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ORIGINAL ARTICLE

Health beliefs, behaviors, and symptoms associated with orthorexia nervosa

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Abstract

Purpose This research explored whether symptoms of orthorexia nervosa (ON), a condition involving obsessive thoughts and compulsive behaviors regarding healthy eating, are associated with differences pertaining to use of nutritional supplements and complementary and alternative medicine (CAM) techniques, to health locus of control, and to symptoms of poor physical health.

Method An anonymous online survey assessing the variables above was completed by college students at a university in the southern United States: 47 in the ON symptoms group, 50 in the healthy-eating control group, and 83 in the normal-eating control group.

Results Compared to both control groups, the ON symptoms group reported greater supplement use and CAM participation, more reasons for these behaviors for the purpose of improving psychological health (i.e., to increase energy, enhance focus, and improve mood), and greater symptoms associated with poor physical health. None of the groups differed on internal or external health locus of control.

Conclusion For those with ON, "healthy" eating behaviors are accompanied by other health behaviors that include supplement use and CAM activities. However, despite their goal of achieving perfect health, these individuals experience diminished physical health with symptoms that may be related to their severe dietary restrictions.

Level of evidence Level V, descriptive cross-sectional study.

Keywords Orthorexia · Supplement use · Complementary and alternative medicine · Health locus of control · Health symptoms

Introduction

Orthorexia nervosa (ON) refers to a conjectured condition that is characterized by obsessive thoughts and compulsive behaviors concerning healthy eating [1]. According to the diagnostic criteria proposed by medical doctors, psychologists, and clinical researchers, these mental preoccupations and corresponding behaviors include following a very restrictive diet that they believe to be healthy and pure [2, 3]. For example, a person with ON may strictly avoid all forms of sugars, trans fatty acids, saturated fats, red meat, dairy, gluten, non-organic foods, processed foods, and so on. Moreover, any violations of their dietary restrictions result in extreme feelings of shame and anxiety [2, 3], and their extreme thoughts and behaviors interfere with their vocational, academic, or social functioning [2, 3]. For example, they may perform poorly at work or school due to interference from their constant thoughts about nutrition, and they may socially isolate themselves from family, friends, and partners as they avoid any gatherings that involve food or interfere with their dietary plan. Perhaps the most significant diagnostic impairment, though, involves medical complications that result from the malnutrition that accompanies severe dietary restrictions [2, 3]. Ironically, the pursuit of perfect physical health may lead to impairments in their physical health.

Although increasing numbers of patients are seeking help from dieticians and psychologists for ON-related impairments [2–4], ON is not currently recognized as a psychiatric

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disorder in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) [5]. Several studies have consistently found that greater ON symptomatology corresponds to greater disordered eating that includes dietary restrictions [6–13], as well as greater obsessive–compulsive tendencies [10–16]. Despite this overlap with anorexia nervosa and obsessive–compulsive disorder, ON is believed to comprise a distinct behavioral pattern driven by the goal of achieving purity and perfect physical health, rather than as a means of addressing a distorted body image [1, 2]. Moreover, whereas anorexia nervosa is defined by low body weight [5] and is more common in women than men at an average ratio of 9:1 [17–20], research reveals that ON symptomatology is not negatively correlated with body mass index (BMI) [9–11, 21–25] and is not significantly greater in women than men [8–10, 21–24, 26–31]. Thus, ON may be a unique condition in need of further investigation, and the current study adds to the literature by exploring the health behaviors, beliefs, and symptoms associated with ON.

Health behaviors

Given that ON thoughts and behaviors are driven by the desire to achieve perfect physical health, the commitment to healthy eating may conceivably extend to exercise activity as part of a more comprehensive healthy lifestyle. Indeed, ON symptomatology has been associated with significantly greater levels of sport and physical activity [6, 25, 31–33], which may develop into an exercise addiction involving a compulsive need to follow a rigid regime of intense exercises even when faced with illness, injury, or other problems [34, 35]. The results from these quantitative research studies compliment the findings from a qualitative focus-group study with experienced personal trainers who also had nutritional advisory roles [36]. Based on both their experiences with clients and their personal experiences, these personal trainers argued that exercise addiction is a key component of ON, whereby people with ON possess a need for complete control over both their dietary and exercise plans, which are excessively strict. Interestingly, an analysis of exercise motivations revealed that people with ON exercise not only for the purpose of improving their physical health (and avoiding ill health), but also to improve their psychological health using exercise as a means to manage stress, become revitalized, and enhance positive affect [34].

An obsession with healthy living would likely also entail avoiding smoking and alcohol, as well as incorporating nutritional supplements and other complementary and alternative medicine (CAM) techniques into their lifestyle. Supporting this hypothesis is research showing that ON symptomatology is significantly greater in those who use supplements [8] and those who do not smoke cigarettes [33] or drink alcohol [25]. Although three other studies failed to find that ON symptomatology is greater in non-smokers, these studies lack generalizability with their restricted samples of health care professionals [29], medical students [9], and performance artists like ballet dancers [21]. Regarding supplement use, in contrast to the results from the study finding a significant relationship [8], two studies with diverse samples found a positive but not statistically significant relationship between ON symptomatology and supplement use [22, 25]. All three of these latter studies, however, assessed supplement use with only a single yes-or-no question, and no prior research has investigated the association between ON symptomatology and use of CAM techniques. The current study will build on this past research by investigating the quantity and types of nutritional supplements and CAM techniques used, as well as the different reasons for their use.

