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Frontal Lobe Functions and Quality of Life in Individuals with Obesity with and without Binge Eating Disorder

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Abstract: Frontal lobe functions (FLFs) play an important role in human behavioral regulation and can be a determinant of eating behavior. The aim of this study was to analyse FLFs in individuals with obesity, with and without binge eating disorder (BED), compared to individuals with normal weight (NW), and to analyse the effect of sex and binge disorder on quality of life, with age and BMI as covariates. A total of 114 participants, comprising three different groups (NW individuals, individuals with obesity but without BED, and individuals with obesity and BED), completed the Frontal Assessment Battery (FAB) and Impact of Weight on Quality of Life (IWQOL-lite) questionnaires. The results showed that individuals with obesity, with and without BED, have poorer frontal lobe functioning than the NW group. Individuals with obesity and BED have lower performance in terms of FLFs than individuals with obesity but without BED. Male participants have a higher perception of quality of life in all dimensions, with women showing lower values in self-esteem and sex life. Individuals with obesity and BED show greater weaknesses in physical function. These results suggest that low FLFs and worse quality of life characterize individuals with obesity, and this is more evident in these individuals with BED.

Keywords: frontal lobe functions; quality of life; obesity; binge eating disorder

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1. Introduction

In the field of global public health, obesity is one of the biggest challenges and has been considered the "epidemic of modern times". According to the World Health Organization (WHO) [1], over one billion people worldwide are obese, including 650 million adults, which is 13% of the worldwide population. Obesity is the second preventable cause of death, which justifies the urgency of intervention in this area [1].

Eating behavior, when pathological, is a multifactorial and complex phenomenon [2]. The literature indicates that many individuals with obesity have eating and intake disorders [3,4]. An eating and intake disorder is described in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR) as a persistent disorder associated with intake or diet that results in altered food absorption or consumption, which causes significant deficits in an individual's psychosocial functioning or physical health [5]. These disorders are incapacitating and are frequently associated with an over-evaluation of body shape and weight and purging behaviors [6]. Based on DSM-5 [7], misericism, pica, avoidant/restrictive food intake disorder, bulimia nervosa, anorexia nervosa, and binge eating disorder (BED) are included as pathological eating behaviors. It is estimated that 23.9% of patients who have BED seek treatment for obesity [8].

Binge eating disorder (BED) is characterized by a sense of loss of control while consuming unambiguously large amounts of food and is reported by 9–29% of adults with

obesity [9]. The etiology of BED is complex, including genetic and environmental factors as well as neuroendocrinological and neurobiological contributions. Recent data from the worldwide prevalence of BED between 2018 and 2020 revealed rates ranging from 0.6 to 1.8% in adult women and from 0.3 to 0.7% in adult men [10].

An understanding of the role of cognitive functions and the neuronal mechanisms in controlling the additive and hedonic components of intake has generated a high interest in neuropsychology [11]. According to Lu et al. [12], individuals with normal weight showed higher global cognitive functioning when assessed compared to subjects with obesity. Obesity has been related to a decrease in total brain volume [13], specifically in the frontal lobe areas [14]. Volkow et al. [15] found a negative correlation between Body Mass Index (BMI) and metabolic activity in the prefrontal cortex and anterior cingulate gyrus, measured with PET (Positron Emission Tomography), which is positively correlated with executive performance. It is known that cognitive processes, specifically executive functions (EFs), are involved in eating behaviors. EFs are the mental processes required to solve external and internal problems [16] and include a wide set of self-regulation functions that enable the organization, control, and coordination of other cognitive functions and behavioral and emotional responses [17].

A number of studies have shown that when compared to normal-weight (NW) adults, individuals with obesity (OB) have lower EF [18–21], particularly in planning and problem solving [22], cognitive flexibility [14,22–24] inhibitory control [25,26], and decision making [22,27]. The results from the study of La Marra et al. [28] have shown that individuals with obesity morbidly reported even lower EF than individuals that are overweight normal-weight individuals.

