavioral patterns. Despite that, while the link between AN and female autism presentations is well known in the literature, no study has yet investigated the relationship between ON and autism spectrum. This work aims to investigate the relationship between ON and autistic traits in a university population.

Methods. An e-mail invitation was sent to all the students and University workers of University of Pisa. Subjects were asked to fulfill the ORTO-15 and the Adult Autism Subthreshold spectrum (AdAS spectrum) questionnaires.

Results. A total of 2426 subjects joined the survey: 623 subjects (26.3%) reported a score associated with significant orthorexic symptoms according to ORTO-15 (ON group), while 1789 subjects (73.7%) did not report ON symptomatology and were considered as healthy controls (HC). The ON group scored significantly higher on almost all AdAS spectrum domains. Moreover, being female and scoring higher on AdAS spectrum were statistically predictive factors for the presence of ON symptomatology. Among AdAS spectrum domains, higher scores on AdAS spectrum *inflexibility and adherence to routine* and *restricted interests and rumination* domains, as well as lower scores on *verbal communication* domain, were statistically predictive of orthorexic symptoms.

Conclusions. Our findings highlight an overlap between ON and autism spectrum psychopathology. Further studies are needed to clarify the relationship between restrictive eating disorders and female autism phenotypes.

Introduction**Feeding and eating disorders (FED): current perspectives**

FED are a set of conditions with different presentations and a multifactorial pathogenesis, featuring the interaction between neurobiological, genetic, and environmental factors.^{1,2} Although in this field of psychiatry often the pathogenetic role of social environment has been overly stressed, recent studies, focused in particular on restrictive eating disorders, pointed out that the psychopathological core underlying this kind of FED can be found unaltered in different socio-cultural conditions, although these latter may influence the specific clinical presentation.^{3,4} This core, linked to individual vulnerability factors,^{4,5} is characterized by traits such as restriction or avoidance in food intake, perfectionism, rituality, inflexibility, and eventually, emotional dysregulation and impulsivity.^{4,6} It should be noted that these traits are detectable not only among those patients who require a treatment for a FED, but also among the wider population of subjects who show milder, subthreshold manifestations of the same psychopathological spectrum.⁴ In the last decades, increasing research has stressed the importance of a dimensional approach in psychiatry, which may reconsider mental diseases as a continuum spanning from personality traits to full-fledged clinical syndromes, and including core, typical manifestations as well as atypical, subclinical, temperamental, and behavioral traits.^{7–11}

The emerging phenomenon of orthorexia nervosa (ON)

In the last few years, it has been reported an increased spreading of different kinds of behavioral patterns that may fall in the spectrum of FED, sometimes featuring possible new full-fledged

clinical disorders⁴; among the others, particular attention has been paid to the emerging phenomenon of ON.

ON could be defined as a fixation on healthy food, featuring “highly sensitive cognitions and worries about healthy nutrition, leading to such an accurate food selection that a correct diet becomes the most important part of life.”^{12–14} Subjects with ON typically show strong nutritional beliefs and generally attribute a great value to the perceived healthiness and to nutritional properties of foods, rather than to the taste and the enjoyment of the food itself.^{15–17} The pervasive concern for correct nutrition, health and well-being leads orthorexic subjects to check daily the food quality, origin, and packaging, resulting in severe distress, and sometimes, in an impairment in social, occupational, or school functioning.^{18–20} Moreover, the tendency toward a progressively stricter selection on food may finally lead to malnutrition and/or severe weight loss, similar to those reported among AN patients.⁴ To date, ON is not formally included in the last edition of the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5), nor in the International Classification of Diseases 11th Revision (ICD-11).²¹ It is still debated whether ON should be considered a specific and unique disease, a variant of other syndromes or, more simply, a behavioral attitude influenced by the cultural context.^{22–24} However, many authors reported data that seem to support the existence of a continuum between ON and AN.^{4,25–30} A higher prevalence of ON has been reported among female subjects with low body mass index and restrictive food patterns,^{4,25} while both ON and AN are characterized by restrictive eating habits and traits of perfectionism, rigidity, anxiety, poor insight, and a tendency toward weight loss (although in ON it may appear as an indirect effect of food selection rather than a direct effect of a full-fledged drive for thinness).^{26–30} Furthermore, it has been noticed how severe ON symptoms may represent a risk factor for AN.²⁶ The mean prevalence of ON symptoms has been reported to be 6.9% among the general population and 35% to 57.8% among high-risk subjects, such as dietitians, nutrition students, other healthcare professionals, or also sport practitioners and performance artists.^{4,15,16}