Health beliefs

Relevant past research reveals that healthy eating and exercise behaviors are associated with a high internal health locus of control whereby individuals believe that their health is largely controlled by themselves, and a low external health locus of control whereby individuals believe that their health is rarely controlled by external forces such as chance or other people in their lives [37]. By extension, given that ON is characterized by an obsessive fixation on healthy eating and exercise behaviors, ON symptomatology would logically be associated with a high internal and low external health locus of control.

Although locus of control has not been previously investigated in relation to ON, predictions may be made on the basis of past research on people with symptoms of eating disorders and obsessive–compulsive disorder, which are two areas of overlap with ON [6, 7, 9–16]. These studies found a low internal locus of control and a high external locus of control associated with both eating disorder pathology [38–42] and obsessive–compulsiveness [43–45]. Given the shared commonalities that ON has with other eating disorders and with obsessive–compulsiveness, we might likewise expect that ON symptomatology would be associated with a low internal and high external locus of control. However, this prediction is contrary to the one based on research showing that healthy eating and exercise behaviors are associated with a high internal and low external health loci of control [37]. The current study will test these conflicting hypotheses.

Health symptoms

Research supports the positive impact of healthy eating on physical health. For example, eating a nutrient-rich diet that consists predominantly of fruits and vegetables may decrease one's risk of such life-threatening diseases as cardiovascular disease and cancer [46–48]. In addition,

greater fruit and vegetable consumption is also associated with greater self-reported health and fewer complaints of such problems as pain, breathing difficulty, and circulatory-related symptoms [49].

Yet, according to the ON diagnostic criteria that are based on case studies presented by dieticians, psychologists, and medical doctors [2, 3], ON results in impaired physical health in the form of medical complications stemming from the malnutrition that accompanies severe dietary restrictions. In two of the three published empirical studies examining ON correlates with physical health, ON symptomatology did not significantly differ between those who did versus those who did not report the presence of a chronic illness or other health problems [11, 28]. Comparably, the third study found that ON symptomatology was not correlated with continuous measures of general health, physical functioning, bodily pain, or role limitations due to problems with physical health [31]. The lack of consistency between these findings and the ON criteria could be due to a few different factors. First, perhaps medical complications may be a problem only for a subset of individuals with ON. Second, the prevalence of ON is arguably fairly low, perhaps even lower than 1% [28], such that a larger sample size may be needed to ensure sufficient variability in ON scores. Third, all three of these studies measured ON symptomatology with the ORTO-15 [50], whose validity and reliability have been shown to be severely lacking [23]. The current study will examine the physical health symptoms corresponding to ON with a larger base sample and a more valid and reliable measure of ON.

Purpose and hypotheses for the current study

As indicated above, the current study explores the health behaviors, beliefs, and symptoms associated with ON. Furthermore, the ON symptoms group will be compared to two different control groups: a normal-eating control group and a healthy-eating control group. The normal-eating control group is the standard low-ON comparison group with individuals who score lowest on a measure ON symptomatology that includes items assessing both healthy eating behaviors and problems as a result of those behavior, whereas the healthy-eating control group is a novel comparison group with individuals who eat healthy but do not experience negative consequences as a result of their healthy eating, in contrast to ON. Regarding health behaviors, consistent with research showing that the extreme eating habits of ON also correspond to extreme exercise habits for the purposes of improving both physical and psychological health [34], we hypothesized that in comparison to both control groups (but especially the normal-eating control group), the ON symptoms group would report greater use of nutritional supplements and CAM techniques, and would endorse more reasons for doing so for the purposes of improving both physical and psychological health. Regarding health beliefs, past research supports two conflicting hypotheses. First, based on research showing that healthy eating and exercise behaviors are associated with a high internal and low external health locus of control [37], we could hypothesize that in comparison to the normal-eating control group, the ON symptoms group would exhibit a higher internal and lower external health locus of control. Second, based on research showing that other eating disorders are associated with a low internal and high external locus of control [38–42], we could hypothesize that in comparison to both control groups, the ON symptoms group would exhibit a lower internal and higher external health locus of control. Finally, regarding health symptoms, based on the diagnostic criteria indicating that ON results in impaired physical health in the form of medical complications that accompany severe dietary restrictions [2, 3], we hypothesized that in comparison to both control groups (but especially the healthy-eating control group), the ON symptoms group would complain of more symptoms associated with poor physical health.

