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The association between personality traits, cognitive reactivity and body mass index is dependent on depressive and/or anxiety status

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ABSTRACT

Objective: A range of biological, social and psychological factors, including depression and anxiety disorders, is thought to be associated with higher body mass index (BMI). Depression and anxiety disorders are associated with specific psychological vulnerabilities, like personality traits and cognitive reactivity, that may also be associated with BMI. The relationship between those psychological vulnerabilities and BMI is possibly different in people with and without depression and anxiety disorders. Therefore, we examined the relationship between personality traits, cognitive reactivity and severity of affective symptoms with BMI in people with and without depression and anxiety disorders.

Methods: Data from 1249 patients with current major depressive and/or anxiety disorder and 631 healthy controls were sourced from the Netherlands Study of Depression and Anxiety. Linear and logistic regression analyses were used to determine the associations between personality traits (neuroticism, extraversion, conscientiousness), cognitive reactivity (hopelessness, aggression, rumination, anxiety sensitivity), depression and anxiety symptoms with BMI classes (normal: 18.5–24.9, overweight: 25–29.9, and obese: ≥30 kg/m^2) and continuous BMI. Due to significant statistical interaction, analyses were stratified for healthy individuals and depressed/anxious patients.

Results: Personality traits were not consistently related to BMI. In patients, higher hopelessness and aggression reactivity and higher depression and anxiety symptoms were associated with higher BMI. In contrast, in healthy individuals lower scores on hopelessness, rumination, aggression reactivity and anxiety sensitivity were associated with higher BMI.

Conclusion: These results suggest that, particularly in people with psychopathology, cognitive reactivity may contribute to obesity.

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1. Introduction

Overweight and obesity are among the leading global public health concerns [1,2]. The prevalence of these conditions is high, with lifetime percentages of around 39% for overweight (body mass index; BMI ≥ 25) and 13% for obesity (BMI ≥ 30). A high BMI has been found to be associated with negative health outcomes, functional impairment, and increased mortality [3]. BMI is influenced by a broad range of genetic, behavioral, environmental, and social factors [4–9]. In addition, several psychiatric and psychological characteristics may make people more vulnerable for higher BMI. Psychiatric disorders such as depression and anxiety have been related to increased BMI, both cross-sectionally and longitudinally [3,5–9,11]. Depression and anxiety disorders are highly comorbid [12] and are associated with specific psychological vulnerabilities that may also be associated with BMI. This paper focuses on the association of two psychological constructs that have been related to depressive and anxiety disorders - personality and cognitive reactivity – with BMI.

Evidence from a large body of research suggest that specific personality traits are associated with a high BMI. A recent systematic review of Gerlach et al. [13] found associations between personality traits neuroticism and to some extent extraversion as risk factors, and conscientiousness as a protective factor of a higher BMI. However, results differed dependent on the samples studied. While the vast majority of the population-based studies showed more pronounced associations, the

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results within the clinical samples (e.g. patients with binge eating disorders, or obese patients undergoing bariatric surgery) were less consistent, some failing to find associations between personality and BMI [13]. Although the association between depression/anxiety disorders and personality traits such as higher neuroticism and lower extraversion and conscientiousness is well established [14,15], no studies have investigated whether the association between these personality traits and BMI is similar in people with and without depression or anxiety disorders. Given the associations between depressive and anxiety disorders with BMI, the influence of disorder-related factors on BMI might predominate, thereby reducing the influence of personality characteristics in diseased people. On the other hand, given the large impact of their disorder, people with a depressive or anxiety disorder might be more vulnerable to other risk factors for high BMI as well, thereby increasing the influence of a vulnerable personality. It has not been tested whether persons with and without psychiatric disorders might have differential association between BMI and personality."

