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Research paper

Affective temperaments and obesity: Is there an association with binge eating episodes and multiple weight cycling?

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ABSTRACT

Background: affective temperaments have been so far understudied in the field of obesity. Therefore, we aimed to assess affective temperaments in outpatients with obesity reporting symptoms of binge eating (BE) and multiple weight cycling (MWC) and to investigate the likelihood of an association between affective temperaments and risk of both conditions.

Methods: A total of 300 individuals with obesity seeking treatment at the Obesity Unit of an academic hospital were asked to complete self-report measures of affective temperaments, BE, depressive and anxiety symptoms, and quality of life.

Results: Even in the absence of full-blown mental disorders, symptoms of anxiety and depression emerged in the sample; 197 individuals (65.6%) reported BE and 162 (54%) MWC. The most frequent affective temperament was the depressive one. Depression symptoms and cyclothymic scores (directly), and age and hyperthymic score (inversely) were significantly associated with BE risk, while being an active smoker (directly) and hyperthymic score (inversely) were significantly associated with MWC risk, after controlling for confounders in a multiple logistic regression.

Limitations: sample size was small, the study was limited to a single center, no formal definition of weight cycling exists and MWC was self-reported.

Conclusions: A substantial number of outpatients with obesity reported BE and MWC notwithstanding the absence of a formal psychiatric diagnosis. Cyclothymic scores were positively associated with BE while the hyperthymic temperament showed a protective effect on both BE and MWC. These findings suggest the need for multidisciplinary treatments for people with obesity enhancing research on temperament-based psychological interventions.

1. Introduction

Obesity is now an officially recognized disease with a worldwide epidemic increase in its prevalence (Wharton, et al., 2020). It carries an increased risk for many diseases, such as cardiometabolic, lung, osteoarticular, and many cancers, leading to a reduced lifespan (Wharton, et al., 2020).

Obesity and psychopathology are linked by bidirectional relationships, with both "obesity-to-psychopathology" and "psychopathology-to-obesity" pathways (Weiss et al., 2020). The former refers to the multifaceted effects of obesity in terms of neuroinflammation, endocrine disorders and metabolic dyshomeostasis (Weiss et al., 2020). On the

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other hand, eating disorders (da Luz et al., 2018), mood disorders (Mansur et al., 2015), attention deficit and hyperactivity disorders (Cortese, 2016) frequently entail obesity.

Over the past decades, psychosocial research focused on the investigation of personality in obesity, given its relevance as a vulnerability and prognostic factor (Dalle Grave et al., 2018; Robinson et al., 2020) according to different models, including mostly the Temperament and Character Inventory and the Five Factor Model (Bordignon et al., 2017). However, other studies focused on the investigation of affective temperaments which offer a model linking personality to subclinical affective states. This could be of importance in the field of obesity, frequently accompanied by sub-threshold affective conditions (Weiss et al., 2020). Indeed, the temperamental traits of patients with obesity could represent a main factor conditioning the relationship with food since adolescence (Marzola et al., 2014).

Temperament can be broadly defined as an aspect of personality which is the product of complex interactions among genetic, biological, and environmental factors over the life-span. Affective temperaments reflect clinically observable, biologically-based predispositions toward certain patterns of emotions, cognitions and behaviors (Akiskal and Akiskal, 2005); they are constitutionally determined and can be conceived as sub-threshold forms of clinical conditions with a heritable component (Gonda et al., 2009) and marked biological underpinnings (Gonda et al., 2009; Kawamura et al., 2010). According to Akiskal's conceptualization, five main affective temperaments exist: depressive, hyperthymic, cyclothymic, irritable, and anxious. This model for the investigation of temperament has been widely applied to several fields in psychiatry, ranging from affective disorders (Solmi et al., 2016) to eating disorders (EDs) (Marzola et al., 2020). However, to date scant attention has been paid to affective temperaments in obesity. The available studies reported either elevated cyclothymic, irritable, and anxious temperaments (Amann et al., 2009), marked depressive (Barbuti et al., 2021), or hyperthymic (Borelli and Lara, 2014) temperaments in obesity. Still, the aforementioned findings refer mostly to bariatric surgery candidates who are not fully comparable with patients not seeking surgery instead.