Method

Participants

This study's participants were recruited from a variety of undergraduate psychology courses at a large university in the southern region of the United States. As detailed below, from the 382 participants who completed the survey, data were retained for 47 who comprised the ON symptoms group, 50 who comprised the healthy-eating control group, and 83 who comprised the normal-eating control group. This sample of 180 students included 30 men and 150 women, whose ages ranged from 18 to 48 years ($M = 21.43$, $SD = 3.55$). Based on self-reported ethnicity, 43% were Caucasian, 31% were Hispanic or Latino, 15% were African American, 3% were Asian American, 7% were biracial or multiracial, and 1% were of another ethnicity. Please see Table 1 for a demographic breakdown as a function of eating group for this study.

Materials and procedure

This study was approved by the Institutional Review Board of Texas State University. Upon giving informed consent, participants completed an anonymous online survey with a demographic questionnaire, the Eating Habits Questionnaire (EHQ) [12], the Supplements and CAM Questionnaire (SCAMQ), the Multidimensional Health Locus of Control Questionnaire (MHLCQ) [51], and the Cohen-Hoberman Inventory of Physical Symptoms (CHIPS) [52].

Table 1 Sample demographics

	ON symptoms group ($n=47$)	Healthy eating controls ($n=50$)	Normal eating controls ($n=83$)	χ^2 or F	p	η_p^2
Gender				1.03	0.60	
% female	78.72%	84.00%	85.54%			
% male	21.28%	16.00%	14.46%			
Ethnicity				5.60	0.23	
% White	59.09%	39.53%	47.95%			
% Black	18.18%	13.95%	17.81%			
% Hispanic	22.73%	46.51%	34.24%			
Age *M* (*SD*)	21.79 (2.44)	21.52 (4.70)	21.18 (3.30)	0.46	0.64	0.01
EHQ rating *M* (SD)						
All items[b]	2.53 (0.28)	2.03 (0.17)	1.34 (0.09)	683.20	< 0.001	0.89
Behaviors scale[b]	2.59 (0.49)	2.29 (0.26)	1.19 (0.13)	411.59	< 0.001	0.82
Problems scale[b]	2.22 (0.28)	1.29 (0.13)	1.11 (0.10)	658.49	< 0.001	0.88
Feelings scale[a]	3.19 (0.67)	3.18 (0.49)	2.17 (0.41)	89.15	< 0.001	0.50

[a]ON symptoms group significantly differed from normal eating controls but not healthy eating controls; healthy eating controls significantly differed from normal eating controls

[b]All groups significantly differed from one another

Eating Habits Questionnaire

The EHQ [12] is a measure of ON symptomatology with 21 statements, to which participants provide a Likert rating to indicate how well each statement represents their current eating habits (1 = not at all true, 2 = slightly true, 3 = mainly true, 4 = very true). Subsequent research [23] demonstrated that the EHQ consists of three internally-consistent scales: Behaviors scale with eight items about healthy eating behaviors (e.g., "I follow a diet with many rules"; Cronbach's alpha = 0.87), Problems scale with nine items about problems associated with those behaviors (e.g., "My healthy eating causes significant stress in my relationships"; Cronbach's alpha = 0.79), and Feelings scale with four items about feelings associated with those behaviors (e.g., "Eating the way I do gives me a sense of satisfaction"; Cronbach's alpha = 0.73). Overall, the EHQ has excellent reliability with Cronbach's alpha of 0.90 [23] and test–retest coefficient of 0.78 [12]. Further, both the authors of the EHQ [12] and subsequent researchers [53] demonstrated its validity, finding its scores positively correlated with higher levels of both disordered eating behaviors and obsessive–compulsive tendencies, consistent with past research that found these same correlations but with a different measure of ON symptomatology [6, 7, 9–11, 13–16]. Although the EHQ was published three years prior to publication of the most recently proposed diagnostic criteria for ON [2], other researchers [54] have illustrated that the EHQ better aligns with these diagnostic criteria than the more frequently used ORTO-15 [50]. In particular, although both scales adequately address the first criterion of mental preoccupation and compulsive behavior regarding affirmative and restrictive dietary practices believed to be healthy, the last three criteria pertaining to the very important clinical impairments are better assessed with the EHQ that has nine relevant items compared to only three relevant items on the ORTO-15. Moreover the ORTO-15 has recently been criticized for its low reliability and validity [23, 53–55].

Based on the EHQ scores, three participant groups were formed: ON symptoms group, normal-eating control group, and healthy-eating control group. Three criteria were used for selection into the ON symptoms group. First, the total EHQ score had to be within the top 25th percentile, indicative of the highest degree of ON symptomatology. Second, the average Likert rating for the EHQ Behaviors scale had to be at least 2 (i.e., "slightly true"), reflecting that the statements about healthy eating behaviors did describe them at least slightly. Third, the average Likert rating for the EHQ Problems scale also had to be at least 2 (i.e., "slightly true"), reflecting that the statements about problems resulting from their healthy eating behaviors did describe them at least slightly. This latter criterion is especially important, because many individuals with a commitment to healthy eating would not be considered at risk of ON if they did not experience any problems as a result of their healthy eating behaviors [2, 3]. Of the 96 students with total EHQ scores within the top 25th percentile, 2 did not meet the second criterion, and 47 did not meet the third criterion, leaving 47 students who met all three criteria for selection into the ON symptoms group.