The relationship between autism spectrum and FED

It is noteworthy how traits such as perfectionism, rituality, cognitive rigidity, and narrow interests, which can be commonly found in AN, have previously led some authors to stress a possible association between AN and obsessive–compulsive disorder.^{29,31–33} However, an increasing number of researchers hypothesized also a possible relation between AN and autism spectrum disorder (ASD) stressing the presence among patients with AN not only of a pattern of narrow interests and stereotyped behaviors linked to food and diet, but also of an impairment in social functioning, including social anhedonia and an altered theory of mind.^{4,34,35} A possible relationship between ASD and AN was firstly hypothesized by Gillberg, who stressed the presence of several symptomatology overlaps as well as a familiar association for these conditions.³⁶ After Gillberg’s report, several data, including results from studies with a longitudinal design, reported a higher prevalence of ASD among subject with AN.^{37–41} The recent interest in a dimensional approach toward ASD psychopathology progressively leads to expand the investigation on the relationship between AN and ASD, including also subthreshold autistic symptoms and traits. The importance of subthreshold forms of ASD was firstly stressed when investigating the presence of autistic-like traits among first degree relatives of patients with ASD.^{42,43} However, further studies

stressed that autistic traits seem to be distributed in a continuum ranging from the general to the clinical population, with higher prevalence among specific groups and in clinical sample of patients with other psychiatric disorders.^{42–44} The importance of investigating autistic traits lies in the fact that they seem to be associated, also when subthreshold, with a higher vulnerability toward psychopathology, traumatic events, and suicidality risk.^{42,45–51} In this framework, several studies highlighted the presence of autistic-like traits among patients with AN, stressing how the pattern of pervasiveness, rigidity, and stereotyped behaviors that characterizes the eating habits of patients with AN, closely resembles the one of ASD patients.^{36,52} Both disorders present social anhedonia,^{34,53,54} deficit in emotional intelligence,^{55,56} impairment of executive functions,^{57,58} and rigidity in the set-shifting test.^{35,59} Moreover, a common structural and functional alteration in the regions of the “social brain,” such as superior temporal sulcus, fusiform face area, amygdala, and frontal orbital cortex, was observed in both AN and ASD.^{60,61} Prevalence studies also reported a higher prevalence of autistic traits among patients with AN by means of the Autism Spectrum Quotient (AQ), an instrument developed and validated for measuring subthreshold autistic symptoms.⁶² These findings support Gillberg’s initial hypothesis that ASD and AN share common cognitive characteristics and neural phenotypes, although showing an inverted gender prevalence.^{36,60,63,64} According to this evidence, some authors also hypothesized how AN may be considered as a female phenotype of autism spectrum, featuring the typical pattern of narrow interest and repetitive behaviors, although focused on food and diet.^{4,36,45,52,60,63–65} Studies about specific female manifestations of ASD highlighted several differences from the typical male presentations, including a milder impairment of social functioning, with a higher tendency to camouflage social difficulties by imitating peers’ behaviors.⁶⁶ A different pattern of narrow interest has also been independently reported among females of the autism spectrum, featuring more social acceptable activities, such as enjoying fictions, spending time with animals, or focusing on food and diet.^{66,67} Despite the significant body of data about AN and autism spectrum, limited literature has focused on the prevalence of autistic like traits in other kinds of FED. A few studies available suggest the presence of underlying autistic traits also in bulimia nervosa (BN) and binge eating disorder (BED).^{68–70} One of the most recent studies in this field, a multicenter study led by our research group, compared levels of autistic traits in a sample of patients with restrictive or binge-purging AN, BN, and BED as well as in healthy controls (HC) by means of the Adult Autism Subthreshold spectrum (AdAS spectrum), a questionnaire developed and validated to evaluate the wide range of autism spectrum manifestations.⁴⁵ Results from this study evidenced a higher prevalence of autistic traits in all FED patients when compared to HC, although the highest levels were found among patients with restrictive type of AN, suggesting a higher degree of autism spectrum in patients with restrictive FED.⁴⁵

