



Orthorexia nervosa and substance use for the purposes of weight control, conformity, and emotional coping

Crystal D. Oberle¹ · Haley S. Marcell¹ · Natalie A. Noebel¹

Received: 27 February 2021 / Accepted: 5 April 2021 / Published online: 18 April 2021
© The Author(s), under exclusive licence to Springer Nature Switzerland AG 2021

Abstract

Purpose Orthorexia nervosa (ON), characterized by extreme behaviors driven by the goal of eating only healthy and pure foods, could plausibly be associated with avoidance of nicotine, alcohol, and illicit drugs. However, findings from the limited research on these relationships are mixed, and other eating disorders are associated with greater substance abuse.

Method An online survey was completed by 471 participants (86% women, mean age = 20) recruited from undergraduate courses and through an Instagram advertisement. The questionnaires assessed ON symptomatology; frequency of smoking, alcohol consumption, and illicit drug use; abuse of these substances; and motivations for using these substances.

Results ON scores were not significantly related to the level of use or abuse of nicotine, alcohol, or most illicit drugs. Yet, ON scores were positively correlated with frequency of using illicit depressant drugs. Further, among substance users, ON scores were positively associated with smoking or vaping for the purpose of weight control, and with consuming alcohol and using illicit drugs for the purposes of conformity and coping with such negative emotions as anxiety and depression.

Conclusion Although people who are high in ON symptomatology may be at least partly driven by a strong desire to be as healthy as possible, they are not less likely to use potentially harmful drugs. Instead, many of them may even turn to certain drugs for the same weight control and emotional-coping motives that guide the behaviors of individuals with other eating disorders.

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

Keywords Orthorexia nervosa · Smoking · Alcohol · Drugs · Substance use

Introduction

Orthorexia nervosa (ON) is a speculated condition (not currently classified as a mental disorder) that is characterized by the following theorized diagnostic criteria: (a) mental and behavioral preoccupation with healthy eating that includes rigidly following a very restrictive diet believed to be healthy and pure, (b) significant emotional distress experienced in response to any violations of this restrictive diet, (c) physical impairments due to nutritional deficiencies or malnutrition resulting from this restrictive diet, and (d) corresponding psychosocial impairments that negatively impact interpersonal relationships and/or vocational/academic work [1–5]. Considering their obsessive behaviors and mental

preoccupation with healthy nutrition, people with ON may conceivably also be driven to follow other healthy lifestyle rules, such as not smoking, not consuming alcohol, and not using other addictive drugs. However, as revealed in the literature review below, the findings on such relationships are mixed.

Cigarette smoking

Whereas one study did indeed find that ON symptomatology is significantly greater in non-smokers than smokers [6], two studies found the opposite relationship with ON symptomatology being significantly greater in smokers than non-smokers [7, 8]. In addition, seven studies found no relationship between ON symptomatology and smoking status [9–15]. It should be noted, however, that all but two of these studies used the ORTO-15 (or briefer ORTO-11), which suffers from inadequate reliability and validity [2, 15–22]. Moreover, half of these studies used limited-generalizability

✉ Crystal D. Oberle
oberle@txstate.edu

¹ Department of Psychology, Texas State University, 601 University Dr., San Marcos, TX 78666, USA

samples including medical/nutrition professionals or students [7–9], fitness participants [10], and performance artists [11]. The current study will reassess this relationship between ON symptomatology and smoking status with a large, more generalizable sample of participants completing a reliable and valid measure of ON based on the four theorized diagnostic criteria discussed previously.

Regarding hypotheses, whereas commitment to a healthy lifestyle would explain the possibility of ON symptomatology being greater in non-smokers than smokers, some other relevant past research may explain the possibility of the opposite relationship. Namely, past research reveals that smoking prevalence is greater in people with concerns about their weight than people without such concerns [23, 24] and is greater in people intentionally trying to lose weight than people without a history of trying to lose weight [25–27]. In some cases, ON may develop out of concerted efforts to lose weight by individuals with relatively higher body fat who turn to healthy eating with the goal of achieving an optimal weight to improve their physical health. In fact, ON symptomatology has been positively correlated with both overweight preoccupation [28, 29] and drive for thinness [14], and a recent study of people self-diagnosing with ON revealed that most of them actively tried to lose weight for health reasons [30]. Perhaps some of these individuals smoked as a means of appetite suppression to help with weight loss. Such a possibility is further consistent with clinical research showing that smoking prevalence is greater in people with eating disorders (especially bulimia) than healthy controls [31–34]. The current study, in addition to asking participants about their smoking status and level of dependence, will ask smokers about their reasons for smoking (e.g., weight control, tension reduction, pleasure) to help explain the reasoning behind a potential relationship between ON symptomatology and smoking.

Alcohol consumption

Although one study found that ON symptomatology is significantly greater in those who do not drink alcohol than those who do [15], five studies found no relationship between ON symptomatology and alcohol consumption [9–13]. As with the smoking literature, however, all but two of these studies used the ORTO-15 (or briefer ORTO-11) that suffers from inadequate reliability and validity, and half of these studies used the limited-generalizability samples previously mentioned. The current study will reassess this relationship with a large representative sample and a reliable and valid ON measure.