Individuals with obesity can report abnormal eating patterns not meeting full criteria for an ED. Episodes of binge eating (BE) (i.e., the consumption in a recurrent and limited period of time of an amount of food greater than what most people would consume) frequently occur, leading to weight cycling, a condition defined as repetitive periods of intentional weight loss followed by unintentional regain of body weight. The presence of BE and multiple weight cycling (MWC), i.e., the presence of $\geq$2 cycles of weight loss and subsequent regain, could be associated with adverse health outcomes and the failure of future weight loss attempts (El Masri et al., 2020) but their investigation from a temperament perspective is to date lacking.

Given the aforementioned gaps in literature, the objectives of the present cross-sectional study were: a) to assess clinical features, general psychopathology, and affective temperaments in outpatients with obesity with BE and MWC in a real-world setting; b) to investigate the likelihood of an association between specific affective temperaments and the risk of BE and MWC.

2. Methods

2.1. Participants

We analyzed all patients who attended their first visit at the obesity unit, Endocrinology Division, of the "Città della Salute e della Scienza" Hospital of Turin, Italy, starting from January 2018 until December 2020. Eligible patients were those aged 18-75 years with a BMI$\geq$30 kg/m^2 and $<$45 kg/m^2. Exclusion criteria were: secondary causes of obesity, previous bariatric surgery, known mental disorders (including EDs) diagnosed by a psychiatrist, substance use disorders within the last 12 months, and pregnancy. The first consecutive 300 eligible patients were enrolled. All patients gave their written informed consent for the collection and analysis of their data; the study was approved by the local Ethics Committee and was conducted in accordance with the principles of the Declaration of Helsinki.

2.2. Assessments

All treatment seekers were interviewed over the phone by a dietitian of our Unit prior to the first visit to collect clinical data including psychiatric history and current psychiatric diagnoses. If self-reported eating symptoms emerged during the phone interview, the patient was referred to the Eating Disorders Center of our hospital before being assessed at our Obesity Unit. Our weight loss program has been previously described (Ponzo et al., 2020) and included a multi-disciplinary approach, with the teamwork of endocrinologists, psychiatrists, psychologists, dieticians, and nurses. Briefly, the weight-loss program included a minimum of 6 meetings, and it usually lasted 12 months; but it can be extended, and supplementary visits could be scheduled in case of need. During the first visit, the patients completed sociodemographic, psychological, and food questionnaires and were visited by the endocrinologist, the psychologist, and the dietician. During the following scheduled visits, participants received assessments by the dietician and the endocrinologist. Two psychologists, specialized in obesity treatment, individually visited all patients at baseline and discussed with them their weight-loss motivation, expectations, perceptions, and self-confidence, and their satisfaction level with their current weight, and gave advice about the importance of self-monitoring, goal setting, stimulus control, problem-solving, relapse prevention, and self-manage during hunger moments or social gatherings. If psychological reinforcement or support was needed, individual meetings (up to eight) were proposed during the weight-loss program. Trained nurses welcomed all participants, explained the program and followed-up the patients by 3-4 individual meetings in which they reinforced the patients' motivation, by analyzing and sharing their strengths, weaknesses, and opportunities. Patients received at least four visits with trained endocrinologists, who evaluated their health status, performed a detailed anamnestic data collection and physical examination, evaluated their blood parameters, provided clear explanations about the medical risks of obesity and the benefits of a healthy lifestyle, established reasonable weight objectives to minimize excessive expectations and explained the mechanisms implicated in weight regain and hunger/satiety control and the rationale of maintaining adequate muscle mass, and, if needed, suggested further specific exams and prescribed drugs. Trained dieticians provided verbal and written dietary, exercise and behavior recommendations to all participants, and an individually prescribed diet in line with the Mediterranean diet composition with an energy restriction ranging from 500 to 1000 kcal, based on the individual caloric requirements and usual assumption.

Weight and height were measured with the participants wearing light clothes and no shoes respectively by a mechanical column scale (SECA model 711) and a Stadiometer (SECA 220 measuring rod, Hamburg, Germany). Waist and neck circumferences were assessed by a plastic tape meter at the umbilicus level or under the cricoid cartilage, respectively. Arterial blood pressure values were measured on the left arm, while sitting, after at least 10 minutes of rest, with a mercury sphygmomanometer with appropriate cuff sizes (ERKA Perfect-Aneroid, Germany). Blood samples were collected after an overnight fast; the laboratory methods were previously described (Bo et al., 2017). With a clinical interview, all patients were asked whether they had ever tried to lose weight; in the case of affirmative answer, they had to indicate in their lifetime the number of times they have intentionally lost weight and the amount of weight loss. Weight cycling was defined as intentional weight loss of $\geq$3 kg followed by involuntary weight regain of $\geq$3 kg in line with literature (Rossi et al., 2019; El Masri et al., 2020). Patients who experienced $\geq$2 cycles were considered as multiple weight cyclers (El Masri et al., 2020).