Aims of this study

In this framework, despite the increasing body of research about ON psychopathology, and the frequent reported similarities between ON and AN,^{4,29} no study, to the best of our knowledge, has yet investigated the presence of autistic traits among subjects with ON. However, as in the case of AN, subjects with ON show several traits similar to those of subjects in the autism spectrum.⁴

They are obsessed with a correct nutrition, showing a strict cognitive focus on food and diet and reporting ritualized patterns of food preparation and ingestion; moreover, they often experience social isolation due to their feelings of moral superiority and intolerance from other's food beliefs, with severe difficulties to adjust with social environment.⁴ These symptoms resemble, as it has been stated for AN, to the inflexible adherence to routine and to the pattern of repetitive behaviors and narrow interests, together with impaired social interaction, typical of the autism spectrum. Therefore, the aim of this study was to investigate the relationship between ON and autistic traits in an Italian University population.

Methods

Participants

An e-mail invitation through University of Pisa Institutional Governance (Rectorate) was sent to all the students and University workers of University of Pisa. Subjects were asked to provide a set of socio-demographic data and to fulfill the psychometric questionnaires through an anonymous online form. No subject received payment or other benefits for agreeing to participate in the survey. The study was conducted in accordance with the Declaration of Helsinki and the local Ethics Committees approved all recruitment and assessment procedures.

Instruments

ORTO-15

The ORTO-15 questionnaire, developed by Donnini et al, is the instrument most frequently used to assess orthorexia symptoms in the literature.^{12,25,71,72} It is composed of 15 items providing a 4-point Likert scale for answers. The items are tailored to investigate cognitive, emotional, and behavioral patterns linked to ON. Scores range from 15 to 60; a lower score is associated with higher orthorexic tendencies.^{12,71} According to previous studies from our group, in the present work, we used the cutoff of 35,^{25,72} which demonstrated good specificity (94.2%) and negative predictive value (91.1%).^{4,25,38}

AdAS spectrum

The AdAS spectrum is an instrument developed and validated with the aim to evaluate the wide range of autism spectrum symptoms and traits in adults without intellectual impairment and language development alterations. It is composed of 160 dichotomous items (answer Yes/No) organized in seven domains: *Childhood/adolescence, verbal communication, nonverbal communication, empathy, inflexibility and adherence to routine, restricted interests and rumination, and hyper/hypo-reactivity to sensory input*.

According to the validation study, the AdAS spectrum demonstrated a good validity and reliability, and it has been already employed in several researches in clinical and nonclinical settings as a reliable measure of the autism spectrum.⁷³

Statistical analysis

The sample was divided in two groups on the basis of the score reported on ORTO-15. Subjects who reported a score lower than 35, which is associated in the scientific literature with the presence of significant orthorexic symptoms^{12,71} were included in the "ON group," while the other subjects were considered as HC. Chi-square

tests and Student's *t*-test were employed to compare socio-demographic variables and AdAS spectrum scores between groups. A multiple linear regression analysis was performed with ORTO-15 score as the dependent variable and AdAS spectrum total score, age, and sex as independent variables. Finally, another multiple linear regression analysis was performed with ORTO-15 score as the dependent variable and AdAS spectrum domain score, age, and sex as independent variables.

All statistical analyses performed with SPSS version 23.0.