Furthermore, the presence of cognitive difficulties in individuals with obesity and BED has been confirmed in different domains [8,29,30], such as attention, memory, and EF. In this last domain, individuals with obesity and BED, when compared with individuals with obesity without BED, reveal lower results [2,4,29–34], more precisely, a lower capacity for planning [30], higher difficulty in decision making [30,32], lower inhibitory control [33,35], lower psychomotor performance [33], lower cognitive flexibility [30,32,33], and increased levels of impulsivity related to food [32,36]. These findings can be an explanation for why individuals with BED experience considerable impairment in functioning and work productivity compared with individuals without BED [37]. According to Costa et al. [38], executive difficulties can spill over into maladaptive eating behavior, and these changes can impact increased adiposity and consequently lead to obesity.

Neurobiological findings highlight impairments in reward processing, inhibitory control, and emotion regulation in individuals with BED [10]. A study developed by Estella et al. [39] that aimed to analyze the white matter (WM) microstructure in women with obesity and BED revealed that these women show white matter alterations in axial diffusion in the fronto-limbic and parietal pathways that are important in decision-making processes. As BMI was a covariate in the analyses, alterations in BED may be part of the pathology, but whether they are a cause or effect of illness is unclear [39]. The results of a 2022 study by Xinyuan and colleagues [40] suggested that altered functional connections between the medial frontal cortex and regions associated with reward and maladaptive eating may be a key aspect of the neural mechanisms of food-specific intentional inhibition in individuals with an overweight status [40]. Despite these results, it is important to bear in mind that the directionality of the relationship between obesity and executive functioning is still unclear.

An association between obesity, psychopathological symptoms, and emotional difficulties has been documented, including depression and anxiety symptoms [41], peer and interpersonal problems [42], and low self-esteem [43,44]. In this way, the impact of obesity seems not to be limited to health issues but also to quality of life (QoL), which is characterized by low self-esteem, social isolation, stress, and mental illnesses [45]. According to Patrick et al. [46] QoL is defined as an individual's own assessment of well-being. In investigations, the quantification of QoL related to health status is referred to as health-related QoL (HRQoL), that is, a multidimensional concept that represents the general

self-perception of the impact of an illness and its treatment on physical, psychological, and social aspects of life. In a recent study, an association between QoL and its components in women with overweight and obesity was found. It seems that overweight women, in comparison to NW individuals, tend to express a lower QoL [47]. Chu et al. [48] found differences, similarly, in the QoL between women with and without obesity.

Individuals with BED also experience comorbid mental health problems. For instance, a systematic review found that BED is significantly associated with depression [49], and it was found that BED is associated with anxiety disorders [50]. BED can also be associated with HRQoL. Some studies have shown a reduced HRQoL in individuals with BED than without BED [10,51–53]. In the study of Vancampfort et al. [53], it was concluded that individuals with obesity and BED experience a poorer HRQoL than NW individuals. In addition, QoL can be particularly lower in women with BED compared to men with BED [53]. In sum, there is a significant link between BED and poor mental health (i.e., depression, anxiety, psychological stress, and QoL).

There has been a growing interest in the study of the relationship between FLFs and obesity and FLFs and disorders in eating behavior; however, there is a lack of studies looking at the role of FLFs in individuals with obesity with and without BED. Given that obesity is an epidemic with serious biological and psychosocial repercussions and BED is commonly associated with obesity and with somatic and mental health comorbidities, it is important to gain additional knowledge in order to understand the role of FLFs in eating behavior.

Because the majority of studies investigating the relationship between OB and the domains of FLFs are cross-sectional rather than longitudinal, the question of the directionality of the relationship remains uncleared [54]. Changes in EF can predict weight gain [26] and may be an important determinant of dietary behavior throughout the lifespan [55]. Taken together, these findings support the evidence of a robust association between obesity and FLF impairment and suggest that neuropsychological evidence can provide an accurate understanding of the determinants of eating behavior.