Pertaining to hypotheses, although commitment to a healthy lifestyle would explain the possibility of ON symptomatology being greater in non-drinkers than drinkers, other research may explain the possibility of the opposite

relationship. Most notably, alcohol abuse and dependence have been shown to be greater in people with eating disorders (including bulimia and anorexia) than healthy controls [35–37], findings that may partially be attributed to the comorbid depression and anxiety experienced by people with eating disorders [38–40]. Relevant to orthorexia, ON symptomatology has been positively correlated with levels of both depression [12, 41–43] and anxiety [13, 43], which may lead some individuals to turn to alcohol as a means of trying to cope with their negative emotions. The current study, in addition to asking participants about their drinking behaviors, will ask about their reasons for consuming alcohol (e.g., coping, conformity, enhancement) to shed light on the reasoning behind a potential relationship between ON symptomatology and alcohol consumption.

Illicit drug use

To the best of our knowledge, only two studies have investigated whether ON symptomatology is associated with use of illicit drugs, and both found no relationship [10, 13]. These researchers asked a yes-or-no question pertaining to participants' drug use, not accounting for the use of different types of illicit drugs, such as illegal non-prescribed stimulants (e.g., cocaine, methamphetamine), depressants (e.g., barbiturates, rohypnol), opiates (e.g., heroin, fentanyl), or hallucinogens (e.g., PCP, LSD). Moreover, these researchers did not assess the level of drug dependence or the reasons for using the drugs. Regarding what we might expect, as with smoking and alcohol consumption, commitment to a healthy lifestyle would explain the possibility of ON symptomatology being greater in non-users than users, but other research may explain the possibility of the opposite relationship. Specifically, illicit drug abuse and dependence have been shown to be greater in people with eating disorders (including bulimia and anorexia) than healthy controls [35–37]. The reasons underlying these relationships may depend on the particular drugs being used. For instance, stimulant use in people with eating disorders may be associated with a desire to lose weight [44], whereas the use of other drugs such as opioids and cannabis, whose dampening effects are comparable to alcohol, may be associated with the comorbid depression and anxiety experienced by people with eating disorders [38–40].

Purpose of the current study

In summary, because a defining feature of ON is a mental and behavioral preoccupation with eating only what is believed to be healthy and pure, we might expect that the avoidance of unhealthy foods would also entail the avoidance of unhealthy substances including nicotine, alcohol, and illicit drugs. However, the majority of studies failed to

find relationships between ON symptomatology and use of these substances. As mentioned previously, these findings may partly be due to most of these studies using an ON measure lacking in reliability and validity, and/or using limited-generalizability samples such as health professionals. Another possibility, though, is that people with higher levels of ON symptomatology are driven not only by the desire to be physically healthy but also by other motivations that include the desire to lose weight (associated with use of nicotine and other stimulant drugs) and/or the desire to overcome negative emotions (associated with use of alcohol and other depressant drugs). The current study sought to use a large representative sample and an ON measure established to be reliable and valid, in addition to assessing the prevalence and frequency of using these substances (i.e., nicotine, alcohol, and illicit drugs), the level of dependence on these substances, and the reasons for using these substances. Such data will allow for a better exploration of potential relationships between ON symptomatology and substance use/abuse, including the reasons underscoring those relationships.

Method

Participants

Using convenience sampling, participants were recruited from undergraduate courses (in nutrition, exercise science, athletic training, and psychology) at a large university in the southern region of the United States, as well as through an Instagram advertisement with the audience interests set to target healthy eaters (e.g., “healthy eating,” “clean eating,” “paleo”). The recruitment of students from health-related courses and of Instagram users following healthy eating accounts was for the purpose of increasing the likelihood of obtaining participants with ON symptomatology. Of the 471 participants who completed the survey, the majority were women (86%; 13% men, 1% non-binary), were White (48%; 28% Hispanic or Latinx, 9% Black, 5% Asian American, 9% biracial or multiracial), and had some college without a degree at the time (59%; 4% Bachelor’s degree, 6% Associate’s degree, 25% high school diploma, 5% no high school diploma). Their ages ranged from 18 to 46 years ($M = 19.98$, $SD = 3.56$), and body mass index (BMI) ranged from 15.45 to 48.25 kg/m² ($M = 24.77$, $SD = 5.67$).

Procedure

For this study, which was approved by Texas State University’s Institutional Review Board, participants provided informed consent and then completed an online survey through Qualtrics. The survey began with a demographic

questionnaire, followed by measures of ON, frequency of substance use, level of dependence or substance abuse, and reasons for using these substances.