Result

Comparison of ORTO-15 scores and sociodemographic variables in the sample

Globally, 2426 subjects answered to all the questions of the psychometric instruments. Among them, 637 subjects (26.3%) reported a score lower than 35 on ORTO-15 questionnaire, and were included in the "ON group," while 1789 subjects (73.7%) did not show a score associated with orthorexic symptoms, and were therefore considered as HC for the purpose of this study. The ON group was composed by a significantly higher proportion of females than males (28.4% vs 22.1%, $P = .001$). Moreover, we found in the ON group a significantly higher proportion of subjects who follow a vegan/vegetarian diet than an omnivorous one (42.3% vs 25.1%, $P < .001$), while opposite results were found in the HC group. The ON group showed also a significantly lower mean age (26.17 ± 9.68 vs 27.19 ± 10.35 , $P = .024$). Groups did not significantly differ with respect to years of education and academic role (student, teacher/researcher, and administrative/technical employer) (see Table 1).

Comparison of AdAS spectrum scores between groups

Subjects in the ON group reported significantly higher AdAS spectrum total and domain scores, with the exception of the AdAS spectrum *Empathy* domain, for which the two groups did not show a significantly different score (see Table 2).

Multiple linear regression analyses with ORTO-15 score as dependent variable

We performed a multiple linear regression analysis in order to evaluate the statistically predictive value of sex and autistic traits with respect to ORTO-15 score, considering this latter as the dependent variable and AdAS spectrum total score and sex as predictive variables. According to our results, the regression equation was significant: ($F[3, 2422] = 15.930$, $P < .001$). A higher AdAS spectrum total score, younger age, and female gender were statistically predictive of a lower ORTO-15 score (higher orthorexic tendency) (see Table 3). In light of this result, a further multiple linear regression was performed in order to specifically identify which AdAS spectrum domains were statistically predictive of ORTO-15 score, including all AdAS spectrum domains, age, and sex as independent variables. The model identified the following predictors of a higher orthorexic tendency (lower ORTO-15 score): female gender, younger age, a lower AdAS spectrum *verbal communication* domain score, a higher AdAS spectrum *inflexibility and adherence to routine and restricted interests and rumination* domain scores, with a significant regression equation: ($F[9, 2416] = 8.338$, $P < .001$) (see Table 4).

Table 1. Comparison of Socio-Demographic Features Between Groups.

	ON (N = 637)	HC (N = 1789)	Chi-Square	P
Sex N (%)				
M	185 (22.1%)	651 (77.9%)	11.226	.001
F	452 (28.4%)	1138 (71.6%)		
Academic role N (%)				
Student	577 (27%)	1564 (73%)	4.532	.104
Professor/Researcher	20 (20.6%)	77 (79.4%)		
Administrative/technical employer	40 (21.3%)	148 (78.7%)		
Type of diet N (%)				
Omnivorous	558 (25.1%)	1664 (74.9%)	18.270	<.001
Vegan/vegetarian	53 (42.3%)	77 (57.7%)		
	ON (N = 637)	HC (N = 1789)	t	P
Mean age (mean ± SD)	26.17 ± 9.68	27.19 ± 10.35	−2.254	.024
Years of education (mean ± SD)	17.18 ± 3.29	17.15 ± 3.16	0.199	.842

Abbreviations: HC, healthy controls; ON, orthorexia nervosa; SD, standard deviation. The p of statistically significant results are reported in bold.

Table 2. Comparison of AdAS Spectrum Score Between Groups.

	ON (N = 637)	HC (N = 1789)	t	P
AdAS Spectrum	Mean ± SD	Mean ± SD		
Childhood/adolescence	7.66 ± 4.06	6.95 ± 3.98	3.853	<.001
Verbal communication	5.55 ± 3.28	5.19 ± 3.15	2.502	<.001
Nonverbal communication	10.39 ± 5.06	9.27 ± 4.87	4.899	.012
Empathy	3.031 ± 2.20	2.91 ± 2.33	1.138	.255
Inflexibility and adherence to routine	14.22 ± 7.16	12.46 ± 6.79	5.524	<.001
Restricted interests and rumination	8.64 ± 4.34	7.52 ± 4.40	5.554	<.001
Hyper/hypo reactivity to sensory input	4.52 ± 3.39	3.77 ± 3.08	4.857	<.001
Total score	54.01 ± 23.91	48.07 ± 23.39	5.472	<.001

Abbreviations: AdAS, Adult Autism Subthreshold; HC, healthy controls; ON, orthorexia nervosa; SD, standard deviation. The p of statistically significant results are reported in bold.