Comparably, three criteria were used for selection into the normal-eating control group. First, the total EHQ score had to be within the bottom 25th percentile, indicative of the lowest degree of ON symptomatology. Second, the average

Likert rating for the EHQ Behaviors scale had to be less than 1.5 (i.e., closer to "not at all true" than to "slightly true"), reflecting that the statements about healthy eating behaviors did not describe them. Third, the average Likert rating for the EHQ Problems scale also had to be less than 1.5 (i.e., closer to "not at all true" than to "slightly true"), reflecting that the statements about problems resulting from healthy eating behaviors did not describe them. Of the 92 students with total EHQ scores within the bottom 25th percentile, 8 did not meet the second criterion, and 1 did not meet the third criterion, leaving 83 students who met all three criteria for selection into the normal-eating control group.

Although much clinical research examines only high versus low symptom groups, we felt it necessary to include an additional group for this particular study. For selection into the healthy-eating control group, the average Likert rating for the EHQ Behaviors scale had to be at least 2 (i.e., slightly true), and the average Likert rating for the EHQ Problems scale had to be less than 1.5 (i.e., closer to "not at all true" than to "slightly true"). From the original sample, 50 students met these two criteria, indicative of these participants partaking in healthy eating behaviors but not experiencing any problems as a result of those behaviors.

Supplements and CAM Questionnaire

The first part of the SCAMQ included questions pertaining to the use of dietary supplements. First, participants selected from a list all supplements they took at least once during the past 12 months. This list included 18 vitamin or mineral supplements (multivitamin or multimineral; Vitamins A, B, C, D, E, K; biotin; calcium; chromium; copper; iodine; iron; magnesium; manganese; potassium; selenium; zinc), 21 herbal supplements (acai pills, caffeine pills, cranberry pills, echinacea, fiber or psyllium pills or powder, flaxseed oil or pills, garcinia cambogia, garlic pills, ginger pills, ginkgo biloba, ginseng, green tea pills, maca powder, methylsulfonylmethane, milk thistle, prebiotics, saw palmetto, spirulina, St. John's wort, turmeric or curcumin pills, valerian), and 11 generally animal-based miscellaneous supplements (amino acid supplements, coenzyme Q10, collagen supplements, creatine, digestive enzymes, fish oil or DHA, glucosamine or chondroitin, lecithin, melatonin, probiotics, protein powders). Second, participants listed any other dietary supplements taken at least once during the past 12 months (one participant each identified the following: colloidal silver, tejocote root, and timed cognitive priming). Third, they indicated how many dietary supplements they are currently taking on a regular basis, at least once a week. Last, they selected from a list all of their reasons for taking the supplements. This list included six items relevant to psychological health (increase energy; improve mood; prevent or treat depression or anxiety; enhance memory performance; enhance focus, attention, or concentration; enhance brain function), and eight items relevant to physical health (improve or maintain the following: overall health; immune function; cardiovascular health; respiratory health; digestive or urinary health; bone, joint, or muscle health; skin, hair, or nail health; eye health).

The second part of the SCAMQ included questions pertaining to participation in CAM techniques. First, participants selected from a list all CAM techniques in which they participated at least once during the past 12 months. This list included 22 items: acupuncture or acupressure, reflexology, massage, chiropractic or osteopathy, yoga, tai chi or qigong, meditation, relaxation or breathing techniques, visualization, hypnotherapy, biofeedback, brain training program, aromatherapy, art therapy, music therapy, psychotherapy or counseling, spiritual healing including prayer, reiki energy healing, therapeutic touch, magnet therapy, crystal therapy, and color or light therapy. Second, participants listed any additional CAM techniques in which they participated at least once during the past 12 months (one participant identified the following: dry needling). Third, they indicated how many CAM techniques in which they currently participate on a regular basis, at least once a week. Last, they selected from a list all of their reasons for participating in the CAM techniques that they identified in the previous questions. This list included the same 14 items that were listed as possible reasons for taking the supplements.

Multidimensional Health Locus of Control Questionnaire

The MHLCQ [51] is a measure of health locus of control with 18 health-belief statements, to which participants provide a Likert rating to indicate their level of agreement with each statement. The MHLCQ consists of three scales: Internality scale with six items about how much one believes their health is controlled by themselves (e.g., "If I take care of myself, I can avoid illness"), Powerful Others scale with six items about how much one believes their health is controlled by other people (e.g., "Having regular contact with my physician is the best way for me to avoid illness"), and Chance scale with six items about how much one believes their health is controlled by chance (e.g., "If it's meant to be, I will stay healthy"). The Internality, Powerful Others, and Chance scales have good internal consistency (Cronbach's alphas = 0.73, 0.70, and 0.70, respectively) and stability over time (test–retest coefficients = 0.75, 0.63, and 0.75, respectively) [56]. Further, the authors of the MHLCQ demonstrated the construct validity of this measure, finding that the scores on its three scales correlated with the scores on their counterpart general locus of control scales of Levenson's Multidimensional Locus of Control Questionnaire [57], after which the MHLCQ was modeled. Finally, research has demonstrated the predictive validity of this measure, finding that

healthy eating and exercise behaviors are positively correlated with Internality scores and negatively correlated with Chance scores, as would be expected [37].