All participants self-completed the following questionnaires:

- Temperament Evaluation of Memphis, Pisa, Paris and San Diego Auto-questionnaire (TEMPS-A) (Akiskal and Akiskal, 2005): it is an instrument of 110 (109 for males) items with hyperthymic, depressed, irritable, cyclothymic, and anxious subscales requiring yes/no answers. For this study, the Italian validation has been used (Pompili et al., 2008).
- Binge Eating Scale (BES) (Gormally et al., 1982): it is a 16-item Likert-type questionnaire with Italian validation (Di Bernardo et al., 1998), aimed to assess BE. Scores range from 0–46 with score 27 as cut-off for the presence of BE.
- Medical Outcome Survey Short-Form 36 (SF-36) (McHorney et al., 1993): it measures general health-related quality of life, with different domains with scores ranging from 0 to 100 (higher values indicate a better quality of life, a value <50 corresponds to low health status for each domain).
- Beck Depression Inventory (BDI) (Beck et al., 1961): it is a 13-item instrument with sound psychometric properties used to assess severity of depressive symptoms. Symptoms can be minimal (scores 0-4), mild (scores 5-7), moderate (scores 8-15) and severe (scores 16-39).
- State-Trait Anxiety Inventory (STAI) (Spielberger et al., 1983): it is a widely used and psychometrically questionnaire investigating both state anxiety, a transitory state, and trait anxiety, a stable individual disposition. The anxiety scores range from 20 to 80 with higher values corresponding to higher anxiety.

2.3. Statistical analyses

Comparisons were made between the following two groups of individuals: those at risk of BE *vs* patients not at risk (cutoff scores ≤27), and those with MWC *vs* patients without MWC (<2 cycles of ≥3 kg weight loss and subsequent regain). T-Student's and chi-square test, when appropriate, were used to assess between-group differences. Because the distributions of the BDI score was skewed, the Mann-Whitney test was employed to evaluate the differences between-group. A multiple logistic regression model was used to assess the associations between the risk of BE (outcome dependent variable) and the variables which resulted significantly different between-groups (independent variables). The same model was employed to evaluate the variables associated with the risk of MWC (outcome dependent variable).

In line with the theoretical underpinning of the TEMPS-A (Akiskal and Akiskal, 2005; Pompili et al., 2008), affective temperaments are not measured as present/absent; rather, they are considered altogether as different combinations of affective temperamental domains that could represent vulnerability markers. Given the aims of this study, the TEMPS-A scores were standardized as z-scores to facilitate comparisons. All patients were assigned to a predominant subtype of temperament based on the highest z-score in each temperament. This procedure allowed to identify a temperamental predominance, by classifying patients according to the most abnormal temperament score based on the average values of all participants. ANOVA, Kruskal-Wallis test (for BDI score), and chi-square tests were used to assess differences among the

Table 1
Characteristics of the whole cohort and by risk of episodes of binge eating and multiple weight cycling.