Table 3. Linear Regression Analysis with AdAS Spectrum Total Score, Age, and Sex as Independent Variables and ORTO-15 Score as Dependent Variable.

Model	B (SE)	Beta	95% CI	t	P
k	37.741 (0.400)	–	36.957 to 38.524	94.427	<.001
Sex (one male, two female)	−0.64 (0.156)	−0.080	−0.930 to −0.317	−3.987	<.001
Age	0.023 (0.007)	0.065	0.009 to 0.038	3.146	.002
AdAS spectrum total score	−0.013 (0.003)	−0.083	−0.019 to −0.007	−4.044	<.001

$R^2 = 0.019$; Adjusted $R^2 = 0.018$.

Abbreviations: AdAS, Adult Autism Subthreshold; CI, confidence intervals; SE, standard error. The p of statistically significant results are reported in bold.

Discussion

The aim of the present study was to investigate the relationship between autism spectrum and ON in a large sample of university students and employers of the University of Pisa. To date, although a large amount of data is available about the relationship between restrictive eating disorders and ASD, no study has yet evaluated the presence of a possible association between autistic traits and ON.

Orthorexic symptoms and socio-demographic features in the sample

In our sample, we found the prevalence of significant orthorexic symptoms was 26.3%, as reported by means of ORTO-15. Moreover, ON group showed a significant lower mean age, which was also a significant predictive factor for the presence of ON in the regression analyses. This finding is in line with previous results in

Table 4. Linear Regression Analysis with AdAS Spectrum Domain Scores, Age, and Sex as Independent Variables and ORTO-15 Score as Dependent Variable.

Model	B (SE)	Beta	95% CI	t	P
k	37.512(0.401)	–	36.715 to 38.309	92.252	<.001
Sex (one male, two female)	–0.555(0.158)	–0.071	–0.864 to –0.245	–3.511	<.001
Age	0.025(0.007)	0.070	0.011 to 0.040	3.396	.001
Childhood/adolescence	–0.006(0.026)	–0.007	–0.057 to 0.045	–0.231	.817
Verbal communication	0.106(0.035)	0.091	0.037 to 0.174	3.035	.002
Nonverbal communication	–0.003(0.024)	–0.004	–0.050 to 0.045	–1.22	.903
Empathy	0.064(0.038)	0.040	–0.011 to 0.140	1.672	.095
Inflexibility and adherence to routine	–0.054 (0.018)	–0.101	–0.090 to –0.018	–2.954	.003
Restricted interests and rumination	–0.057(0.032)	–0.068	–0.114 to –0.001	–1.933	.053
Hyper/hypo reactivity to sensory input	–0.031(0.032)	–0.27	–0.095 to 0.033	–0.957	.033

$R^2 = 0.030$; Adjusted $R^2 = 0.027$.

Abbreviations: AdAS, Adult Autism Subthreshold; CI, confidence intervals; SE, standard error. The p of statistically significant results are reported in bold.

similar samples, which reported a prevalence around 30% when considering the whole university population, with a slightly higher prevalence among students and among younger subjects.^{25,72} These data further confirm the higher vulnerability toward ON among academic populations, which seem to show a prevalence of ON symptoms higher than the one reported by studies conducted among the general population.^{25,54,72,73–77}

Moreover, we found that the ON group was composed in higher proportion by females and by subjects who follow a vegan/vegetarian diet, while opposite proportions were found among HC. These data are in line with previous researches that reported a higher prevalence of ON among females; some authors hypothesized that females may show a higher interest on healthy diet due to the purpose of controlling body weight and reaching a specific kind of physical appearance, influenced by social media campaigns.^{25,38,41,68,72,78} The association between ON and female gender supports the possible presence of a continuum between AN and ON.^{25,72} Concerning the higher prevalence of vegan/vegetarian diet in the ON group, it should be noted that the link between ON and a specific interest on dietary habits, with a tendency toward ritualized behaviors related to food, was reported also by previous studies and may support the presence of similarities with the autism spectrum continuum.^{4,25,41,77,79}