Cohen-Hoberman Inventory of Physical Symptoms

The CHIPS [52] is a measure of physical health with 33 symptoms, to which participants provide a Likert rating to indicate how much they have been bothered or distressed by each symptom during the past two weeks. Subsequent research [58] demonstrated that the CHIPS consists of eight internally-consistent scales, with seven sympathetic/cardiac symptoms (e.g., "pains in heart or chest"; Cronbach's alpha = 0.83), six muscular symptoms (e.g., "muscle tension or soreness"; Cronbach's alpha = 0.75), five metabolic symptoms (e.g., "feeling low in energy"; Cronbach's alpha = 0.74), five gastrointestinal symptoms (e.g., "diarrhea"; Cronbach's alpha = 0.71), four vasovagal symptoms (e.g., "dizziness"; Cronbach's alpha = 0.74), two cold/flu symptoms (e.g., "stuffy head or nose"; Cronbach's alpha = 0.84), two headache symptoms (e.g., "headache"; Cronbach's alpha = 0.69), and two minor hemorrhagic symptoms (e.g., "nosebleed"; Cronbach's alpha = 0.31). Moreover, the composite CHIPS demonstrated excellent reliability and validity, with a Cronbach's alpha of 0.88, and with its total score being positively correlated with use of the student health services among a sample of college students [52].

Statistical analyses

Regarding health behaviors, ANOVAs were conducted to assess group differences in the following variables: number of supplements currently taken on a regular basis; numbers of vitamin/mineral, herbal, and miscellaneous supplements taken at least once during the past 12 months; numbers of reasons for taking supplements for the purposes of improving psychological health and improving physical health; number of CAM techniques done a regular basis; number of CAM techniques done at least once during the past 12 months; and numbers of reasons for doing CAM techniques for the purposes of improving psychological health and improving physical health. Further, crosstab Chi square analyses were conducted to assess group differences in the most frequently used supplements (by at least 10% of the sample), in the most frequently endorsed reasons for taking supplements (by at least 10% of the sample), in participation in the most frequently done CAM techniques (by at least 10% of the sample), and in the most frequently endorsed reasons for doing CAM techniques (by at least 10% of the sample).

Additionally, ANOVAs were conducted to assess group differences in the MHLCQ scales (Internality, Powerful Others, and Chance) that assessed health locus of control beliefs, and in the CHIPS total score and the following scales that assessed symptoms associated with poor physical health: Sympathetic/Cardiac Symptoms, Muscular Symptoms, Metabolic Symptoms, Gastrointestinal Symptoms, Vasovagal Symptoms, Cold/Flu Symptoms, Headache Symptoms, and Minor Hemorrhagic Symptoms. For all ANOVAs, in cases of significant results, Tukey HSD post-hoc tests were conducted to determine which groups significantly differed from one another.

Results

Regarding group differences in supplement behaviors, compared to the normal-eating control group, the ON symptoms group reported a significantly greater number of regularly-used supplements and significantly greater numbers of vitamin/mineral, herbal, and miscellaneous supplements used at least once during the last 12 months (see Table 2). Although these numbers for the ON symptoms group were likewise greater than those for the healthy-eating control group, the only statistically significant differences were for the numbers of herbal and miscellaneous supplements used during the last 12 months. Examination of the most frequently used supplements revealed that a significantly greater percentage of the ON symptoms group used protein powders and fish oil in comparison to the normal-eating control group, and a significantly greater percentage of the ON symptoms group used Vitamin B (any form) in comparison to both control groups (see Table 3). As to the reasons for using supplements, compared to both control groups, the ON symptoms group endorsed significantly more reasons relevant to improving their psychological health; no significant group differences were found regarding endorsement of reasons relevant to improving their physical health (see Table 2). Examination of the most frequently endorsed reasons revealed that a significantly greater percentage of the ON symptoms group reported using supplements for the reasons of increasing energy, improving mood, and enhancing focus or concentration, in comparison to both control groups (see Table 4).