The main aim of this study was to compare the FLFs of individuals with obesity, with and without BED, and with NW individuals. A second purpose of this study was to analyze the effect of sex and binge disorder on the dimensions of quality of life, with age and BMI as covariates. We hypothesized that individuals with obesity, with and without BED, had poorer frontal functioning than NW individuals. It was also hypothesized that individuals with obesity and BED were also predicted to perform worse in terms of FLFs than individuals with obesity but without BED. Regarding QoL, it was expected that individuals with obesity and BED would have a lower level of QoL than individuals with obesity but without BED.

2. Materials and Methods

2.1. Participants

In this study, a total of 114 individuals of both sexes aging from 20 to 60 years old (M = 42.3, SD = 9.7) participated. The majority were female (69.3%), married (65.8%), actively working (80.7%), and had 9 years of schooling (40.4%). An analysis of variance (one-factor ANOVA) was performed to analyze the effect of age in the groups, with no statistically significant differences found ($F(2,113) = 1.20$; $p = 0.30$). Furthermore, no statistically significant differences among the groups were found for the variables gender ($\chi^2(2) = 0.08$; $p = 0.96$), level of education ($\chi^2(8) = 4.32$; $p = 0.83$), marital status ($\chi^2(6) = 11.58$; $p = 0.07$) and professional status ($\chi^2(10) = 8.33$; $p = 0.60$).

Thirty-eight participants had a normal weight, 38 were obese without binge disorder and 38 were obese with binge disorder (see Table 1). Three groups were constituted according to their weight and clinical conditions as follows: (1) individuals with normal weight (NW), composed of 38 participants (27 female and 11 male), who did not present a medical diagnosis of obesity or BED based on a score equal to or lower than 17 (which means no periodic binge eating) on the Periodic Binge Eating Scale [56] and whose BMI

ranges between 18 kg/m^2 and 24.9 kg/m^2; (2) individuals with obesity without BED (O), composed of 38 individuals with obesity (26 female and 12 male), who do not present with BED, evaluated by physicians and specialists in psychiatry, and who scored equal to or below 17 (without periodic binge eating) on the Periodic Binge Eating Scale [56] and whose BMI is higher than 30 kg/m^2; and (3) individuals with obesity and binge eating disorder (O+BED), composed of 38 individuals with obesity (26 female and 12 male), who are clinically diagnosed with BED, scored equal to or above 27 (severe periodic binge eating) on the Periodic Binge Eating Scale [56] and whose BMI is higher than 30 kg/m^2 (see Table 1). All the individuals with obesity had the diagnosis of obesity for at least six months and were in the process of evaluation for bariatric surgery.

Table 1. Characteristics of the groups (n = 114).

	Groups								
	NW (n = 38)			**O (n = 38)**			**O+BED (n = 38)**		
	Min	**Max**	**M (SD)**	**Min**	**Max**	**M (SD)**	**Min**	**Max**	**M (SD)**
Age	20	60	40.5 (10.8)	23	60	43.9 (9.2)	25	60	42.5 (9.0)
Weight	43	85	60.7 (9.3)	76	184	123.9 (23.4)	83	149	116.9 (13.9)
Height	147	189	164.8 (8.3)	147	180	163.3 (9.4)	144	180	162.0 (7.9)
BMI	18.75	24.91	22.2 (1.8)	31.7	64.1	46.6 (8.1)	35.5	61.7	45.1 (5.1)

Note: NW: individuals with normal weight; O: individuals with obesity but without BED; O+BED: individuals with obesity and BED.

Participation in this study required compliance with the following criteria: over 18 years of age and a minimum of four years of formal education; not performing any type of diet at the time of this study; no diagnosis of hypertension, diabetes, or cardiovascular disease; no history of neurological, neuropsychological, and/or psychopathological disorders clinically diagnosed; no prior history of alcohol or drug abuse or dependence on psychotropics; not having undergone any surgical intervention in the context of obesity; not presenting bulimia or anorexia nervosa symptomatology, scored equal to or lower than 20 on Eating Attitudes Test-26 (EAT-26) [57]; not having emotional maladjustment (scored equal to or below 2.5 on the Severity Index in the Global Symptom Check-List-90-R, Portuguese version [58]); no mild cognitive decline assessed by the Portuguese version score of the Mini-Mental State Examination (MMSE) [59].