Cognitive reactivity, which is strongly linked to personality, is another factor that is possibly associated to BMI. Whereas personality traits are presumed to be global dimensions, reflecting a general vulnerability for negative emotionality and both physical and mental disorders, cognitive reactivity has been described as the more specific, cognitive manifestation of personality traits [16–19]. Cognitive reactivity is the ease at which negative thinking patterns are reactivated through minor triggers [20]. Several specific dysfunctional cognitive responses, such as hopelessness, rumination, aggression/hostility and anxiety sensitivity have been closely linked to depression and anxiety, as both a cause and a consequence [17,18,21–27]. To date, no studies have investigated the relationship between cognitive reactivity and BMI. The few studies into the association of cognitive reactivity and other weight-related concepts (e.g. eating behavior, food intake) are inconclusive. Some find associations between negative affect, rumination and anxiety sensitivity and unhealthy eating styles and high calorie intake [28–31], but others do not [32,33]. Furthermore, it is unclear what the role of depressive and anxiety disorders is in the potential association between cognitive reactivity and BMI.

Since depression and anxiety disorders are significantly associated with specific personality traits and cognitive reactivity on the one hand, and to high BMI on the other hand, it is relevant to study the associations between personality traits, cognitive reactivity and BMI. Psychological vulnerabilities such as personality traits and cognitive reactivity could contribute to a high BMI. The aim of the current study therefore is to examine the association of personality traits and cognitive reactivity with BMI in a large group of people with and without depressive and/or anxiety disorders, and to test whether these associations are different for those with and without depressive/anxiety disorders.

2. Methods

2.1. Study sample

Data from the Netherlands Study of Depression and Anxiety (NESDA), an ongoing cohort study of people with depression and anxiety disorders and healthy controls were used [34]. In order to represent diverse settings and developmental stages of psychopathology, 2981 adults (18–65 years) from the community (19%), general practice (54%) and specialized mental health care (27%) were included at baseline. Exclusion criteria were a primary clinical diagnosis of psychotic disorder, obsessive-compulsive disorder, bipolar disorder, or severe substance abuse disorder, and insufficient command of the Dutch language. The research protocol was approved by the Ethical Committees of the contributing universities and all participants provided written informed consent. A detailed description of the NESDA study design can be found elsewhere [34]. Between September 2004 and February 2007, all participants underwent a baseline assessment containing an extended face-to-face interview conducted by a trained research assistant, which included a standardized diagnostic psychiatric interview (Composite International Diagnostic Interview (CIDI) version 2.1, [35]) and self-report questionnaires. The presence of major depressive disorder, dysthymic disorder, social phobia, panic disorder, agoraphobia, and general anxiety disorder was established with use of the CIDI interview. For the current study, we used baseline data of patients with a current (within the past six months) depressive and/or anxiety disorder ($N = 1249$) and healthy controls without a lifetime depression/anxiety disorder and without antidepressant use ($N = 631$), leaving out all others. In addition, we excluded underweight participants ($n = 123$ and $n = 65$ in the patient and control group, respectively) because it can be expected that this is a specific group that differs from those with normal BMI [36], and this underweight group is outside the realm of the current research question.

2.2. Measurements

Overweight and obesity were determined with BMI (kg/m^2). Objective and standardized assessments of height and weight were performed during the face-to-face interview. Body weight was measured on a standard balance beam scale to the nearest 0.1 kg, wearing light clothing and without shoes. Height was measured barefoot using a wall-mounted stadiometer to the nearest 0.1 cm. BMI was calculated as weight in kilograms divided by height in meters squared. BMI was studied both as continuous variable and categorical variable (categorized into normal (18.5–24.9), overweight (25.0–29.9) and obese (≥30)).

Personality traits were determined by the NEO Five-Factor Inventory (NEO-FFI), a short form of the Revised NEO Personality Inventory (NEO-PI-R) [37]. The NEO-FFI is a self-report questionnaire to determine personality traits containing 60 questions that analyze five main personality domains (neuroticism, extraversion, openness, agreeableness and conscientiousness), using a five-point scale (0 through 4). Psychometric studies indicated good psychometric properties for the NEO-FFI, with high internal consistency rates and good validity measures like facet scale stability and cross-observer validity [38,39].