Regarding group differences in CAM behaviors, compared to the normal-eating control group, the ON symptoms group reported participating in a significantly greater number of CAM techniques, both currently on a regular basis and at least once during the last 12 months (see Table 2). Although these numbers for the ON symptoms group were likewise greater than those for the healthy-eating control group, the differences were not statistically significant. Examination of the most frequently participated-in CAM techniques revealed that a significantly greater percentage of the ON symptoms group participated in yoga in comparison to the normal-eating control group (see Table 3). As to the reasons for participating in CAM techniques, compared

Table 2 Group Differences in Use of Supplements and Participation in CAM Techniques

	ON symptoms group *M* (*SD*)	Healthy eating controls *M* (*SD*)	Normal eating controls *M* (*SD*)	*F*	*p*	η_p^2
Number of supplements used and CAM techniques done least once in past 12 months						
All supplements[b]	6.64 (3.69)	4.38 (2.93)	3.48 (3.04)	12.48	< 0.001	0.12
Vitamin/mineral[a]	3.43 (2.94)	2.32 (2.14)	1.89 (2.19)	6.19	0.003	0.07
Herbal[b]	1.00 (1.23)	0.54 (0.84)	0.43 (0.77)	5.78	0.004	0.06
Miscellaneous[b]	2.21 (1.65)	1.50 (1.15)	1.14 (1.25)	9.52	< 0.001	0.10
CAM techniques[a]	2.98 (2.03)	2.40 (1.95)	1.89 (1.57)	5.51	0.005	0.08
Number of supplements used and CAM techniques done currently on a regular basis						
Supplements[a]	1.77 (1.87)	1.10 (1.40)	0.67 (1.46)	7.34	0.001	0.08
CAM techniques[a]	1.19 (1.41)	0.78 (1.23)	0.63 (0.91)	3.67	0.03	0.04
Number of endorsed reasons for behaviors pertaining to improving physical health						
Supplements	1.70 (1.76)	1.54 (1.39)	1.16 (1.22)	2.51	0.08	0.03
CAM techniques[b]	1.30 (1.88)	0.64 (1.31)	0.43 (0.61)	7.32	0.001	0.08
Number of endorsed reasons for behaviors pertaining to improving psychological health						
Supplements[b]	1.49 (1.40)	0.80 (0.90)	0.57 (0.99)	10.92	< 0.001	0.11
CAM techniques[b]	2.19 (1.70)	1.40 (1.53)	1.04 (1.20)	9.71	< 0.001	0.10

[a]ON symptoms group significantly differed from normal eating controls; no other significant group differences

[b]ON symptoms group significantly differed from both normal eating and healthy eating controls; no other significant group differences

Table 3 Group Differences in Most Commonly Used Supplements and CAM Techniques

	ON symptoms group (%)	Healthy eating controls (%)	Normal eating controls (%)	χ^2	*p*
Percent of group who used the supplements					
Multivitamin or multimineral	59.6	64.0	44.6	5.56	0.06
Vitamin C	48.9	30.0	32.5	4.62	0.10
Protein powders[a]	51.1	46.0	20.5	15.54	< 0.001
Probiotics	42.6	28.0	22.9	5.65	0.06
Melatonin	29.8	20.0	34.9	3.36	0.19
Biotin	31.9	30.0	24.1	1.09	0.58
Vitamin B (any form)[b]	40.4	18.0	16.9	10.41	0.005
Fish oil[a]	31.9	28.0	12.0	8.61	0.01
Vitamin D	27.7	20.0	13.3	4.12	0.13
Iron	23.4	18.0	12.0	2.88	0.24
Calcium	19.1	14.0	15.7	0.50	0.78
Amino acid supplements	21.3	10.0	8.4	4.93	0.09
Percent of group who participated in the CAM techniques					
Massage	38.3	30.0	36.1	0.82	0.66
Yoga[a]	46.8	42.0	24.1	8.30	0.02
Relaxing/breathing techniques	40.4	36.0	30.1	1.49	0.48
Meditation	36.2	32.0	21.7	3.56	0.17
Spiritual healing	23.4	18.0	19.3	0.49	0.78
Aromatherapy	21.3	20.0	16.9	0.44	0.80
Psychotherapy or counseling	21.3	16.0	13.3	1.43	0.49
Music therapy	23.4	16.0	10.8	3.62	0.16

[a]ON symptoms group significantly differed from normal eating controls; no other significant group differences

[b]ON symptoms group significantly differed from both normal eating and healthy eating controls; no other significant group differences

Table 4 Group Differences in Most Commonly Endorsed Reasons for Supplements and CAM Techniques

	ON symptoms group	Healthy eating controls	Normal eating controls	χ^2	p
Percent of group endorsing the reason for taking supplements					
Overall health	44.7	58.0	42.2	3.30	0.19
Increase energy[b]	59.6	42.0	27.7	12.81	0.002
Skin, hair, or nail health	29.8	26.0	27.7	0.17	0.92
Immune health	29.8	30.0	18.1	3.39	0.18
Digestive or urinary health	25.5	14.0	14.5	3.09	0.21
Improve mood[b]	25.5	8.0	12.0	6.74	0.03
Bone, joint, or muscle health	14.9	14.0	8.4	1.58	0.45
Enhance focus/concentration[b]	21.3	10.0	4.8	8.63	0.01
Percent of group endorsing the reason for participating in CAM techniques					
Improve mood[‡]	66.0	44.0	37.3	10.07	0.007
Overall health	46.8	34.0	33.7	2.50	0.29
Treat depression or anxiety	38.3	34.0	22.9	3.92	0.14
Increase energy[b]	44.7	24.0	21.7	8.45	0.02
Enhance focus/concentration[b]	38.3	20.0	12.0	12.47	0.002
Enhance brain function	19.1	10.0	8.4	3.53	0.17
Bone, joint, or muscle health[a]	19.1	12.0	3.6	8.35	0.02