2.2. Instruments

The Frontal Assessment Battery (FAB) [60] was used to assess the functions of the frontal lobe. It is a tool validated for the Portuguese population by Lima et al. [61], and its ability to evaluate executive functions has been replicated in some studies [61,62]. It consists of six subtests: similarities, lexical fluency, motor series, conflicting instructions, go–no go, and prehension behavior, scored from 0 to 3. Total scores range from 0 to 18, with higher scores corresponding to better functioning. The FAB presented optimal interrater reliability (k = 0.87; $p < 0.001$), a Cronbach's $\alpha = 0.78$, and good discriminant validity (89.1%) using the Mattis Dementia Rating Scale (DRS) [61].

The Impact of Weight on Quality of Life-Lite (IWQOL-lite; Kolotkin et al. [63]; Portuguese version of Engel et al. [64]) is a specific questionnaire for the evaluation of quality of life for individuals diagnosed with obesity developed by Kolotkin et al. [63]. This instrument asks individuals to describe the effects their weight has on five areas of functioning: (1) physical functioning (11 items), (2) self-esteem (7 items), (3) sex life (4 items), (4) distress in public (5 items), and (5) work (4 items). This is a self-response instrument consisting of 31 items. It presents responses on a Likert-type scale, where the option "Always" is worth 5 points; "Usually", 4 points; "Sometimes", 3 points; "Rarely", 2 points; and "Never", 1 point. A total score for each dimension and the whole scale is obtained by summing all the items, with higher scores corresponding to a worse quality of life. The IWQOL-lite presents strong psychometric properties [65]. The internal consistency, measured with

Cronbach's alpha, varied from 0.82 to 0.94 for the several dimensions and 0.96 for the total score. The test–retest with a one-year interval revealed a confidence that ranged from 0.81 to 0.88 for the scales and 0.94 for the total score. The results of the internal consistency and the test–retest for obese individuals were similar to those obtained in the total sample. It presents convergent validity and discriminant validity in obese subjects [65]. As in previous studies conducted on individuals with obesity who have sought treatment, the IWQOL-lite is a valid and reliable measure of the specific quality of life of subjects with obesity who do not seek treatment. As in the original version, the Portuguese version presents alpha coefficients that ranged from 0.77 (work) to 0.95 (total) [64].

2.3. Procedure

The psychiatry services, as well as endocrinology and obesity services, of different hospitals were contacted. The Ethics Committee of the Hospital de Santa Maria and the Scientific Councils of the Santarém and Fernando da Fonseca Hospitals approved this study. To get the control group, we had the authorization of the Instituto do Emprego e Formação Profissional of Santarém.

Participants signed informed consent and were informed about the study prior to participation. Anonymity and confidentiality were guaranteed, and participants were aware that they could quit at any time during participation. Participants were assessed individually by a trained clinical neuropsychologist during a 60-min session. An anamnesis was performed in order to obtain demographic and clinical information, and the BMI was reassessed. The SCL-90-R, MMSE, and EAT-26 were used in order to define exclusion criteria.

All individuals with obesity were diagnosed by endocrinologists according to the criteria of the WHO International Classification of Diseases (ICD-10; Obesity), and the BMI was defined by psychiatrists according to the DSM-5-TR; Binge Eating Behavior.

2.4. Data Analysis

The statistical analyses were performed with the Statistical Package for the Social Sciences (IBM, SPSS Statistics, version 28.0 of Windows). This is a comparative and cross-sectional study.

Descriptive analysis of the three groups included mean and standard deviation, as well as minimum and maximum values. To compare the results in the FAB subtests across the three groups, an ANOVA was performed, with the FAB subtests and total score as dependent variables and group being a factor. Then, the effects of sex and binge disorder in the quality of life of the individuals with obesity were evaluated, and in order to reduce possible effects of age and BMI, these variables were introduced as covariates. A full factorial model was used, accounting for both main effects as well as interaction effects. In all analyses, a significance level of 0.05 was used.