To measure cognitive reactivity, the Leiden Index of Depression Sensitivity-Revised (LEIDS-R, [20,40]) and the Anxiety Sensitivity Index (ASI, [41]) were used. The LEIDS-R is a self-report measure of cognitive reactivity to sad mood, measured with 34 items on a 5-point scale (0 *(not at all)* through 4 *(very strongly)*, where a higher score means a more pronounced cognitive reaction). The LEIDS-R has been found to discriminate between never-depressed and recovered depressed groups [20,42]. LEIDS-R scores are associated with biological vulnerability markers of depression [43,44], and longitudinal studies also support the validity of the LEIDS-R as a measure of depression vulnerability [40,45–47]. The LEIDS-R has 6 subscales: hopelessness/suicidality, acceptance/coping, aggression, control/perfectionism, harm avoidance and rumination. The ASI is a 16-item self-report questionnaire, which measures the fear of anxiety related symptoms. The items are rated on a 5-point scale (0 through 4, where a higher score means a more pronounced cognitive reaction).

Furthermore, since severity of symptoms can be an indication as well as a consequence of cognitive reactivity, the severity of depressive and anxiety symptoms was assessed. The Inventory of Depressive Symptomatology – Self Report (IDS-SR) is a self-administered questionnaire designed to assess the severity of depressive symptoms [48]. The questionnaire consists of 30 items, each with four answering options (coded 0 through 3). The Beck Anxiety Inventory (BAI) is a 21-item self-report instrument with four answering options (coded 1 through 4) that assesses the overall severity of anxiety [49].

The sample was described using demographic characteristics which included gender, age and years of education.

2.3. Statistical analysis

First, demographic variables were described for each group, showing the group sizes, means, standard deviations and percentages for categorical variables of sociodemographic variables, personality traits, cognitive reactivity and clinical symptoms. Second, to study the relation between the eight psychological vulnerability measures and BMI, associations between three personality traits, three cognitive reactivity and depressive and anxiety symptoms as determinants and BMI as continuous outcome measure were tested using linear regression analyses. Demographic variables age, gender and years of education were taken into account as control variables. Finally, to study whether the psychological vulnerability measures were related to overweight or to obesity, we used multinomial logistic regression analysis in the patient and the control groups, with BMI as the dependent variable, using normal BMI (18.5–24.9 kg/m^2) as reference category. Results were presented per SD increase, using standardized predictor variable scores.

Analyses were stratified for the patient and control groups, to study the two groups separately of each other. To verify whether differences found between the patients and healthy controls were statistically significant, we tested whether the interaction term between psychopathology status * psychological vulnerability was significantly associated with continuous BMI as outcome. This was done for each standardized psychological vulnerability variable, in the overall sample in models that also contained the direct terms (psychopathology status and standardized psychological predictor variables). Also, we checked whether the direction and strength of the associations between psychological vulnerability measures and BMI were different for the different psychiatric disorders (depressive versus anxiety disorders) included in our sample. This by comparing the regression coefficients, p-values and confidence intervals of the different linear regression analyses performed stratified for the different psychiatric disorders. Additionally, we checked the normality of residuals and multicollinearity statistical assumptions before starting the analysis, as well as the internal consistency of the questionnaires used. Results at level $p < 0.05$ were considered to be significant. We used SPSS version 20.0 (IBM Corp., Armonk, NY, USA).

