

Inhibitory control and ability to maintain response in obesity and binge eating disorder

Controle inibitório e capacidade de manter a resposta na obesidade e distúrbios alimentares

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ABSTRACT

The aim of this study was to analyse the inhibitory control and the ability to maintain response in obese patients with and without Binge Eating Disorder (BED), compared to normalweight subjects. A total of 114 participants comprised three different groups (obese with BED, obese without BED and normal-weight) completed the Frontal Assessment Battery, the Stroop Neuropsychological Screening Test and the Wisconsin Card Sorting Test. The results showed differences between the obese groups and normal-weight group, to inhibitory control. There were also differences between the two obese groups in the ability to maintain the response. These results suggest that low inhibitory control, characterizes obesity and the difficulties to maintain the response, characterizes the binge eating disorder.

Keywords: inhibitory control, ability to maintain response, obesity, binge eating disorder.

RESUMO

O objetivo deste estudo foi analisar o controle inibitório e a capacidade de manter a resposta em pacientes obesos com e sem Binge Eating Disorder (BED), em comparação com indivíduos de peso normal. Um total de 114 participantes compreendeu três grupos diferentes (obesos com BED, obesos sem BED e com peso normal) completaram a Bateria de Avaliação Frontal, o Teste de Triagem Neuropsicológica de Stroop e o Teste de Triagem do Cartão de Wisconsin. Os resultados mostraram diferenças entre os grupos de obesos e o grupo de peso normal, para controle inibitório. Também houve diferenças entre os dois grupos de obesos na capacidade de manter a resposta. Estes resultados sugerem que o baixo controle inibitório, caracteriza a obesidade e as dificuldades para manter a resposta, caracteriza o distúrbio alimentar binge.

Palavras-chave: controle inibitório, capacidade de manter a resposta, obesidade, distúrbio alimentar binge.

1 INTRODUCTION

Obesity is a result from prolonged consumption of excessive energy in relation to energy expenditures. According to the World Health Organization [1], the Body Mass Index (BMI) is a measure that determines the severity of obesity, based on the association between the individual's weight and height [$BMI = \text{weight}(\text{Kg}) / \text{height}^2(\text{m})$]. According to WHO [1], obesity is one of the biggest challenges in the field of global public health, and has been considered the "epidemic of modern times". Statistical data from 2016 reported that more than 1.9 million adults over the age of 18 were overweight and 650 million were obese [1]. In the European Union (EU) obesity has been increasing since the 1980s and remains in an alarming rate, affecting around 30% of the total population of different age groups. In Portugal obesity rates have also increased in the last decade, with 17% of adults being obese in 2019, slightly higher than the EU average (16%). According to the WHO [1], obesity is the second cause of death possible to prevent, justifying the need for intervention in this area. Thus, obesity is a public health problem, a multi-determined chronic disease, with physical, psychological, social, and cultural repercussions [2,3], presenting a higher risk of premature death [3]. It is estimated that 23.9% of patients seeking treatment for obesity have binge eating disorder (BED) [4].

Pathological eating behavior corresponds to a complex and multifactorial phenomenon [5]. Previous studies indicated that there are several obese patients with eating and intake disorders [6-9]. Eating and intake disorder is described in DSM-5 as a persistent disorder in diet or intake that results in a change in food consumption or absorption, which causes significant deficits in physical health or psychosocial functioning [10]. These severe mental disorders are often disabling, and are often associated with purging behaviors and over-evaluation of form and weight [11]. Based on DSM-5 [10], pica, misercism, avoidant/restrictive food intake disorder, anorexia nervosa, bulimia nervosa, and BED are included in pathological eating behavior. The essential features of BED includes the presence of recurrent episodes of compulsive intake that should occur, on average, at least once a week for three months, deep malaise when

recalling compulsive eating intake, and is not associated with regular use of inappropriate compensatory behaviors [10].

In neuropsychology the understanding of neuronal mechanisms that control the hedonic and additive components of ingestion and the influence of cognitive functions in this process, has generated a growing interest [12]. Cognitive processes, more specifically executive functions (EF) are involved in eating behavior. EFs are mental processes required to solve internal and external problems [13]. EF includes a wide set of self-regulation functions that allow the control, organization, and coordination of other cognitive functions, emotional and behavioral responses [14].