3. Results

3.1. ANOVA of the FAB across Groups

The scores of the six subtests of the FAB, as well as the total score, were compared across the three groups—normal weight and obesity without and with BED. In Table 2, it is clear that in all subtests and the total score, the normal-weight group performed better than the groups with obese participants, and in these, the group with BED performed worse in all subtests and the total score than the group of participants without BED.

The results of the ANOVA show significant differences between the groups in all subtests and the total score. In subtests 3 ("Motor series"), 4 ("Conflicting instructions"), 6 ("Prehension behavior), and in the total score, significant differences occur between the normal-weight group and the two groups with obesity. In subtests 1 ("Similarities") and 5 ("Go–No Go"), the group with BED differs significantly from the normal-weight group, while in subtest 2 ("Lexical fluency"), the difference is between the group with BED and the other two groups (see Table 2).

Table 2. Analysis of variance of the FAB subtests and total score by group.

	Group				
	NW (*n* = 38)	**O (*n* = 38)**	**O+BED (*n* = 38)**		
FAB Subtests	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**F (2,111)**	***p***
FAB 1 Similarities (conceptualization)	2.6 (0.6) [a]	2.2 (0.8) [a,b]	2.1 (0.7) [b]	4.24	0.017
FAB 2 Lexical fluency (mental flexibility)	2.9 (0.3) [a]	2.7 (0.6) [a]	2.1 (0.8) [b]	18.80	<0.001
FAB 3 Motor series (programming)	2.9 (0.3) [a]	2.4 (0.8) [b]	2.1 (1.1) [b]	8.71	<0.001
FAB 4 Conflicting instructions (sensitivity to interference)	2.9 (0.3) [a]	2.1 (1.3) [b]	2.1 (1.4) [b]	6.91	0.001
FAB 5 Go–No Go (inhibitory control)	2.7 (0.7) [a]	2.3 (1.2) [a,b]	1.9 (1.4) [b]	5.51	0.005
FAB 6 Prehension behavior (environmental autonomy)	3.0 (0.0) [a]	2.7 (0.5) [b]	2.5 (0.6) [b]	12.42	<0.001
FAB_Total	17 (1.2) [a]	14.3 (3.3) [b]	12.9 (3.4) [b]	21.55	<0.001

Note: different superscripts identify significantly different groups (if one group does not differ from the other group, they both share superscripts "[a]" or "[b]", and when the groups differ from each other, they do not share any superscripts, one is "[a]" and the other is "[b]"). Note: FAB—Frontal Assessment Battery; NW: individuals with normal weight; O: individuals with obesity but without BED; O+BED: individuals with obesity and BED.

3.2. Multivariate Analysis

A multivariate analysis of covariance (MANCOVA) was performed to analyze the effect of sex and BED on the dimensions of quality of life, with age and BMI as covariates. A type III sum of squares was used with a full factorial model.

The multivariate tests revealed that sex (Wilks' $\lambda = 0.697$, $p < 0.001$) and group (Wilks' $\lambda = 0.835$, $p = 0.035$) were the main variables with significant effects, while the interaction between sex and group (Wilks´ $\lambda = 0.936$, $p = 0.501$) was not significant.

The descriptive scores for the dimensions considered are shown in Table 3. That is, in Table 3, the mean values of the comparisons are represented, and in Table 4, their significance is represented. When sex is the comparison factor, we can see that the quality of life is superior (corresponding to lower scores) in all its dimensions in male participants, while when the group is used to compare participants, those without BED also present lower mean scores in all dimensions of quality of life when compared to those participants with BED. With regard to sex, the dimensions where significant differences occur are self-esteem ($F(1,69) = 20.15$, $p < 0.001$) and sexual life ($F(1,69) = 8.04$, $p = 0.006$), in both cases, with females presenting higher values corresponding to worse quality of life (see Table 4). When the groups are compared according to the presence or absence of BED, the only significant difference occurs in the physical function, with higher mean values in participants with BED ($F(1,69) = 8.10$, $p = 0.006$).

Table 3. Means (SD) of the dimensions of the IWQOL by sex and binge eating disorder.