[a]ON symptoms group significantly differed from normal eating controls; no other significant group differences

[b]ON symptoms group significantly differed from both normal eating and healthy eating controls; no other significant group differences

to both control groups, the ON symptoms group endorsed significantly more reasons relevant to improving both their physical and psychological health (see Table 2). Examination of the most frequently endorsed reasons revealed that a significantly greater percentage of the ON symptoms group reported participating in CAM techniques for the reasons of increasing energy, improving mood, and enhancing focus or concentration, in comparison to both control groups (see Table 4).

Regarding group differences in health beliefs and physical symptoms, interestingly, although the groups did not significantly differ on any of the MHLCQ scales, they did differ in physical symptoms (see Table 5). Compared to both control groups, the ON symptoms group had significantly greater total scores on the CHIPS indicative of greater symptoms associated with poor physical health. Analyses with the individual CHIPS scales revealed that the ON symptoms group had significantly greater scores on the Metabolic Symptoms scale than the healthy-eating control group, and significantly greater scores on the Vasovagal Symptoms scale than the normal-eating control group.

Discussion

This research explored the health behaviors, beliefs, and symptoms associated with ON. Regarding health behaviors, the results partially supported the first set of hypotheses that in comparison to both control groups (but especially the normal-eating control group), the ON symptoms group would report greater use of nutritional supplements and CAM techniques, and would endorse more reasons for doing so for the purposes of improving both physical and psychological health. The ON symptoms group indeed reported greater use of both supplements and CAM techniques (most notably, B vitamins, fish oil, protein powders, and yoga) when compared to the normal eating group; however, these health behaviors did not significantly differ between the ON symptoms group and the healthy-eating control group. These greater health behaviors by the ON symptoms group in comparison to the normal-eating control group may be attributed to the former's fundamental goals of achieving purity and perfect physical health [1–3], and this result is consistent with past research showing that ON symptomatology is greatest in non-smokers and non-drinkers [25, 33] and is associated with greater levels of sport and physical activity [6, 25, 31–36].

Although the ON symptoms group did report greater use of supplements and CAM techniques compared to the healthy-eating control group, the differences were not significant which leads us to believe that both groups care about their physical health and behave in ways to maintain a healthy lifestyle. The difference between these groups can be seen when comparing the reasons for their behaviors. Compared to both control groups, the ON symptoms group endorsed more physical-improvement

Table 5 Group Differences in Health Beliefs and Physical Symptoms

	ON symptoms group *M* (*SD*)	Healthy eating controls *M* (*SD*)	Normal eating controls *M* (*SD*)	*F*	*p*	η_p^2
Health locus of control scores from MHLCQ scales						
Internality	26.45 (5.00)	26.38 (4.48)	25.95 (4.23)	0.24	0.79	0.01
Power of others	17.57 (5.35)	15.34 (4.68)	16.23 (4.90)	2.48	0.09	0.03
Chance	19.02 (5.51)	16.58 (5.09)	17.33 (4.84)	2.95	0.06	0.03
Physical health symptom scores from CHIPS scales						
All symptoms[b]	64.13 (19.65)	55.46 (14.99)	56.62 (14.96)	4.18	0.02	0.05
Sympathetic/cardiac	11.62 (5.12)	9.98 (3.37)	9.95 (3.69)	2.93	0.06	0.03
Muscular	10.89 (4.23)	10.10 (3.73)	9.57 (2.96)	2.07	0.13	0.02
Metabolic[c]	12.91 (4.46)	10.64 (3.94)	11.61 (4.31)	3.49	0.03	0.04
Gastrointestinal	9.77 (4.17)	8.08 (3.49)	8.70 (3.57)	2.56	0.08	0.03
Vasovagal[a]	7.30 (3.13)	6.14 (2.21)	5.96 (2.17)	4.68	0.01	0.05
Cold/flu	4.55 (2.63)	4.08 (2.23)	4.24 (2.09)	0.54	0.58	0.01
Headache	4.36 (2.11)	3.98 (1.73)	4.14 (2.21)	0.42	0.66	0.01
Hemorrhagic	2.72 (1.31)	2.46 (0.71)	2.57 (0.83)	0.94	0.39	0.01

[a]ON symptoms group significantly differed from normal eating controls; no other significant group differences

[b]ON symptoms group significantly differed from both normal eating and healthy eating controls; no other significant group differences

[c]ON symptoms group significantly differed from healthy eating controls; no other significant group differences

and psychological-improvement reasons for their behaviors (most notably, to increase energy, improve mood, and enhance focus and concentration). This finding is consistent with past research showing that people with ON exercise not only for the purpose of improving their physical health, but also to improve their psychological health using exercise as a means to manage stress, become revitalized, and enhance positive affect [34]. Further, the greater prevalence of B vitamins and yoga in the ON symptoms group suggests a greater urge to increase energy and gain a mental edge.