In order to understand appetite and weight, Carnell et al. [15], using neuroimaging techniques, reported changes in several brain regions related to reward, homeostatic regulation of ingestion, sensory and motor processing, cognitive control, and attention. In neuropsychology, these results are in line with the association between worse executive performance and failure to maintain an adequate diet [16,17]. Previous literature have shown that obese patients report difficulties in different components of executive functions (EF), such as inhibitory control [18-22]; working memory [22-23], planning and problem solving [24], sustained attention [19], cognitive flexibility [19,23-26] and decision-making [25,27,28].

Several authors have reported that the EFs of individuals with BED, seem to be weak [5,8,29-34]. In patients with BED, the presence of cognitive deficits has been confirmed in different domains [4,31,34-36], such as executive functioning, attention, and memory. In addition, the association between this disorders and the presence of cognitive errors, is also well known [37,38]. Duchesne *et al.* [26] reported that subjects with BED, present more executive deficits, evidenced by difficulties in problem-solving capacity, cognitive flexibility, and operative memory, than normal-weight (NW) subjects. Other authors indicated that patients with BED, reveal weaker indices in planning [34], decision-making [30,34], inhibitory control [29,39], psychomotor performance [29], cognitive flexibility [29,30,34], and higher rates of impulsivity, related with food, than obese patients without BED [30,40].

There has been an interest in the study of the relationship between obesity and EF, and disturbances in eating behavior and EF, however there is a lack of studies that focus on the role of inhibitory control and the ability to maintain the response, in obese patients, with and without BED. Since obesity is an epidemic with severe organic and psychosocial repercussions, it is important to obtain further information in order to understand the role of inhibition control and the ability to maintain response in eating behavior.

The purpose of this study was to compare the inhibitory control and the ability to maintain response of obese patients, with BED and without BED, and with normal-weight persons. We hypothesized that obese patients with BED and without BED, had poorer performance in inhibitory control and the ability to maintain the response than NW. It was also expected that obese patients with BED had lower performance in inhibitory control and the in ability to maintain response than obese patients without BED.

2 MATERIALS AND METHODS

2.1 PARTICIPANTS

The sample consisted of 114 Portuguese subjects, 35 male (30.7%) and 79 female (69.3%) with age ranged between 20 to 60 years ($M = 42.33$; $SD = 9.69$). Participants were divided in three groups according to their clinical condition: 1) Normal-weight (NW), composed of 38 NW participants (11 male and 27 female), who do not present a medical diagnosis of obesity or BED, obtained a score equal to or lower than 17 (without periodic binge eating) on the Periodic Binge Eating Scale [41] and their BMI ranges between 18 kg/m^2 to 24.9 kg/m^2 ; 2) Obesity without BED (O-BED), composed of 38 obese patients (12 male and 26 female), who do not present BED, evaluated by physicians specialists in Psychiatry, scored equal to or below than 17 (without periodic binge eating) on the Periodic Binge Eating Scale [41] and their BMI is greater than 30 kg/m^2 ; and 3) Obesity with binge eating disorder (O+BED), composed of 38 obese patients (12 male and 26 female), who present BED clinically diagnosed, scored equal to or greater than 27 (severe periodic binge eating) on the Periodic Binge Eating Scale [41] and their BMI are greater than 30 kg/m^2 . The others inclusion criteria for this study were: do not present pica symptoms, mericism, avoidant/restrictive food intake disorder, anorexia nervosa and/or bulimia nervosa score; scored equal to or lower than 20 on Eating Attitudes Test -26 (EAT-26) [42,43]; not performing any type of diet at the moment of this study; over 18 years of age; at least 4 years of formal education; do not present a history of neurological, neuropsychological and/or psychopathological disorders clinically diagnosed; do not present in their clinical history a past of usage of psychotropic drugs; had not undergone any surgical intervention in the context of obesity; had no history of alcohol and/or drug abuse; do not present emotional changes, scored equal to or below 2.5 on the Severity Index (*Global Symptom Check-List- 90- R* (SCL-90-R), Portuguese adaptation [44]; scored equal to or higher than 22 in the *Mini-Mental State Examination* (MMSE), Portuguese adaptation [45]. Table 1 shows the sociodemographic characteristics of each group.