	Sex * Group				Total			
	Male		**Female**		**Sex**		**Group**	
	O (*n* = 12)	**O+BED (*n* = 12)**	**O (*n* = 26)**	**O+BED (*n* = 26)**	**Male (*n* = 24)**	**Female (*n* = 52)**	**O (*n* = 38)**	**O+BED (*n* = 38)**
IWQOL Subtests	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Physical function	2.8 (1.4)	3.5 (0.8)	3.3 (0.9)	3.6 (0.9)	3.1 (1.2)	3.4 (0.9)	3.1 (1.1)	3.5 (0.8)
Self-esteem	2.2 (1.1)	2.5 (0.9)	3.4 (1.2)	3.6 (1.0)	2.3 (1.0)	3.5 (1.1)	3.0 (1.3)	3.3 (1.1)
Sexual life	1.8 (0.8)	1.8 (1.3)	2.7 (1.5)	2.9 (1.4)	1.8 (1.1)	2.8 (1.5)	2.4 (1.4)	2.5 (1.4)
Public distress	2.1 (1.2)	2.3 (0.9)	2.6 (1.2)	2.8 (1.3)	2.2 (1.1)	2.7 (1.2)	2.4 (1.3)	2.6 (1.2)
Work	2.2 (1.2)	2.3 (1.0)	2.4 (1.3)	2.7 (1.4)	2.2 (1.1)	2.6 (1.4)	2.3 (1.3)	2.6 (1.3)
Total	2.3 (1.0)	2.7 (0.7)	3.0 (1.0)	3.3 (0.8)	2.5 (0.9)	3.1 (0.9)	2.8 (1.0)	3.1 (0.8)

Note: IWQOL—Impact of Weight on Quality of Life; O: individuals with obesity but without BED; O+BED: Individuals with obesity and BED.

Table 4. Results of the between-subjects effects of the multivariate analysis of IWQOL by sex and group (BMI and age as covariates).

	Dependent Variables									Covariates					
	Sex			Group			Sex * Group			BMI			Age		
IWQOL	**MS**	**F (1,69)**	***p***	**MS**	**F (1,69)**	***p***	**MS**	**F (1,69)**	***p***	**MS**	**F (1,69)**	***p***	**MS**	**F (1,69)**	***p***
Physical function	0.71	0.95	0.333	6.07	8.10	0.006	0.71	0.94	0.335	0.71	0.94	0.335	0.38	0.50	0.481
Self-esteem	22.31	20.15	<0.001	1.01	0.92	0.342	0.01	0.01	0.932	2.04	1.84	0.179	1.32	1.19	0.279
Sexual life	15.23	8.04	0.006	0.28	0.15	0.703	0.06	0.03	0.865	2.69	1.42	0.237	2.19	1.15	0.286
Public distress	3.23	2.36	0.129	0.91	0.66	0.418	0.02	0.01	0.908	1.92	1.4	0.241	0.88	0.64	0.425
Work	1.92	1.23	0.270	0.25	0.16	0.689	1.08	0.69	0.409	2.65	3.21	0.075	2.86	1.41	0.239
Total score	5.47	7.76	0.007	1.93	2.74	0.103	0.01	0.01	0.913	2.12	3.01	0.087	1.34	1.90	0.173

Note: IWQOL—Impact of Weight on Quality of Life Questionnaire; BMI—Body Mass Index; F—F test; MS—Mean Squares.

4. Discussion

The main aim of this study was to compare the FLFs of individuals with obesity, with and without BED, and individuals with a NW. Our results from the FAB confirm the hypothesis that individuals with obesity, with and without BED, had poorer frontal functioning than NW persons and that individuals with obesity with BED had lower performance in terms of FLFs than individuals with obesity but without BED. Our findings are in line with the previous literature [2,4,18–21,28–34] and can help to explain the alterations in the eating behavior of individuals with obesity, with and without BED, and their difficulties in changing and maintaining the motivation that may exist. Specifically, in this study, it was found that what most differentiates the NW group from the two groups of individuals with obesity are the frontal dimensions of "Motor series", "Conflicting instructions", and "Prehension behavior", which reflect the lower global frontal functioning of the group with individuals with obesity, especially in planning, inhibitory control, and dependence on the environment.