	All	Binge eating episodes			Multiple weight cycling		
		yes	no	P	yes	no	P
Number	300	197	103		162	138	
Age (years)	47.7 ± 15.3	45.4 ± 15.1	52.1 ± 14.7	**<0.001**	48-3 ± 14.7	47.0 ± 16.0	0.46
Males (%)	22.3	18.8	29.1	**0.041**	19.1	26.1	0.15
Residing in a rural area (%)	17.0	15.2	20.4	0.26	19.8	13.8	0.17
Active smoker (%)	18.0	21.3	11.7	**0.038**	22.2	13.0	**0.039**
Living alone (%)	44.3	48.2	36.9	0.06	42.6	46.4	0.51
Not working/retired (%)	42.7	38.6	50.5	0.05	42.6	42.8	0.98
Secondary schools/graduation (%)	67.7	70.6	62.1	0.14	71.6	63.0	0.11
Multiple weight cycling (%)	54.0	58.4	45.6	**0.035**	-	-	
Age of weight gain (years)	27.0 ± 14.4	25.5 ± 14.3	30.0 ± 14.1	**0.008**	25.8 ± 13.7	28.4 ± 15.1	0.13
Weight (kg)	98.8 ± 16.4	98.8 ± 16.2	98.9 ± 16.9	0.94	99.8 ± 16.5	97.7 ± 16.4	0.29
Height (cm)	163.7 ± 8.1	163.5 ± 7.9	164.0 ± 8.6	0.66	163.7 ± 7.7	163.7 ± 8.6	0.99
BMI (kg/m^2)	36.8 ± 4.6	36.8 ± 4.7	36.6 ± 4.4	0.71	37.1 ± 4.7	36.4 ± 4.5	0.15
BMI>=40 kg/m^2 (%)	18.3	18.3	18.5	0.97	19.8	16.7	0.49
Waist circumference (cm)	114.7 ± 12.0	114.5 ± 11.9	115.2 ± 12.2	0.63	114.8 ± 11.8	114.6 ± 12.2	0.88
Neck circumference (cm)	38.1 ± 4.0	38.0 ± 4.1	38.3 ± 4.0	0.59	38.2 ± 4.0	38.1 ± 4.1	0.96
Systolic blood pressure (mmHg)	131.3 ± 13.3	130.3 ± 13.5	133.3 ± 12.7	0.07	130.3 ± 12.9	132.4 ± 13.7	0.18
Diastolic blood pressure (mmHg)	81.3 ± 6.5	81.1 ± 6.8	81.7 ± 5.9	0.42	81.0 ± 6.4	81.6 ± 6.7	0.45
Fasting glucose (mg/dL)	96.0 ± 17.7	94.9 ± 15.2	98.2 ± 21.6	0.13	96.2 ± 16.2	95.8 ± 19.3	0.57
Glycated hemoglobin (mmol/mol)	37.4 ± 7.7	36.5 ± 6.1	39.2 ± 9.9	**0.005**	37.7 ± 8.1	37.2 ± 7.1	0.85
Total cholesterol (mg/dL)	194.0 ± 34.7	196.2 ± 36.3	189.8 ± 31.1	0.13	191.4 ± 32.8	197.1 ± 36.6	0.16
HDL cholesterol (mg/dL)	51.2 ± 10.9	52.4 ± 10.7	49.0 ± 10.9	**0.010**	51.0 ± 10.0	51.5 ± 11.8	0.65
Triglycerides (mg/dL)	127.5 ± 50.3	126.2 ± 50.4	130.1 ± 50.2	0.53	126.8 ± 51.3	128.4 ± 49.3	0.79
Creatinine (mg/dL)	0.79 ± 0.20	0.79 ± 0.22	0.80 ± 0.16	0.69	0.79 ± 0.23	0.79 ± 0.16	0.88
Psychological questionnaires							
BDI	8.0 (9.0)	10.0 (9.0)	5.0 (7.0)	**<0.001**	9.0 (8.0)	7.0 (8.0)	**0.002**
STAI-state	46.9 ± 12.1	48.7 ± 12.4	43.5 ± 10.7	**<0.001**	48.2 ± 11.5	45.3 ± 12.6	**0.036**
STAI-trait	48.4 ± 11.4	51.7 ± 10.8	42.2 ± 9.8	**<0.001**	50.3 ± 10.8	46.2 ± 11.7	**0.002**
BES	32.7 ± 10.2	38.4 ± 7.7	21.8 ± 3.5	**<0.001**	34.0 ± 10.3	31.1 ± 10.0	**0.015**
SF-36 (overall health state)	49.3 ± 20.0	48.2 ± 18.5	51.4 ± 22.4	0.18	47.6 ± 17.5	51.3 ± 22.4	0.11
SF-36 (mental health)	53.1 ± 20.4	47.1 ± 18.0	64.5 ± 19.9	**<0.001**	48.7 ± 19.0	58.2 ± 20.8	**<0.001**
TEMPS-A scores							
Depressive	10.5 ± 3.7	11.4 ± 3.6	8.7 ± 3.3	**<0.001**	10.9 ± 3.6	10.0 ± 3.8	**0.039**
Cyclothymic	7.3 ± 4.6	8.4 ± 4.6	5.3 ± 4.0	**<0.001**	8.1 ± 4.9	6.4 ± 4.1	**0.001**
Hyperthymic	9.2 ± 5.1	8.0 ± 4.3	11.4 ± 5.6	**<0.001**	8.5 ± 4.7	10.0 ± 5.4	**0.007**
Irritable	5.4 ± 4.2	6.2 ± 4.3	3.9 ± 3.4	**<0.001**	6.0 ± 4.4	4.8 ± 3.7	**0.01**
Anxious	10.8 ± 5.9	12.0 ± 5.9	8.6 ± 5.2	**<0.001**	11.8 ± 6.0	9.7 ± 5.6	**0.002**