3. Results

3.1. Sample characteristics

Table 1 shows the distribution of study characteristics of the 1249 patients (n = 272 for depression disorder, n = 238 for anxiety disorder, n = 739 for comorbid depression and anxiety disorder) and 631 healthy controls. Patients had a mean age of 40.9 (SD = 12.4), and had followed on average 11.6 years of education (SD = 3.3). Around one third of the patients were male. Around half of the patients had a normal BMI, almost one third suffered from overweight, and 19.6% suffered from obesity. Healthy participants were on average 41.0 years old (SD = 14.7) and followed 12.8 years of education (SD = 3.2). Less than half of the healthy controls were male. More than half of the healthy participants had a normal BMI, around one third had overweight, and 19.5% had obesity. Patients obtained higher neuroticism, cognitive reactivity and depression and anxiety symptom scores as compared to the healthy controls, whereas controls obtained higher extraversion and conscientiousness scores. The five questionnaires used (NEOFFI subscales, LEIDS-R, ASI, IDS-SR and BAI) all showed a high internal consistency (Cronbach's α = 75 to 0.84, 0.92, 0.89, 0.88 and 0.93 respectively).

3.2. Tests for interaction

We studied whether the association between psychological vulnerabilities and BMI differed between patients and controls by testing the interaction terms between psychopathology status * psychological vulnerability and associating those terms with continuous BMI as outcome.

Table 1
Demographic characteristics for patients with depressive and/or anxiety disorders and healthy controls.

	Patients with depressive and/or anxiety disorders (N = 1249)	Healthy controls (N = 631)
Age, yrs	40.9(12.4)	41.0(14.7)
Education, yrs	11.6(3.3)	12.8(3.2)
Gender, male, %	34.0	38.7
Continuous BMI	25.8(5.3)	25.1(4.6)
BMI 18.5–24.9%	51.4	55.3
BMI 25.0–29.9, %	29.0	31.2
BMI ≥ 30, %	19.6	19.5
Personality		
Neuroticism	41.29(7.26)	26.91(7.39)
Extraversion	33.95(6.98)	42.19(6.15)
Conscientiousness	40.05(6.61)	44.64(5.42)
Cognitive reactivity		
Hopelessness	6.58(5.04)	1.60(2.15)
Aggression	5.99(4.79)	2.62(2.67)
Rumination	11.42(4.88)	4.80(3.94)
Anxiety sensitivity	33.53(10.12)	23.35(5.46)
Clinical symptomatology		
Depressive symptoms (IDS)	30.43(12.65)	8.35(7.39)
Anxiety symptoms (BAI)	17.48(10.81)	3.88(4.66)

Values are presented as mean (standard deviation) unless indicated otherwise.

These interaction tests indicated that the association between the psychological predictor variables and continuous BMI differed with psychopathology status (Supplementary Table 1). Of the nine interaction terms, those of neuroticism, hopelessness, aggression, rumination, severity of depression and severity of anxiety had p-values of <0.05. This justified stratified analyses by psychopathology status.

3.3. Personality, cognitive reactivity, clinical characteristics and BMI in patients

Table 2 shows the associations of (standardized) personality, cognitive reactivity and clinical symptoms with BMI as continuous outcome variable for 1249 depressed/anxious patients. The associations between psychological vulnerabilities and BMI did not substantially differ for the different psychiatric disorders (MDD versus dysthymia and anxiety disorders; data not shown), and therefore results are presented for the

Table 2
Association between personality traits and cognitive reactivity as determinants, and BMI (continuous) as outcome variable in 1249 patients and 631 healthy controls.

	Patients BMI		Healthy controls BMI	
	Beta	p-Value	Beta	p-Value
Personality				
Neuroticism	0.02	0.50	−0.06	0.15
Extraversion	0.01	0.72	0.09	**0.03**
Conscientiousness	−0.01	0.86	0.02	0.55
Cognitive reactivity				
Hopelessness	0.07	**0.02**	−0.12	**0.003**
Aggression	0.07	**0.02**	−0.07	0.07
Rumination	−0.01	0.77	−0.08	**0.04**
Anxiety Sensitivity	0.01	0.65	−0.19	0.55
Clinical symptomatology				
Depressive symptoms (IDS)	0.13	<**0.001**	0.02	0.66
Anxiety symptoms (BAI)	0.09	**0.001**	−0.04	0.34