Materials

ON was assessed with the Orthorexia Nervosa Inventory (ONI) [12] that is comprised of 24 statements about eating, to which participants use a 4-point Likert rating to indicate how true each statement is for them based on their current eating habits. This inventory produces scores on three different scales. First, the ONI Behaviors scale includes nine items on obsessive behaviors and preoccupation with healthy eating (e.g., “I strictly avoid all foods I feel are unhealthy”). Second, the ONI Impairments scale includes ten items on either psychosocial impairments (e.g., “My healthy eating is a significant source of stress in my relationships”) or physical impairments (e.g., “The stricter I become with my diet, the more I seem to experience one or more physical symptoms such as fatigue, faintness, heart racing, nausea, diarrhea, pain, etc.”) resulting from their oftentimes extreme behaviors. Third, the ONI Emotions scale includes five items on emotional distress resulting from violations of their strict dietary rules (e.g., “I feel much guilt or self-loathing when I stray from my healthy diet”). For all scales, higher scores represent higher levels of ON symptomatology. Regarding internal consistency, with data from the current study, Cronbach’s alpha was 0.93 for the total ONI, and ranged from 0.86 to 0.89 for its three scales, which is comparable to the values of 0.88–0.90 found in the initial validation study [12].

Frequency of substance use was assessed as both a dichotomous categorical variable (i.e., users vs. non-users) and a continuous variable. For the categorical variables, three yes-or-no questions asked whether the participants smoke cigarettes or vape, whether they drink alcoholic beverages, and whether they have ever consumed or used a non-prescribed illicit/illegal drug. For the continuous variables, seven questions, each with five response options, asked how much they smoke or vape per day (with responses ranging from “0–5 cigarettes or comparable vaping” to “30+ cigarettes or comparable vaping”), how often they have a drink containing alcohol (with responses ranging from “Never” to “4+ times a week”), and how many times they used the following non-prescribed illicit drugs during the past 12 months (with responses ranging from “Not at all” to “More than 20 times”): stimulants such as amphetamines, methamphetamine, or cocaine; depressants such as barbiturates, benzodiazepines, or rohypnol; opiates such as heroine, fentanyl, or vicodin; hallucinogens such as PCP, LSD, or ecstasy; and marijuana/cannabis.

Substance dependence or abuse was assessed with the Cigarette Dependence Scale (CDS) [45], the Alcohol Use Disorders Identification Test (AUDIT) [46], and

the UNCOPE [47]. First, the CDS includes five Likert-response questions that were slightly modified for the current study to include vaping along with cigarette smoking (e.g., “How would you rate your addiction to cigarettes/vaping on a scale of 0–100?”). Second, the AUDIT includes ten Likert-response questions asking about problematic drinking behavior (e.g., “How often during the last year have you found that you were not able to stop drinking once you had started?”). Finally, the UNCOPE includes six yes-or-no questions asking about drug abuse or dependence (e.g., “Have you ever neglected some of your usual responsibilities because of using drugs?”). For all scales, higher scores represent higher levels of substance dependence or abuse. With data from the current study, Cronbach’s alpha was 0.94 for the CDS, 0.83 for the AUDIT, and 0.86 for the UNCOPE. These internal consistency values are comparable to those found in the initial validation studies: 0.84 for the CDS [45], 0.91 for the AUDIT [46], and 0.92 for the UNCOPE [47].

The motivations for using substances were assessed with the Reasons for Smoking Scale (RSS) [48], the Drinking Motives Questionnaire-Revised (DMQ-R) [49], and a modified DMQ-R as described below. First, completed only by smokers or vapers ($n = 97$), the RSS is comprised of 11 statements pertaining to reasons for smoking or vaping, to which participants use a 5-point Likert rating to indicate how true each statement is for them. It includes four scales: RSS Pleasure (e.g., “I find smoking cigarettes or vaping pleasurable”), RSS Stimulation (e.g., “I smoke cigarettes or vape to stimulate me, to perk myself up”), RSS Tension Reduction (e.g., “I light up a cigarette or vape when I feel angry about something”), and RSS Weight Control (e.g., “I rely upon smoking cigarettes or vaping to control my hunger and eating”). Second, completed only by alcohol drinkers ($n = 344$), the DMQ-R is comprised of 20 reasons typically given for drinking alcohol, to which participants use a 5-point Likert rating to indicate how often they drink for each reason. It includes four scales: DMQ-R Enhancement (e.g., “Because it’s exciting”), DMQ-R Social (e.g., “To be sociable”), DMQ-R Conformity (e.g., “Because your friends pressure you to drink”), and DMQ-R Coping (e.g., “Because it helps you when you feel depressed or nervous”). Last, completed only by illicit drug users ($n = 191$), the modified DMQ-R was nearly identical to the original DMQ-R, except that “drink/drinking alcohol” was revised to “use/using drugs” throughout the instructions and questionnaire items. With data from the current study, Cronbach’s alpha ranged from 0.79 to 0.87 for the RSS scales, 0.85–0.90 for the DMQ-R scales, and 0.90–0.92 for the modified DMQ-R scales. These internal consistency values are comparable to those found in the initial validation

studies: 0.76–0.88 for the RSS scales [48] and 0.84–0.88 for the DMQ-R scales [49].