Legend: BMI: body mass index; TEMPS-A: Temperament Evaluation of Memphis, Pisa, Paris and San Diego Auto-questionnaire; BDI: Beck Depression Inventory; BES: Binge eating scale; STAI: State-Trait Anxiety Inventory; SF-36: Medical Outcome Survey Short-Form 36.

predominant temperament categories. In the case of multiple comparisons, the Scheffe's test was employed.

3. Results

3.1. Socio-demographic and clinical features of the obese sample

Out of 345 patients who attended the first visit at our obesity unit starting from January 2018, 300 met the inclusion criteria. Most were women (Table 1); weight gain was reported on average 20 years before their first visit to our unit. A high percentage of not working and living alone individuals was found with respect to the general Italian population (https://www.istat.it/it/files//2019/12/Asi-2019.pdf). Even though full-blown mental disorders were exclusion criteria, symptoms of anxiety, depression and BE episodes emerged, and 197 individuals (65.6%) reported symptoms of BE. Furthermore, 162 participants (54%) reported MWC.

Individuals with BE were more frequently females and active smokers, with lower age, age of weight gain, glycated hemoglobin (HbA1c), and higher HDL-cholesterol and MWC. They reported higher scores on depressive, cyclothymic, irritable, anxious temperaments, and lower hyperthymic scores, and greater depression and anxiety scores, and lower overall mental health at the SF-36 questionnaire.

Patients with MWC reported a median number of cycles and amount of weight loss of 4.5 and 9 kg, respectively. Seventy patients (23.3%) reported severe MWC (median number of cycles = 6; median amount of weight loss = 15 kg). Individuals with MWC were more frequently active smokers and reported higher depressive, cyclothymic, irritable and anxious temperaments, with lower hyperthymic scores, and greater scores for depression, anxiety, BE, and lower overall SF-36 mental health (Table 1).

3.2. Prevalent affective temperaments

The most frequent affective temperament was depressive while irritable was the least common (Table 2). Patients characterized by hyperthymic and irritable affective temperaments were more frequently males, currently working and had higher height and lower HDL-cholesterol; irritable individuals showed the highest level of education. Individuals with predominant hyperthymic temperament displayed significantly lower weight cycling and symptoms of depression, anxiety, binge eating, and increased scores for overall health state and mental health.

3.3. Associations between affective temperaments and BE and MWC

In a multiple logistic regression model, depression symptoms and cyclothymic scores (directly), and age and hyperthymic score (inversely) were significantly associated with the risk of BE (Table 3). Data did not change significantly, after adjusting for age of weight gain and trait-anxiety.

When analyzing the association between affective temperaments and MWC with a multiple logistic regression model, being an active smoker (directly) and hyperthymic score (inversely) were significantly associated with the risk of MWC (Table 3). Data did not change after adjusting for STAI-trait score.

4. Discussion

Three main findings emerged by the present study. First, a substantial number of outpatients with obesity in a real-world setting showed episodes of BE and MWC, although in the absence of a current psychiatric diagnosis. Second, patients with BE and MWC reported more severe general psychopathology and a different profile of affective

Table 2
Characteristics of the patients by their prevalent affective temperament tract.