Linear regression analyses were done for all predictor variables separately.
Analyses are adjusted for age, education and gender as covariates.
Results are presented per standard deviation (SD) increase in the standardized predictor variables.
SD scores patients: neuroticism, 7.24; extraversion, 6.69; conscientiousness, 6.63; hopelessness, 5.06; aggression, 4.83; rumination, 4.89; anxiety sensitivity, 10.18; IDS, 12.75; BAI, 11.17.
SD scores controls: neuroticism, 7.37; extraversion, 6.17; conscientiousness, 5.40; hopelessness, 2.15; aggression, 2.67; rumination, 3.94; anxiety sensitivity, 5.45; IDS, 7.46; BAI, 4.85.

disorders combined. Preliminary assumption checking revealed no violation of statistical assumptions. Linear regression analyses showed significant positive associations of cognitive reactivity subscales' hopelessness and aggression, depressive and anxiety symptoms with BMI. The multinomial logistical regression analyses showed that depressive symptomatology was related to an increased odds for overweight relative to normal BMI (odds ratio (OR) 1.24, 95% confidence interval (CI) 1.01–1.45) (Table 3). In line with our findings with continuous BMI, higher hopelessness, higher aggression, higher depressive symptoms and higher anxiety symptoms were related to an increased odds for obesity, relative to normal BMI (hopelessness, OR 1.20, 95% CI 1.04–1.40; aggression, OR 1.17, 95% CI 1.01–1.36; depressive symptoms, OR 1.56, 95% CI 1.30–1.87; anxiety symptoms, OR 1.25, 95% CI 1.08–1.44; Table 3).

3.4. Personality, cognitive reactivity, clinical characteristics and BMI in healthy controls

Table 2 shows the associations of (standardized) personality, cognitive reactivity and clinical symptoms with BMI as continuous variable for the 631 healthy controls. Preliminary assumption checking revealed no violation of statistical assumptions. In contrast to the patients, linear regression analyses showed significant negative associations between extraversion, hopelessness, rumination and BMI. The multinomial logistical regression analyses showed that higher extraversion were related to an increased odds for overweight, relative to normal BMI (OR 1.26, 95% CI 1.01–1.59). Lower hopelessness, aggression, rumination and anxiety sensitivity were related to an increased odds for obesity, relative to normal BMI (hopelessness, OR 0.31, 95% CI 0.14–0.67; aggression, OR 0.53, 95% CI 0.32–0.89; rumination, OR 0.62 95% CI 0.42–0.90; anxiety sensitivity, OR 0.59, 95% CI 0.53–0.98; Table 3). Other personality traits and depression/anxiety symptoms were not related to BMI

4. Discussion

The current study found no associations between personality traits and BMI in the patient group, and in healthy controls only between high extraversion and a high BMI. In depressed/anxious patients, we observed that higher hopelessness and aggression scores were associated with higher BMI. In addition, higher symptoms of both depressive and anxiety symptomatology were related to a higher BMI among patients. In contrast, in healthy controls, we found that all cognitive reactivity subscales were inversely associated with higher BMI, suggesting that a relatively favorable, protective cognitive profile was associated with a higher BMI. These results were only present in people with obesity but not in those with overweight, suggesting that relationships between cognitive reactivity and weight only occur in those with a substantial higher than normal BMI.

According to our hypothesis and earlier research, a relationship was found between higher extraversion and higher BMI in the healthy controls. However, despite the large sample size, no relationship was found between personality traits and BMI in the patient group, or between other personality traits and BMI in the healthy controls. This is not in accordance with the recent systematic review of Gerlach et al. [13], which found significant associations between neuroticism and to a lesser extent extraversion as risk factors, and conscientiousness as a protective factor and high BMI in both population and clinical samples. Some of the studies reviewed by Gerlach et al. found that eating behavior moderated the relation between personality and BMI. It is possible that the associations between neuroticism, conscientiousness and BMI are only present in people with specific eating styles (emotional and restrained eating), which the current study did not measure. This needs to be further researched in future longitudinal research.