Statistical analyses

Data were analyzed using the SPSS Statistics 26 software. Independent-measures *t* tests were conducted to assess group differences between users and non-users on the total ONI score and each of its scales, and Pearson correlation analyses were conducted to assess the ONI relationships with the remaining, continuous variables measuring frequency of use, level of dependence or abuse, and motivations for use. A standard alpha criterion of 0.05 was used to determine statistical significance. For significant group differences, Cohen’s *d* was calculated, with a value of 0.2 considered a small effect, 0.5 a medium effect, and 0.8 a large effect. For significant correlations, an *r* value of 0.1 was considered a weak relationship, 0.3 a moderate relationship, and 0.5 a strong relationship.

Results

Table 1 presents the inferential results on associations between ONI scores and levels of substance use/abuse. The only significant group differences were for the ONI Behaviors scale. The ONI Behaviors scores were greater for non-smokers ($M = 15.27$, $SD = 5.57$) than for smokers ($M = 13.79$, $SD = 4.29$; Cohen’s $d = 0.30$), greater for those who do not consume alcohol ($M = 15.87$, $SD = 6.14$) than for those who do ($M = 14.63$, $SD = 5.01$; Cohen’s $d = 0.22$), and greater for those who do not use illicit drugs ($M = 15.56$, $SD = 5.84$) than for those who do ($M = 14.08$, $SD = 4.44$; Cohen’s $d = 0.29$). Similarly, ONI Behaviors scores were negatively correlated with frequency of smoking, alcohol consumption, and marijuana use, as well as with CDS scores. In contrast, frequency of using illicit depressant drugs was positively correlated with all ONI scores (i.e., total ONI scores and scores on each of its scales), indicating that greater use of illicit depressant drugs is associated with greater ON symptomatology. Regarding level of substance dependence or abuse, although the AUDIT and UNCOPE scores were each positively correlated with both the ONI Impairments and ONI Emotions scores, they were not significantly correlated with the ONI Behaviors scores or the total ONI scores.

Table 2 presents the inferential results on associations between ONI scores and motivations for using these substances. Among smokers or vapers, the RSS Weight Control scores were positively correlated with all ONI scores. Next, among those who consume alcohol, the DMQ-R Coping and DMQ-R Conformity scores were each positively correlated with all ONI scores. Finally, among those who use illicit

Table 1 Associations between ON symptomatology and degree of substance use/abuse

Substance use variable	ONI scale							
	Total		Behaviors		Impairments		Emotions	
Substance users vs. non-users	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>
Smoke (<i>n</i> = 97) or not (<i>n</i> = 374)	0.10	.92	2.82	.005**	− 1.37	.17	− 1.37	.17
Drink (<i>n</i> = 344) or not (<i>n</i> = 127)	1.13	.26	2.03	.04*	0.55	.58	− 0.26	.80
Use drugs (<i>n</i> = 191) or not (<i>n</i> = 280)	1.03	.30	3.12	.002**	− 0.28	.78	− 0.54	.59
Frequency of substance use (<i>n</i> = 471)	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Smoking	− .02	.73	− .10	.02*	.05	.26	.03	.49
Alcohol	− .06	.17	− .13	.007**	− .01	.78	− .01	.88
Marijuana	− .04	.39	− .11	.02*	.01	.84	.02	.69
Illicit depressant drugs	.12	.01*	.10	.03*	.10	.03*	.12	.02*
Illicit stimulant drugs	.08	.07	.06	.17	.08	.07	.07	.15
Illicit opiate drugs	.02	.67	.01	.78	.06	.24	− .02	.61
Illicit hallucinogen drugs	.02	.74	.01	.96	.05	.28	− .01	.82
Dependence or abuse (<i>n</i> = 471)	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
CDS	− .02	.65	− .10	.03*	.06	.21	.01	.92
AUDIT	.06	.17	− .04	.45	.12	.01*	.10	.03*
UNCOPE	.06	.22	− .06	.18	.11	.02*	.13	.006**

ONI Orthorexia Nervosa Inventory [12], CDS Cigarette Dependence Scale [45], AUDIT Alcohol Use Disorders Identification Test [46], UNCOPE UNCOPE screening for drug abuse [47]

**p* < .05

***p* < .01

drugs, the modified DMQ-R Coping and modified DMQ-R Conformity scores were each positively correlated with all ONI scores except for the ONI Behaviors scores.

Discussion

The past research exploring the relationships between ON and substance use is limited and with mixed conclusions. One perspective is that the ON preoccupation with pure and healthy eating would coincide with the practice of other health-driven behaviors, therefore, lowering the likelihood of engaging in substance use. Conversely, previous research into eating disorders overall suggests that eating disorder pathology may coincide with a greater likelihood to use and abuse substances. The present study sought to further investigate relationships between ON and substance use, assessing ON symptomatology with a more reliable and valid ON measure, as well as inquiring about the motivations behind substance use in this population. Furthermore, this study aimed to address issues of generalizability in previous research through a larger and more representative sample.