	Depressive	Cyclothymic	Hyperthymic	Irritable	Anxious	P
Number (%)	72 (24.0)	64 (21.3)	55 (18.3)	50 (16.7)	59 (19.7)	
Age (years)	47.0 ± 14.1	45.6 ± 17.8	52.5 ± 14.2	46.0 ± 13.5	47.8 ± 15.8	0.12
Males (%)	12.5§^	17.2§^	36.4	36.0	15.3§^	**0.001**
Residing in a rural area (%)	16.7	18.8	18.2	18.0	13.6	0.95
Active smoker (%)	18.1	18.8	16.4	18.0	18.6	0.99
Living alone (%)	45.8	48.4	36.4	40.0	49.2	0.58
Not working/retired (%)	36.1°*	54.7^	38.2	28.0	54.2^	**0.010**
Secondary schools/graduation (%)	72.2	59.4^	69.1	82.0	57.6^	**0.038**
Weight cycling (%)	54.2§	67.2§	32.7	54.0	59.3	**0.004**
Age of weight gain (years)	25.3 ± 14.1	25.6 ± 13.7	30.8 ± 13.5	26.6 ± 14.6§	27.6 ± 15.6§	0.23
Weight (kg)	97.7 ± 14.3	99.3 ± 18.1	101.4 ± 17.1	101.1 ± 15.8	95.3 ± 16.7	0.24
Height (cm)	163.3 ± 7.4	163.3 ± 7.5	164.7 ± 8.4	166.4 ± 9.2*	161.3 ± 7.9	**0.019**
BMI (kg/m^2)	36.6 ± 4.4	37.1 ± 5.5	37.2 ± 4.4	36.4 ± 4.2	36.5 ± 4.4	0.84
BMI>=40 kg/m^2 (%)	23.6	17.2	20.0	16.0	13.6	0.63
Waist circumference (cm)	115.0 ± 10.6	114.3 ± 10.7	117.1 ± 14.3	115.4 ± 12.8	112.0 ± 11.5	0.25
Neck circumference (cm)	38.0 ± 3.8	38.4 ± 3.7	38.8 ± 4.9	38.5 ± 4.3	37.1 ± 3.5	0.24
Systolic blood pressure (mmHg)	129.0 ± 11.2	131.4 ± 14.0	131.9 ± 13.4	132.8 ± 14.2	132.3 ± 13.9	0.52
Diastolic blood pressure (mmHg)	81.0 ± 6.4	80.5 ± 6.9	80.9 ± 6.3	83.4 ± 5.9	80.9 ± 6.8	0.15
Fasting glucose (mg/dL)	96.6 ± 20.5	94.4 ± 16.2	96.1 ± 16.0	97.5 ± 17.9	95.7 ± 17.1	0.91
Glycated hemoglobin (mmol/mol)	37.3 ± 8.7	37.9 ± 7.7	38.8 ± 9.1	35.6 ± 6.2	37.4 ± 5.6	0.32
Total cholesterol (mg/dL)	193.0 ± 32.0	195.1 ± 30.3	191.2 ± 31.6	195.9 ± 42.0	195.0 ± 38.8	0.95
HDL cholesterol (mg/dL)	53.6 ± 11.3^	52.1 ± 9.7	48.8 ± 9.3	47.1 ± 11.7	53.1 ± 10.9	**0.003**
Triglycerides (mg/dL)	128.7 ± 63.1	123.2 ± 39.7	124.1 ± 50.2	139.2 ± 48.5	124.2 ± 44.2	0.44
Creatinine (mg/dL)	0.78 ± 0.16	0.78 ± 0.29	0.79 ± 0.19	0.80 ± 0.11	0.81 ± 0.21	0.92
Psychological questionnaires						
BDI	10.0 (7.0)§	9.0 (7.5)§	3.0 (5.0)	9.0 (9.0)§	9.0 (9.0)§	**<0.001**
STAI-state	47.9 ± 12.0§	46.2 ± 10.7*§	38.9 ± 9.1	47.9 ± 11.6§	53.0 ± 12.6§	**<0.001**
STAI-trait	49.8 ± 10.8§	50.1 ± 10.1§	38.1 ± 8.2	49.0 ± 10.7§	54.0 ± 11.0§	**<0.001**
BES	34.7 ± 9.7§	36.0 ± 9.4§	25.7 ± 8.4	33.8 ± 9.4§	32.1 ± 11.2§	**<0.001**
SF-36 (overall health state)	46.9 ± 16.0§	45.8 ± 17.1§	61.1 ± 21.8	47.5 ± 19.6§	46.4 ± 22.1§	**<0.001**
SF-36 (mental health)	46.3 ± 14.6§	47.8 ± 17.0§	75.1 ± 16.9	52.3 ± 20.3§	47.2 ± 19.3§	**<0.001**

*p < 0.05 *vs* anxious; §p < 0.05 *vs* hyperthymic; ^p < 0.05 *vs* irritable; °p < 0.05 *vs* cyclothymic
Legend: BMI: body mass index; BDI: Beck Depression Inventory; BES: Binge eating scale; STAI: State-Trait Anxiety Inventory; SF-36: Medical Outcome Survey Short-Form 36.