The current study is the first to investigate the associations between cognitive reactivity and BMI, finding a relationship with two higher cognitive reactivity measures and higher BMI in the patient group, and a relation in the opposite direction between all cognitive reactivity measures and BMI in the healthy controls. All but two [32,33] previous population-based studies on weight-related concepts, investigating psychiatrically healthy controls, found associations between higher negative affect, rumination and anxiety sensitivity, and a poor diet and unhealthy eating styles [29–31,50]. These studies used however small to medium sample sizes (n = 16–200). Moreover, since there are clear associations between depression/anxiety and cognitive reactivity [17,18,21–26], the relationship between cognitive reactivity and the weight-related concepts could be mainly driven by the presence of depression and anxiety, which is a factor not considered in general population studies. A review by Gibson [28] found two clinical studies investigating the relationship between cognitive reactivity and eating styles in which this relationship appeared to be reversed. They found

Table 3
Association between personality traits and cognitive reactivity as determinants, and BMI categories as outcome variable (N = 1249 for patients, N = 631 for healthy controls).

	Patients		Healthy controls	
	BMI 25–29.9[a] OR (95% CI)	BMI ≥ 30[a] OR (95% CI)	BMI 25–29.9[a] OR (95% CI)	BMI ≥ 30[a] OR (95% CI)
Personality				
Neuroticism	1.05 (0.88–1.26)	1.08 (0.88–1.33)	0.94 (0.74–1.05)	0.75 (0.54–1.04)
Extraversion	0.99 (0.86–1.15)	1.03 (0.87–1.22)	**1.26 (1.01–1.59)[b]**	1.23 (0.90–1.67)
Conscientiousness	1.00 (0.88–1.15)	0.96 (0.83–1.12)	1.14 (0.92–1.42)	1.08 (0.81–1.46)
Cognitive reactivity				
Hopelessness	1.00 (0.87–1.15)	**1.20 (1.04–1.40)[b]**	0.71 (0.46–1.08)	**0.31 (0.14–0.67)[b]**
Aggression	0.98 (0.85–1.11)	**1.17 (1.01–1.36)[b]**	0.89 (0.66–1.21)	**0.53 (0.32–0.89)[b]**
Rumination	1.02 (0.87–1.20)	1.01 (0.84–1.21)	0.88 (0.69–1.15)	**0.62 (0.42–0.90)[b]**
Anxiety Sensitivity	0.89 (0.77–1.03)	0.98 (0.84–1.16)	1.15 (0.83–1.60)	**0.59 (0.53–0.98)[b]**
Clinical symptomatology				
Depressive symptoms (IDS)	**1.24 (1.01–1.45)[c]**	**1.56 (1.30–1.87)[d]**	1.15 (0.82–1.63)	0.87 (0.54–1.42)
Anxiety symptoms (BAI)	1.06 (0.93–1.21)	**1.25 (1.08–1.44)[c]**	1.13 (0.75–1.68)	0.56 (0.29–1.09)

Multinomial logistic regression analyses were done for all the predictor variables separately.
Results are presented per standard deviation (SD) increase in the standardized predictor variables.
SD scores patients: hopelessness, 5.06; aggression, 4.83; rumination, 4.89; anxiety sensitivity, 10.18; neuroticism, 7.24; extraversion, 6.69; conscientiousness, 6.63; IDS, 12.75; BAI, 11.17.
SD scores controls: hopelessness, 2.15; aggression, 2.67; rumination, 3.94; anxiety sensitivity, 5.45; neuroticism, 7.37; extraversion, 6.17; conscientiousness, 5.40; IDS, 7.46; BAI, 4.85.
Abbreviations: OR, odds ratio; IDS, Inventory of Depressive Symptoms; BAI, Beck Anxiety Index.
Adjusted for gender, age, years of education.
[a] The reference category is BMI 18.5–24.9.
[b] $p < 0.05$.
[c] $p < 0.01$.
[d] $p < 0.001$.