Regarding smoking (of traditional, electronic, or vapor cigarettes), smoking prevalence, frequency, and level of dependence were each negatively associated with healthy

eating behaviors as measured with the ONI Behaviors scale in the current study. These findings seemingly support the hypothesis that the avoidance of unhealthy foods among those with relatively high levels of ON symptomatology also extends to the avoidance of smoking due to its harmful health effects. However, none of these three smoking variables was significantly correlated with the total ONI score that additionally reflects the other three critical aspects of ON: emotional distress, physical impairments, and psychosocial impairments [1–5]. Although an individual may be preoccupied with healthy eating and follow a restrictive diet that they believe to be healthy and pure, without the additional impairments, this person would not be considered by a clinician to have ON. These results are consistent with those of multiple studies not finding a relationship between ON symptomatology and smoking status [9–15]. In regard to reasons for smoking, the only motivation that was correlated with ON symptomatology in the current study was weight control. Perhaps the smokers with relatively high levels of ON symptomatology smoked as a means of appetite suppression either to help lose weight with the goal of achieving a healthier weight [30] or to help maintain a healthy weight and do everything possible to avoid becoming overweight [28, 29], even if using an unhealthy means to achieve or maintain this healthy weight.

Table 2 ON symptomatology and motivations for substances use

Substance use motivations scale	ONI scale							
	Total		Behaviors		Impairments		Emotions	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
RSS (smoking; <i>n</i> = 97)								
Pleasure	.11	.30	.03	.78	.11	.23	.12	.23
Stimulation	.08	.45	.05	.64	.15	.16	.09	.37
Tension reduction	.06	.55	.01	.92	.04	.73	.11	.28
Weight control	.29	.004**	.23	.03*	.22	.04*	.27	.008**
DMQ-R (alcohol; <i>n</i> = 344)								
Enhancement	.07	.12	.01	.93	.09	.10	.12	.03*
Social	.06	.25	.01	.81	.05	.34	.11	.04*
Conformity	.25	.001***	.24	.001***	.19	.001***	.21	.001***
Coping	.29	.001***	.13	.01*	.31	.001***	.33	.001***
Modified DMQ-R (illicit drugs; <i>n</i> = 191)								
Enhancement	.08	.30	.03	.65	.07	.35	.10	.16
Social	.14	.06	.11	.14	.09	.20	.16	.03*
Conformity	.17	.02*	.13	.06	.15	.03*	.16	.03*
Coping	.20	.007**	.01	.86	.21	.003**	.29	.001***

ONI Orthorexia Nervosa Inventory [12], RSS Reasons for Smoking Scale [48], DMQ-R Drinking Motives Questionnaire-Revised [49]

* $p < .05$

** $p < .01$

*** $p < .001$

Relevant to alcohol use, as with cigarette smoking, prevalence and frequency were negatively associated with healthy eating behaviors measured by the ONI Behaviors scale. These findings suggest that the endorsement of healthy eating habits among those with greater ON symptomatology extends to the avoidance of alcohol consumption. However, again similar to cigarette smoking, the total ONI score was not significantly correlated with prevalence, frequency, or dependence on alcohol, consistent with several previous studies that found no relationship between ON and alcohol use [9–13]. Consequently, individuals with ON symptomatology who engage in alcohol consumption behaviors may do so relative to factors external to the disorder. In the current study, among participants who consume alcohol, the total ONI and all subscale scores were positively correlated with motivations to drink for the purposes of coping and conformity. Concerning the relationship to coping, it is possible that drinkers who experience ON symptomatology may engage in alcohol consumption as a means of deterring the emotional distress, anxiety, and depression that have been associated with ON [12, 13, 41–43]. Such coping motivations also underly the alcohol abuse seen in some people with other eating disorders who suffer from comorbid anxiety and depression [38–40]. Furthermore, the relationship between higher ON symptomatology and drinking to conform

suggests that among more severe cases of ON, individuals prioritize evading social scrutiny and ostracization over the unhealthiness of alcohol.

Regarding illicit drug use, the ONI Behaviors score was negatively correlated with prevalence of illicit drug use and with frequency of marijuana use. These findings seem to indicate that greater endorsement of healthy eating behaviors may partly deter individuals from using illicit drugs, just as it may partly deter them from smoking cigarettes or consuming alcohol. However, as with cigarettes and alcohol, the total ONI score was not correlated with prevalence, frequency, or dependence on illicit drugs, consistent with two other studies finding no relationship between ON and use of illicit drugs [10, 13]. The only exception was for frequency of using illicit depressant drugs, which was positively correlated with all aspects of ON symptomatology. Examination of motivations revealed that, similar to the reasons for consuming alcohol, ON symptomatology was associated with using illicit drugs for the purposes of coping and conformity, with emotional coping being the strongest predictor. This finding is consistent with several studies that found drug use to be an unhealthy coping mechanism for comorbid anxiety and depression among individuals with eating disorders [38–40]. Thus, clinicians who are treating patients

for ON must be sure to also assess and treat potentially underlying anxiety or depression conditions that may lead some individuals to turn to alcohol or other addictive depressant drugs for the purpose of trying to cope with their negative emotions.