The motor programming difficulties are consistent with the results obtained by Boeka and Lokken [22], who concluded that there are differences at the level of planning between normal-weight individuals and individuals with obesity. The results of the group with individuals with obesity show that there are no differences in motor programming depending on the presence or absence of BED. Regardless of whether or not they binge eat, obese individuals have difficulties in programming their behavior, which may include eating behavior. A diet and the act of ingestion require the development of a prospective plan, anticipation of outcomes, and testing of complex sequences of eating behavior. This finding may explain the difficulty of individuals with obesity in programming a diet, such as what they will eat, how, and when they will eat it, since they have to take into account not only intra-individual variables (cognitions and affects), but also the family, the guidelines given by professionals, the social context, and the environment in which they are located [66].

Regarding the differences between the groups of normal-weight individuals and individuals with obesity and BED, the individuals with obesity and BED are characterized by greater difficulties in "Similarities" and "Go–No Go", because these individuals seem to have greater difficulties in abstract thinking than NW individuals. It is possible that the difficulties of individuals with obesity and BED may contribute to understand why they do not consider the emotional state that emerges after a binge (research criteria for the diagnosis of BED: C. Profound discomfort when recalling binge eating, DSM-V-TR) [5] and eat until they feel unpleasantly full and dissatisfied with themselves, depressed, or guilty. These results also could explain their difficulties in understand the causes and consequences of dieting, the repercussions of a balanced diet, and the costs and benefits of a given eating behavior. This fragility, indirectly, can potentiate or enhance limitations

at the levels of capacity for planning [30], decision making [30,32], and poorer cognitive flexibility [30,32,33].

Individuals with obesity and BED also showed more inhibitory control difficulties when compared to NW individuals. These results are in line with the literature and, more specifically, with the results obtained by Eneva et al. [33], Córdova [35], and even Eichen et al. [32] and Kollei et al. [36], who reported higher rates of impulsivity related with food in individuals with obesity and BED. By presenting difficulty in inhibiting responses, these individuals are vulnerable to uncontrolled food intake. Our results provide evidence that individuals with obesity and BED have difficulty inhibiting the act of food intake in the face of a food exposure situation. Taken together, the data suggest that low inhibitory capacity and resistance to interference characterize BED. However, this interpretation could also be promoted in the sense that the frontal lobe "impairment" may also be contributing to obesity and BED.

On the other hand, the group of individuals with obesity and binge eating disorder differs from the group of individuals with obesity but without BED and the normal-weight group with respect to "lexical fluency", which translates to their weaknesses in mental flexibility. Similar results were found by Eneva et al. [33], Eichen et al. [32], and Solano-Pinto et al. [30]. Individuals with obesity with BED seem to present more difficulties in updating, change, and inhibition in planning and in the component of "access" to the contents stored in long-term memory than individuals with obesity but without BED and NW individuals.

A second purpose of this study was to analyze the effect of sex and binge eating disorder on quality of life, with age and BMI as covariates. The results revealed that both the sex and group of participants had a significant effect on their quality of life. Our findings show that men had a higher quality of life in all dimensions than women and that individuals with obesity and BED also presented a poorer quality of life in all dimensions when compared to those participants without binge eating disorder. With regard to sex, women show a worse quality of life in the self-esteem and sexual life dimensions. The results of the present study are in line with Vancampfort et al. [53], who reported that QoL can be particularly poorer in women with BED compared to men with BED. According to Castanha et al. (2018), the effects of obesity impact an individual's quality of life (QoL), whose indicators are characterized by lower social interaction, low self-esteem, social isolation, stress, and mental illnesses [45,47,48]. Appolinario et al. [51], Giel et al. [10], Singleton et al. [52], and Vancampfort et al. [53] also mentioned that individuals with BED experience more comorbid mental health problems, more specifically, depression [49] and anxiety disorders [50]. Wu and Berry [67] concluded that in BED results in weight-related poor self-esteem, and Meseri et al. [68] report that self-esteem is an important factor affecting eating disorders. According to Monteleone et al. [69], individuals with BED show limited access to emotional regulation strategies, which may suggest that for these individuals, eating may be a strategy that helps to cope with negative effects.