Table 3
Associations between affective temperament tracts (expressed as z-scores) and the risk of episodes of binge eating and weight cycling.

	Risk of episodes of binge eating	
	OR; 95% CI	p
Age (years)	0.98; 0.96-1.00	**0.044**
Male gender (%)	1.10; 0.50-2.42	0.82
Active smokers (%)	1.85; 0.81-4.20	0.14
HbA1c (mmol/mol)	0.97; 0.93-1.01	0.14
HDL-cholesterol (mg/dL)	1.03; 0.99-1.06	0.10
BDI score	1.16; 1.07-1.25	**<0.001**
STAI-state score	0.99; 0.96-1.02	0.55
z-score TEMPS-A Depressive	1.20; 0.76-1.97	0.43
z-score TEMPS-A Cyclothymic	1.61; 1.06-2.46	**0.025**
z-score TEMPS-A Hyperthymic	0.60; 0.44-0.81	**<0.001**
z-score TEMPS-A Irritable	1.00; 0.70-1.43	0.99
z-score TEMPS-A Anxious	0.76; 0.48-1.19	0.23
	Risk of multiple weight cycling	
	OR; 95 CI	**P**
Active smokers (%)	2.04; 1.96-3.92	**0.032**
BES score	1.01; 0.98-1.04	0.64
BDI score	1.04; 0.97-1.10	0.26
STAI-state score	1.00; 0.98-1.02	0.93
z-score Depressive	0.75; 0.51-1.09	0.12
z-score Cyclothymic	1.32; 0.92-1.88	0.13
z-score Hyperthymic	0.76; 0.58-0.99	**0.044**
z-score Irritable	1.01; 0.71-1.44	0.95
z-score Anxious	1.27; 0.87-1.86	0.21

Legend: TEMPS-A: Temperament Evaluation of Memphis, Pisa, Paris and San Diego Auto-questionnaire; BDI: Beck Depression Inventory; BES: Binge eating scale; STAI: State-Trait Anxiety Inventory.

temperaments than their counterpart. Finally, higher depressive symptoms and cyclothymic scores were positively associated with BE while the hyperthymic temperament was negatively associated with both BE and MWC conditions.

Our data provide evidence to the need for paying closer attention to the psychological burden that patients with obesity have to face (Henegan et al., 2012). In fact, although not to the point of meeting a formal psychiatric diagnosis, the majority of our patients reported symptoms of BE and several episodes of weight cycling. Since the latter are condition associated to poor treatment outcomes (El Masri et al., 2020), clinicians may want to consider psychological and psychiatric interventions for these patients. In the same vein, since obesity is associated in a relevant number of cases with disordered eating behaviors, follow-up assessments are needed to ascertain patients' psychological condition, even more so if substantial weight loss has been achieved (Castaneda et al., 2019).

Moreover, our findings suggest that, in keeping with the recent conceptualization of obesity as a metabo-psychiatric disorder (Weiss et al., 2020), individuals with BE and MWC showed symptoms of anxiety and depression. These results are in line with a recent meta-analysis (Amiri et al., 2019) showing heightened anxiety in individuals with obesity. Therefore, anxiety should be carefully taken into account in the approach to these patients (van Dammen et al., 2018) in consideration of its associated with weight gain (Grundy et al., 2014). Similarly, since depression has been shown to predict behaviors related to long-term health (Luger et al., 2014; Schuch et al., 2017; Verger et al., 2009), the investigation of depressive symptoms could have implications concerning treatment compliance and response. Still, depressive aspects need to be taken into account given their well-known relevance as both cause (i.e., negative emotions) and consequence (i.e., obesity-related stigma) of obesity (Konttinen et al., 2014). Interestingly, overall quality of life of patients in both BE and MWC groups was unaffected but things changed when the focus shifted to mental health. In fact, patients with BE and MWC reported significantly poorer mental health-related quality of life than the counterpart without BE and MWC. Therefore, our findings shed light on the relevance of the psychological burden also for patients with obesity reporting BE episodes and MWC even if unaffected by full-blown psychiatric conditions.