Regarding health beliefs, the results do not support either of the conflicting hypotheses determining whether the ON symptoms group would exhibit higher or lower levels of internal or external health locus of control compared to the control groups. Relevant past research shows that a high internal and low external health locus of control correspond to greater levels of healthy eating and exercise behaviors in a non-clinical sample [37], but that a low internal and high external locus of control characterize individuals with eating disorder pathology [38–42] and obsessive–compulsiveness [43–45]. ON symptomatology happens to be associated with all three: healthy eating and exercise behaviors as mentioned above, disordered eating behaviors [6–13], and obsessive–compulsive tendencies [10–16]. Perhaps when high-ON individuals first began improving their eating and exercise behaviors, they had a high internal and low external locus of control, but as their behaviors and thought processes became more extreme and dysfunctional, their internal locus of control decreased and external locus of control increased, possibly related to a fear of losing control and subsequent overcompensating excessive behaviors. Although not statistically significant, there is a trend of a higher external locus of control among the ON symptoms group, particularly in comparison to the healthy-eating control group. Further research into the locus of control of ON should be investigated.

Regarding health symptoms, the results supported our final hypothesis that the ON symptoms group would complain of more symptoms associated with poor physical health than the control groups, based on the diagnostic criteria indicating that ON results in impaired physical health in the form of medical complications that accompany severe dietary restrictions [2, 3]. In addition to a greater total score of physical symptoms in comparison to both control groups, the ON symptoms group reported significantly greater metabolic symptoms (e.g., fatigue, lack of energy, weight change) than the healthy-eating control group and significantly greater vasovagal symptoms (e.g., weakness, faintness, dizziness) than the normal-eating control group. On one hand, all of these particular symptoms may be attributed to malnutrition from an overly strict diet and from overexercising, both of which characterize ON [34–36]. On the other hand, it is also possible that at least some individuals with ON initially suffered from several and/or severe somatic symptoms and that they subsequently changed their eating behavior with the goal of healing their symptoms [1].

As with most research, the current study is not without its limitations. First, all of this study's measures were

self-reported questionnaires that are susceptible to social desirability bias. The possibility exists that people with ON may be more knowledgeable about the health benefits of nutritional supplements and CAM techniques, and in an attempt to appear healthier, they may exaggerate their use of these behaviors. Second, the correlational design utilized in this study obviously constrains the internal validity of the research, such that we may not claim that ON leads to these particular increased health behaviors or physical symptoms. For instance, perhaps ill health leads to greater health behaviors to overcome their physical symptoms (e.g., greater vitamin B intake and yoga to overcome fatigue due to a different underlying issue). Moreover, the current study did not control for BMI which may be related to physical health, although past research reveals that ON symptomatology is not negatively correlated with BMI [9–11, 21–25]. Finally, this study was limited to a non-clinical sample of college students in a southern region of the United States. Perhaps different results would be found with samples of participants from geographical regions with differing levels of obesity, and participants from such community settings as health centers and clinics that may serve to increase the range of participant ages and clinical ON symptoms and to increase the diversity of participant cultural and educational backgrounds.

Future research should also include a longitudinal study into the health associated with ON behaviors to determine how these health behaviors, locus of control beliefs, and physical symptoms change over time, allowing for a better assessment of causal relations. Furthermore, such research should be conducted with different groups of people, such as those varying in socioeconomic status. Given that healthier foods, supplements, gym memberships, personal trainers, and nutritionists require a sufficient income, we would expect that ON and its corresponding health behaviors would be most prevalent in wealthier individuals. As mentioned above, additional research should also investigate participant groups that vary in geographic region, cultural upbringing, and educational background that may or may not be related to socioeconomic status. Perhaps the prevalence of ON and corresponding health behaviors would be more prevalent in regions marked by lower levels of obesity, in cultures that emphasize a more individualist versus colloquial perspective, and in individuals with higher levels of education.

Many people begin their fitness journey with a common goal of simply wanting to eat healthier. However, for some individuals, this goal may transform itself over time into a goal of achieving perfect physical health and in an attempt to achieve this incredibly challenging goal, these individuals' thoughts and behaviors become more extreme and obsessive–compulsive, ultimately leading to negative impacts on one's health and quality of life. To the best of our knowledge, the current study was the first to empirically demonstrate that ON symptoms are associated not only with increased intake of nutritional supplements and increased participation in CAM techniques, but also with poorer physical health, which is contrary to their goal of achieving perfect health. Health professionals, including dieticians, trainers, psychologists, and doctors, should share these and related findings with their clients who exhibit ON symptoms, warning of the potential harmful effects of extreme eating and exercise behaviors on their physical and psychological health.

Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

Ethical approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the Texas State University Institutional Review Board and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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