Links between ON symptoms and presence of autistic traits

When considering the relationship between ON and autism spectrum, our results highlighted that subjects in the ON group showed a significantly higher prevalence of autistic traits than HC, as measured by the AdAS spectrum questionnaire. Moreover, the study highlighted that scoring higher on AdAS spectrum, a lower mean age and being female were statistically predictive factors for the presence of orthorexic symptoms. These results were somewhat expected on the basis of the reported overlaps between AN and ON,^{4,29} and, on the other hand, of the increasing literature which stresses the close relationship between AN and female autism phenotypes.^{4,41,52,45} In this framework, ON could be considered as a manifestation of the same autism spectrum phenotype of AN: according to this hypothesis, for both disorders the symptomatological core may be identified in the underlying autistic traits, manifesting with a specific focus on food and diet.^{4,43,45} Differences in subjective mentalization of symptoms between AN and ON (e.g.,

adopting restrictive dietary habits on the basis of subjective beliefs about “healthiness” of foods or on the basis of their caloric intake) may depend from changes in the specific inputs received by social environment and/or by the severity degree of the clinical picture.^{4,45}

Links between specific AdAS spectrum domains and ON

When deepening the investigation about specific autistic features linked to ON, we found that, among AdAS spectrum domains, those statistically predictive of orthorexic symptoms were *inflexibility and adherence to routine* and *restricted interests and rumination*. This result is in line with a previous study⁴⁵ which, when evaluating autistic traits by means of AdAS spectrum in a sample of patients with different kinds of FED, found that patients with restrictive AN scored significantly higher than patients with binge eating behaviors on AdAS spectrum total score and on the *inflexibility and adherence to routine* and *restricted interest/rumination* AdAS spectrum domains. The association reported in the present work between ON and the same AdAS spectrum domains supports the hypothesis that the link between autism spectrum and ON should be considered in close resemblance to the association of autism spectrum with AN, further stressing the presence of common psychopathological underpinnings for these three conditions. Intriguingly, we found also that higher scores on AdAS spectrum *verbal communication* domain negatively predicted the presence of orthorexic symptoms, despite subjects with ON scored higher than HC on the same domain. The positive association of ORTO-15 score with AdAS spectrum *verbal communication* recorded in the regression analysis, despite a reverse direction of effect in the univariate analysis, is a counter-intuitive finding, but an explanation of this result lies in the pattern of associations among the different autistic domains, which were not designed to be orthogonal. The effect of AdAS *verbal communication* score as a negative predictor of higher ON symptoms may be explained in light of previous descriptions of female autism phenotypes, which would feature a more preserved social functioning, often responsible of the underdiagnosis of autistic traits or even full-blown ASD among females.^{4,36,65,80} Girls and women in the autism spectrum are more able to recognize their own social difficulties and mask them through the imitation of others' behaviors, adopting a pattern of camouflaging strategies.^{4,36,80} They often show also higher levels of

social anxiety, a disorder which, as ASD, is associated with an impairment of the social brain but, as AN, is more frequent among females.^{65,66,80–85} In this framework, it is possible that a severe impairment in verbal communication would not be associated with the specific autism phenotype underlying restrictive eating disorders such as AN or ON, which would feature, conversely, a more preserved ability to mask social difficulties with learned behaviors and camouflaging strategies, according to previous literature about female autism phenotypes.^{65,66}

Limits

This study should be regarded in light of several limitations. Firstly, our sample was recruited among university students and personnel, limiting the applicability of our results to other populations. Secondly, subjects were enrolled on voluntary basis, eventually leading to further bias in sample selection. Moreover, both AdAS spectrum and ORTO-15 are self-report questionnaires, and final scores may be biased by over or underestimation of symptoms depending from participant judgment. The design of the study as an online questionnaire evaluation is another element that may have led to inaccuracies in the assessment of symptoms. Finally, the cross-sectional design of the study did not allow making inferences about possible causal or temporal relationships between autism spectrum and ON. Future studies are needed to clarify the link between ON, FED, and autism spectrum. A better understanding in this field may shed light on both autism spectrum and FED psychopathology, leading to improve early diagnosis, prevention, and therapeutic strategies for these disorders.⁴⁵

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