an association between lower, as opposed to higher, cognitive reactivity and comfort eating or binge eating [51,52]. These studies suggest that comfort eating and binge eating can be used to provide short term distraction from negative affect and rumination. However, Gibson states that in the long term, most studies find that comfort eating is associated with a higher negative effect, rumination and stress, and thereby (indirectly) with a greater risk of obesity [28].

In the healthy control group, we observed that more favorable, lower cognitive reactivity was associated with higher BMI. This suggest there is a psychiatrically healthy control group that seems to be protected from the detrimental effects of higher BMI by having a 'healthier' and more resistant cognitive reactivity profile. This is supported by some studies, which also suggest the existence of a healthy obese group who seem resilient to the negative psychological consequences of overweight and obesity [53–59]. These studies found evidence for the so called "jolly fat" hypothesis, in which the obese were hypothesized to be jollier, and therefore obesity was believed to protect against depression, in specific subgroups [60]. One possible explanation could be that those with a high BMI but without the negative psychological characteristics, belong to a specific subgroup characterized by high resilience, better coping strategies and a reduced cognitive response to mood fluctuations [61].

The current study has several important strengths. The first is the large sample of patients with depression and anxiety disorders (N = 1249) as well as the large healthy control sample (N = 631). In addition, psychiatric diagnoses are defined by a well-validated structured psychiatric interview. Also, patients were recruited in the community, general practice and specialized mental health care facilities, which contributes to the generalizability of our findings. This study also has some limitations. First, since this is an observational, cross-sectional study, it is not possible to draw definitive conclusions about causality. Future longitudinal research is necessary to assess whether BMI is a consequence or a cause of personality and cognitive reactivity, and to fully understand the role of depression and anxiety disorders in these relationships. Second, the current study included relatively few people with morbid obesity, and as a consequence it is not possible to generalize the present findings to this specific group. Third, the use of BMI instead of other measures of obesity like waist circumference or visceral adipose tissue might have influenced the results. When only taking BMI into account, there is a chance of incorrectly assigning people with a high muscle mass or fat-free mass to the overweight or obese groups. However, in the general population, there are relatively few people with a very high muscle mass as opposed to people with a high fat mass, and therefore we believe that this chance of misclassification is rather low. In addition, the correlation between BMI and waist circumference is high (see for example [62]) and therefore, we consider BMI to be an adequate measurement of obesity. Fourth, this study did not collect any information about the eating styles of the participants. Since eating styles, and accompanying eating disorders are clearly prevalent in patients with overweight and obesity [63], it is not known whether the associations found are also related to eating styles or eating disorders. Finally, as the analyses were explorative with a lot of comparisons tested, there is a risk of finding relations by chance. However, since this article has an explorative nature, we decided on not correcting for multiple testing. One important reason is that many of the variables are correlated, and taking into account multiple testing by e.g. Bonferroni might be too conservative. Also, findings were largely consistent for continuous and categorical BMI.

In conclusion, this study indicates that in patients with depression and/or anxiety, more severe cognitive reactivity and more severe symptomatology may contribute to a higher BMI. At the same time, we need to realize that there seems to be a group of obese people who do not suffer from severe cognitive reactivity, and may actually be less psychological vulnerable compared to their non-obese counterparts. Depression and anxiety disorders seem to discriminate between obese with and without a vulnerable cognitive profile. Discovering mechanisms that keep the resilient obese subgroup protected from mental disorders could provide us with new insights for creating optimal prevention and therapy strategies.

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Conflict of interest

Dr. Van Der Does reports personal fees from Mitsubishi Pharma Europe, outside the submitted work. The other authors have no competing interests to report.

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