According to the literature, women with obesity have a remarkable tendency to dissociate during sexual contacts with partners when their body esteem is negative [70]. Women who verbalized a dissociation during sexual activities and had greater tendency toward binge eating showed higher cortisol levels when faced with sexual stimuli. Impulsivity appears to increase sexual behaviors in women with binge eating [71]. It was found that when there are more binge eating episodes, there are fewer orgasms, sexual function is worse, and sexual dissatisfaction increases [72]. Women with binge eating episodes were generally characterized by poor sexual functioning and a negative sexual self-concept [73]. This statement is supported by the results of a study by Castellini et al. [70] with sexually active women, which shows that women with BED and obesity seem to have lower sexual function compared to those without BED and obesity and to controls. The results of the present study, which reveal that women have a worse quality of life in the dimension of sexual life, are in line with the literature.

When compared to individuals with obesity but without binge eating disorder, the participants with obesity and BED show a lower quality of life just for their physical function. This finding suggests that individuals with BED seem to have a poorer perception of their physical health than those without BED, which may be a consequence of the sense of loss of control experienced while consuming large amounts of food.

The results of this study reinforce the importance of assessing FLFs and quality of life as important factors in the understanding and intervention strategies of individuals with obesity. The intervention in this population should include neurocognitive training and psychological support. Our data make it clear that obesity can impact the less-studied domains of quality of life, such as public distress, physical function, sexual life, work, and self-esteem, which can promote psychological distress. Indeed, most of the previous studies focused on the health-related dimensions of quality of life.

Comparative studies regarding FLFs between individuals with obesity, with and without BED, waiting for clinical treatment, and individuals with obesity that did not look for treatment should be considered in the future. Additionally, the use of anthropometric measures and the inclusion of data from neuroimaging techniques may contribute to an accurate understanding of the directionality of the link between obesity and FLFs.

Limitations and Strengths

In terms of the limitations of this study, it is important to first notice that we used a convenience sample that may not be representative of the obese population. Secondly, the BMI was the only indicator used to measure the level of adiposity. Because this is a cross-sectional study, one of the main limitations is that it does not allow us to know the direction of causality between obesity and FLFs. The non-use of a stratified sample can also be understood as a limitation.

The results from our study corroborate others from previous studies; however, we used a clinical sample (individuals with obesity, with and without BED, being followed in a hospital service and awaiting bariatric surgery), defined with the direct involvement of the medical staff (neurologists, psychiatrists, endocrinologists, psychologists, neuropsychologists, nutritionists, and social workers) in order to achieve all the inclusion criteria. Additionally, the inclusion of a homogeneous control group in terms of demographic and clinical characteristics and the use of a specific instrument—IWQOL-lite—for assessing the quality of life in individuals with obesity can be referred to as strengths and support the differentiation of this study.

5. Conclusions

In sum, the results of this study showed that individuals with obesity, with and without BED, had poorer FLFs than individuals with a NW. Secondly, individuals with obesity and BED had an even lower performance in FLFs than individuals with obesity without BED. More specifically, it was found that what most differentiated the group of NW individuals from the two groups of individuals with obesity were their difficulties in global frontal functioning, motor programming, sensitivity to interference, and dependence on the environment. From the analysis of the results of the two groups of obese individuals, it was found that those with BED are characterized by greater difficulties in abstract thinking and in inhibitory control. The group with individuals with obesity and BED differs from the group with individuals with obesity without BED and the group of NW individuals, revealing more difficulties in mental flexibility.

As for the quality of life, the men reveal higher levels of quality of life in all dimensions studied than the women. In addition, participants with obesity but without BED also present a higher quality of life than individuals with obesity and BED in all dimension. Regarding sex, the dimensions in which significant differences were found are self-esteem and sex life, in both cases with women presenting a worse quality of life. When the groups are compared according to the presence or lack of BED, the only significant difference occurs in physical function, which is lower in participants with BED.

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