Although the current study utilized a large sample and a more reliable and valid measure of ON, limitations should be considered. First, the recruitment for this study was aimed at health-driven groups, with many of the participants either recruited from nutrition and exercise science courses or recruited with an Instagram advertisement targeting healthy eaters. While such recruitment efforts helped to achieve a greater number of participants with higher levels of ON symptomatology, not specifically targeting substance users or individuals with more unhealthy diets may limit the generalizability of results. Second, the majority of the sample consisted of young, female, college-educated adults, which may additionally limit generalizability of the study's findings. These demographics are likely due to the recruitment of university students and Instagram users online. Regarding the latter, a 2019 Pew Research Center poll revealed that Instagram users are more likely to be young (18–29 years), female, college-educated adults from urban or suburban areas and with relatively higher incomes [50]. Third, this study used self-report measures and is therefore subject to self-report bias. Finally, the sample was a non-clinical sample, largely due to the lack of an established clinical standard for diagnosis of ON, and the subsequent difficulty in recruiting patients with such a diagnosis. Future research should aim to recruit a more behaviorally and demographically diverse sample to increase the generalizability of the results. Moreover, to further understand the underlying mechanisms of substance use among individuals with ON, future studies should aim to recruit a clinical sample of patients with an ON diagnosis, as well as to control for comorbidities that include anxiety and depression, which has been shown to be related to ON and other eating disorders. Finally, future research could further explore the reason why depressants are preferred over other substances, by controlling for personality traits. The use of depressant drugs could reflect neuroticism, for example, which is also visible in terms of coping and conformity being the primary reasons underlying substance use.

What is already known on this subject?

Most past studies found no relationships between ON symptomatology and substance use, but they did not assess use of specific illicit drugs or the motivations underlying substance use.

What does this study add?

ON scores were positively correlated with frequency of using illicit depressant drugs. Further, among substance users, ON scores were positively associated with smoking or vaping for the purpose of weight control, and with consuming alcohol and using illicit drugs for the purposes of conformity and coping with such negative emotions as anxiety and depression.

Declaration

Conflict of interest The authors declare no conflict of interest.

Ethical approval All the 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.

References

1. Barthels F, Meyer F, Pietrowsky R (2015) Duesseldorf orthorexia scale—construction and evaluation of a questionnaire measuring orthorexic eating behavior. *Z Klin Psychol Psychother* 44:97–105. <https://doi.org/10.1026/1616-3443/a000310>
2. Cena H, Barthels F, Cuzzolaro M, Bratman S, Brytek-Matera A, Dunn T et al (2019) Definition and diagnostic criteria for orthorexia nervosa: a narrative review of the literature. *Eat Weight Disord* 24:209–246. <https://doi.org/10.1007/s40519-018-0606-y>
3. Dunn TM, Bratman S (2016) On orthorexia nervosa: a review of the literature and proposed diagnostic criteria. *Eat Behav* 21:11–17. <https://doi.org/10.1016/j.eatbeh.2015.12.006>
4. Moroze RM, Dunn TM, Holland JC, Yager J, Weintraub P (2015) Microthinking about micronutrients: a case of transition from obsessions about health eating to near-fatal “orthorexia nervosa” and proposed diagnostic criteria. *Psychosomatics* 56:397–403. <https://doi.org/10.1016/j.psych.2014.03.003>
5. Setnick J (2013) The eating disorders clinical pocket guide: quick reference for healthcare providers, 2nd edn. Understanding Nutrition, Dallas
6. Hyrnik J, Janas-Kozik M, Stochel M, Jelonek I, Siwiec A, Rybakowski JK (2016) The assessment of orthorexia nervosa among 1899 Polish adolescents using the ORTO-15 questionnaire. *Int J Psychiatry Clin Pract* 20:199–203. <https://doi.org/10.1080/13651501.2016.1197271>
7. Fidan T, Ertekin V, Isikay S, Kirpinar I (2010) Prevalence of orthorexia among medical students in Erzurum, Turkey. *Compr Psychiatry* 51:49–54. <https://doi.org/10.1016/j.comppsy.2009.03.001>
8. Maghetti A, Cicero AFG, D'Ignazio E, Vincenzi M, Paolini B, Lucchin L (2015) Orthorexia prevalence among health care professionals involved in nutrition education: the ADI-O study. *Mediterr J Nutr Metab* 8:199–204. <https://doi.org/10.3233/MNM-140039>