The depressive temperament resulted to be the most prevalent in our patients. This was in line with previous reports on patients who were candidates to bariatric surgery (Barbuti et al., 2021). The cyclothymic temperament was associated with BE, even in the absence of an ED or other psychiatric disorders, according to earlier data on psychiatric populations (Ramacciotti et al., 2004; Marzola et al., 2017) and on bariatric surgery candidates (Amann et al., 2009). The cyclothymic temperament can be defined as a "sharp affective liability and reactivity, admixed with interpersonal sensitivity, poor self-awareness, impulsiveness and "sensation-seeking" self-stimulatory trends" (Weiss et al., 2020). Further longitudinal studies are needed to ascertain whether this temperament can imply different outcome trajectories in patients with obesity. Indeed, the investigation of affective temperaments can be informative for those patients with other potential risk factors (i.e., body image concerns) for a full-blown BE disorder. In contrast, the hyperthymic temperament, mostly referring to extraversion aspects of personality, resulted to protect from the association with BE. Although innovative in the field of obesity, this finding echoes similar results of a protective role of the hyperthymic temperament with respect to mental disorders (Karam et al., 2010).

The hyperthymic temperament resulted to be the only affective trait significantly involved in the association between personality and MWC, with a protective role. The latter phenomenon has been mostly investigated in a metabolic and organic framework. MWC has been found to predict poor early weight loss (El Masri et al., 2020), adverse cardiometabolic markers (Kakinami et al., 2020), lower muscle mass and strength (Rossi et al., 2019). However, to date the connection between temperament and MWC was completely lacking so our data can be informative on those aspects that should be investigated with the overarching goal to implement resilience factors in patients with obesity seeking medical, as opposed to surgical, interventions. Furthermore, it should be remarked upon the similarity of this finding with literature on mental disorders (Karam et al., 2010). In this vein, it is noteworthy that the hyperthymic temperament has been found to play a protective role in several fields of application ranging from suicidal ideation and attempts (Baldessarini et al., 2016; Vàsquez et al., 2018), substance use disorders (Rovai et al., 2017), and outcome of patients with bipolar disorders (Luciano et al., 2021). Similarly, it has shown protective effect also with respect to hypertension (Nemcsik et al., 2016) and Parkinson's disease (Dogan et al., 2019). In keeping with these findings, also our data showed that the hyperthymic temperament played a protective role for with respect to both BE and MWC.

Despite the novel aim to shed light on a neglected topic in literature, this paper suffers from some limitations. First, the sample size was small, and the study was limited to a single center, thus limiting the generalizability of our results. However, the post-hoc power analysis indicated that the study had a >90% power to evaluate the between-group differences in most temperament tracts. Second, the information on weight cycling was self-reported and not objectively assessed, and the definition of weight cycling was arbitrary. These limitations, however, are common to the other studies on this topic because of the lack of standardized definitions. The strengths of the study included the comprehensive assessment of multiple variables for all patients, the interdisciplinary evaluation of the patients, and the "real world" clinical setting of the study.

5. Conclusions

A substantial number of outpatients with obesity reported BE episodes and MWC notwithstanding the absence of a current psychiatric diagnosis. Those individuals showed more severe general psychopathology and a different profile of affective temperaments. Notably, cyclothymic scores were positively associated with BE while the hyperthymic temperament was negatively associated with both BE and

MWC. These findings suggested the need for multidisciplinary treatments in the approach to obesity, in line with current guidelines (Wharton at al., 2020). In the framework of precision medicine, our findings paved the way to the investigation of specific psychological interventions according to the predominant affective temperament.

CRediT authorship contribution statement

Elena Scumaci: Conceptualization, Writing – original draft. **Enrica Marzola:** Writing – original draft. **Giovanni Abbate-Daga:** Writing – review & editing. **Marianna Pellegrini:** Writing – review & editing. **Valentina Ponzo:** Writing – review & editing. **Ilaria Goitre:** Supervision. **Andrea Benso:** Supervision. **Fabio Broglio:** Supervision. **Sara Belcastro:** Supervision. **Chiara Crespi:** Supervision. **Chiara D'Eusebio:** Writing – review & editing. **Franco De Michieli:** Supervision. **Ezio Ghigo:** Writing – review & editing. **Simona Bo:** Conceptualization, Writing – original draft, Formal analysis.

Declaration of Competing Interest

The authors have declared that no conflict of interest exists.

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