9. Karakus B, Hidiroglu S, Keskin N, Karavus M (2017) Orthorexia nervosa tendency among students of the department of nutrition and dietetics at a university in Istanbul. *North Clin Istanbul* 4:117–123. <https://doi.org/10.14744/nci.2017.20082>
10. Almeida C, Vieira Borba V, Santos L (2018) Orthorexia nervosa in a sample of Portuguese fitness participants. *Eat Weight Disord* 23:443–451. <https://doi.org/10.1007/s40519-018-0517-y>
11. Aksoydan E, Camci N (2009) Prevalence of orthorexia nervosa among Turkish performance artists. *Eat Weight Disord* 14:33–37. <https://doi.org/10.1007/BF03327792>
12. Oberle CD, De Nadai AS, Madrid AL (2021) Orthorexia Nervosa Inventory (ONI): development and validation of a new measure of orthorexic symptomatology. *Eat Weight Disord* 26:609–622. <https://doi.org/10.1007/s40519-020-00896-6>
13. Strahler J, Hermann A, Walter B, Stark R (2018) Orthorexia nervosa: a behavioral complex or psychological condition? *J Behav Addict* 7:1143–1156. <https://doi.org/10.1556/2006.7.2018.129>
14. Parra-Fernandez ML, Rodríguez-Cano T, Onieva-Zafra MD, Perez-Haro MJ, Casero-Alonso V, Fernandez-Martinez E, Notario-Pacheco B (2018) Prevalence of orthorexia nervosa in university students and its relationship with psychopathological aspects of eating behaviour disorders. *BMC Psychiatry* 18:364. <https://doi.org/10.1186/s12888-018-1943-0>
15. Varga M, Thege BK, Dukay-Szabo S, Tury F, van Furth EF (2014) When eating healthy is not healthy: orthorexia nervosa and its measurement with the ORTO-15 in Hungary. *BMC Psychiatry* 14:59. <https://doi.org/10.1186/1471-244X-14-59>
16. Alvarenga MS, Martins MCT, Sato KSCJ, Vargas SVA, Philippi ST, Scagliusi FB (2012) Orthorexia nervosa behavior in a sample of Brazilian dietitians assessed by the Portuguese version of ORTO-15. *Eat Weight Disord* 17:29–35. <https://doi.org/10.1007/BF03325325>
17. Arusoglu G, Kabakci E, Koksall G, Merdol TK (2008) Orthorexia nervosa and adaptation of ORTO-11 into Turkish. *Turk J Psychiatry* 19:283–291
18. Brytek-Matera A, Krupa M, Poggiogalle E, Donini LM (2014) Adaptation of the ORTHO-15 test to Polish women and men. *Eat Weight Disord* 19:69–76. <https://doi.org/10.1007/s40519-014-0100-0>
19. Haddad C, Obeid S, Akel M, Honein K, Akiki M, Azar J, Hallit S (2019) Correlates of orthorexia nervosa among a representative sample of the Lebanese population. *Eat Weight Disord* 24:481–493. <https://doi.org/10.1007/s40519-018-0631-x>
20. Missbach B, Dunn TM, König JS (2017) We need new tools to assess orthorexia nervosa: a commentary on 'Prevalence of orthorexia nervosa among college students based on Bratman's test and associated tendencies'. *Appetite* 108:521–524. <https://doi.org/10.1016/j.appet.2016.07.010>
21. Oberle CD, Samaghhabadi RO, Hughes EM (2017) Orthorexia nervosa: assessment and correlates with gender, BMI, and personality. *Appetite* 108:303–310. <https://doi.org/10.1016/j.appet.2016.10.021>
22. Parra-Fernández ML, Rodríguez-Cano T, Perez-Haro MJ, Onieva-Zafra MD, Fernández-Martinez E, Notario-Pacheco B (2018) Structural validation of ORTO-11-ES for the diagnosis of orthorexia nervosa, Spanish version. *Eat Weight Disord* 23:745–752. <https://doi.org/10.1007/s40519-018-0573-3>
23. Copeland AL, Spears CA, Baillie LE, McVay MA (2016) Fear of fatness and drive for thinness in predicting smoking status in college women. *Addict Behav* 54:1–6. <https://doi.org/10.1016/j.addbeh.2015.11.010>
24. Saules KK, Collings AS, Hoodin F, Angelella NE, Alschuler K, Ivezaj V et al (2009) The contributions of weight problem perception, BMI, gender, mood, and smoking status to binge eating among college students. *Eat Behav* 10:1–9. <https://doi.org/10.1016/j.eatbeh.2008.07.010>
25. Lowry R, Galuska DA, Fulton JE, Wechsler H, Kann L (2002) Weight management goals and practices among US high school students: associations with physical activity, diet, and smoking. *J Adolesc Health* 31:133–144. [https://doi.org/10.1016/S1054-139X\(01\)00408-6](https://doi.org/10.1016/S1054-139X(01)00408-6)
26. Saarni SE, Silventoinen K, Rissanen A, Sarlio-Lähteenkorva S, Kaprio J (2004) Intentional weight loss and smoking in young adults. *Int J Obes* 28:796–802. <https://doi.org/10.1038/sj.ijo.0802627>
27. Strauss RS, Mir HM (2001) Smoking and weight loss attempts in overweight and normal-weight adolescents. *Int J Obes* 25:1381–1385. <https://doi.org/10.1038/sj.ijo.0801683>
28. Barnes MA, Calabiano ML (2017) The interrelationship between orthorexia nervosa, perfectionism, body image and attachment style. *Eat Weight Disord* 22:177–184. <https://doi.org/10.1007/s40519-016-0280-x>
29. Brytek-Matera A, Donini LM, Krupa M, Poggiogalle E, Hay P (2015) Orthorexia nervosa and self-attitudinal aspects of body image in female and male university students. *J Eat Disord* 3:2. <https://doi.org/10.1186/s40337-015-0038-2>
30. Valente M, Brenner R, Cesuroglu T, Bunders-Aelen J, Syurina EV (2020) “And it snowballed from there”: the development of orthorexia nervosa from the perspective of people who self-diagnose. *Appetite* 155:104840. <https://doi.org/10.1016/j.appet.2020.104840>
31. Anzengruber D, Klump KL, Thornton L, Brandt H, Crawford S, Fichter MM et al (2006) Smoking in eating disorders. *Eat Behav* 7:291–299. <https://doi.org/10.1016/j.eatbeh.2006.06.005>
32. George A, Waller G (2005) Motivators for smoking in women with eating disorders. *Eur Eat Disord Rev* 13:417–423. <https://doi.org/10.1002/erv.623>
33. King L, Saules KK, Irish J (2007) Weight concerns and cognitive style: Which carries more “weight” in the prediction of smoking among college women? *Nicotine Tob Res* 9:535–543. <https://doi.org/10.1080/14622200701188935>
34. Solmi M, Veronese N, Sergi G, Luchini C, Favaro A, Santonastaso P et al (2016) The association between smoking prevalence and eating disorders: a systematic review and meta-analysis. *Addict* 111:1914–1922. <https://doi.org/10.1111/add.13457>
35. Baker JH, Mitchell KS, Neale MC, Kendler KS (2010) Eating disorder symptomatology and substance use disorders: prevalence and shared risk in a population based twin sample. *Int J Eat Disord* 43:648–658. <https://doi.org/10.1002/eat.20856>
36. Nøkleby H (2012) Comorbid drug use disorders and eating disorders—a review of prevalence studies. *Nord Stud Alcohol Drug* 29:303–314. <https://doi.org/10.2478/V10199-012-0024-9>
37. Root TL, Pisetsky EM, Thornton L, Lichtenstein P, Pedersen NL, Bulik CM (2010) Patterns of co-morbidity of eating disorders and substance use in Swedish females. *Psychol Med* 40:105–115. <https://doi.org/10.1017/S0033291709005662>
38. Baker JH, Thornton LM, Strober M, Brandt H, Crawford S, Fichter MM et al (2013) Temporal sequence of comorbid alcohol use disorder and anorexia nervosa. *Addict Behav* 38:1704–1709. <https://doi.org/10.1016/j.addbeh.2012.10.005>
39. Harrop EN, Marlatt GA (2010) The comorbidity of substance use disorders and eating disorders in women: prevalence, etiology, and treatment. *Addict Behav* 35:392–398. <https://doi.org/10.1016/j.addbeh.2009.12.016>
40. Raney TJ, Thornton LM, Berrettini WH, Brandt H, Crawford S, Fichter MM et al (2008) Influence of overanxious disorder of childhood on the expression of anorexia nervosa. *Int J Eat Disord* 41:326–332. <https://doi.org/10.1002/eat.20508>
41. Gleaves DH, Graham EC, Ambwani S (2013) Measuring “orthorexia:” development of the Eating Habits Questionnaire. *Int J Educ Psychol Assess* 12(2):1–18

42. Luck-Sikorski C, Jung F, Schlosser K, Riedel-Heller SG (2018) Is orthorexic behavior common in the general public? A large representative study in Germany. *Eat Weight Disord* 24:267–273. <https://doi.org/10.1007/s40519-018-0502-5>
43. Zhou X, Schneider SC, Cepeda SL, Storch EA (2020) Orthorexia nervosa in China: an exploration of phenomenology and clinical correlates among university students. *J Cogn Psychother* 34:225–241. <https://doi.org/10.1891/JCPSY-D-19-00027>
44. Root TL, Pinheiro AP, Thornton L, Strober M, Fernandez-Aranda F, Brandt H et al (2010) Substance use disorders in women with anorexia nervosa. *Int J Eat Disord* 43:14–21. <https://doi.org/10.1002/eat.20670>
45. Etter JF, Le Houezec J, Perneger TV (2003) A self-administered questionnaire to measure dependence on cigarettes: the cigarette dependence scale. *Neuropsychopharmacol* 28:359–370. <https://doi.org/10.1038/sj.npp.1300030>
46. Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M (1993) Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption—II. *Addict* 88:791–804. <https://doi.org/10.1111/j.1360-0443.1993.tb02093.x>
47. Proctor SL, Hoffmann NG (2016) The UNCOPE: an effective brief screen for DSM–5 substance use disorders in correctional settings. *Psychol Addict Behav* 30:613–618. <https://doi.org/10.1037/adb0000170>
48. Souza ES, Crippa JA, Pasian SR, Martinez JA (2010) University of São Paulo reasons for smoking scale: a new tool for the evaluation of smoking motivation. *J Bras Pneumol* 36:768–778. <https://doi.org/10.1590/s1806-37132010000600015>
49. Cooper ML (1994) Motivations for alcohol use among adolescents: development and validation of a four-factor model. *Psychol Assess* 6:117–128. <https://doi.org/10.1037/1040-3590.6.2.117>
50. Pew Research Center (2019) Social media fact sheet. <https://www.pewresearch.org/internet/fact-sheet/social-media/>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.