Table 1: Sociodemographic characteristics by group

	NW		O-BED		O+BED		TOTAL	
	M	SD	M	SD	M	SD	M	SD
Age	40,53	10,75	43,95	9,19	42,53	8,97	42,33	9,69
Gender	n	%	n	%	n	%	N	%
Male	11	9,65	12	10,53	12	10,53	35	30,7
Female	27	23,68	26	22,81	26	22,81	79	69,3
Educational level	n	%	n	%	n	%	N	%
4 years	3	2,63	3	2,63	6	5,26	12	10,52
6 years	15	13,16	10	8,77	9	7,89	34	29,82
9 years	14	12,28	16	14,04	16	14,04	46	40,36
12 years	4	3,51	6	5,26	4	3,51	14	12,28
+15 years	2	1,75	3	2,63	3	2,63	8	7,01
Marital status	n	%	n	%	n	%	N	%
Single	9	7,89	8	7,02	3	2,63	20	17,54
Married/Union fact	19	16,67	26	22,81	30	26,32	75	65,80

Divorced/Separated	6	5,26	2	1,75	5	4,39	13	11,40
Widower	4	3,51	2	1,75	0	0	6	5,26
Professional situation	n	%	n	%	n	%	N	%
Student	1	0,88	0	0	1	0,88	2	1,8
Maid/servant	2	1,75	3	2,63	2	1,75	7	6,1
Active	34	29,82	29	25,44	29	25,44	92	80,7
Retired	1	0,88	4	3,51	2	1,75	7	6,1
Unemployed	0	0	1	0,88	3	2,63	4	3,5
Medical leave	0	0	1	0,88	1	0,88	2	1,8

M: Mean; SD: Standard deviation; n: Number of participants; %: Percentage; NP: Normoweight; O-BED: Obese Without BED; O+BED: Obese With BED.

2.2 INSTRUMENTS

The following neuropsychological assessment instruments were applied:

. *Frontal Assessment Battery (FAB)* [46]. It is a tool used to evaluate the functions of the frontal lobe. FAB's ability to evaluate executive functions has been reiterated in some studies [46,47]. It consists of six subtests: Similarities, Lexical Fluency, Motor Series, Conflicting instructions, Go/No Go, and Prehension Behavior. Each of these subtests scores a maximum of three points and total score ranging 0-18. The FAB reveals a good internal consistency (*Cronbach's coefficient alpha*=.78) and discriminant validity (89.1%) [46].

. *Stroop Neuropsychological Screening Test (Stroop)* [48]. It consists of two tasks; the color task, (a list of 112 words of colors written in a congruent color) and the color-word task (a list 112 words of colors written in a incongruent color). The Stroop assess the ability to inhibit an inadequate response [49]. The score is calculated according to the execution time in seconds and the number of correct answers. Psychometric reliability and validity analyses are adequate [48].

. *Wisconsin Card Sorting Test (WCST)* [50]. It is a classical neuropsychological tool used to assess executive functions related to cognitive flexibility and abstract reasoning. It consists of four cards (key stimuli) and 128 response cards from which the subject is instructed to discover a classification rule/criterion. Factor analysis developed by Heaton et al. [50] demonstrated three primary components and seven variables selected to represent them: (I) Cognitive flexibility and accuracy: Total errors; Perseverative responses; Percentage of conceptual level responses and Number of categories completed; (II) Problem solving and learning: Non-perseverative errors and Attempts to complete the first category; (III) Maintenance of response and distraction: Failure to maintain the category [51]. The WCST is a test with reliability and validity [50].

2.3 PROCEDURE

This study was approved by the Ethics Committee of the Hospital de Santa Maria, and by the Scientific Councils of the Fernando da Fonseca and Santarém Hospitals. To collect the control sample, we

had the authorization of the Professional Training Center of Santarém.

All obese patients were first diagnosed by endocrinologists, according to the criteria of the WHO International Classification of Diseases (ICD-10; Obesity), with the BMI defined. All of them had been obese for at least six months and were in the process of evaluation for bariatric surgery. Informed consent was obtained from all subjects involved in the study. They were informed about the aim of the study; anonymity, and confidentiality were protected, and the possibility of getting out of the study at any time was also expressed. We carry out an anamnesis to obtain information about the most relevant personal and family information. We used MMSE, EAT-26, and SCL-90-R to define exclusion criteria. All subjects were evaluated individually in a session lasting sixty minutes by a clinical neuropsychologist with experience in neuropsychological assessment. Forty-seven participants were excluded from this study, due to not meeting some of the characteristics mentioned in the inclusion criteria.

2.4 STATISTICAL ANALYSIS

The statistical analyses was performed with the Statistical Package for the Social Sciences (IBM, SPSS Statistics, version 28.0 of Windows). Firstly, to evaluate the differences between the groups (NW, O-BED, and O+BED) for age, emotional adjustment, and mental state, a variance analysis (ANOVA) of one factor was performed. We used the chi-square method to verify differences in the distributions of the groups for gender, educational level, marital status, and professional situation. In order to analyse the differences between three groups for dependent variables (EF), we performed a variance analysis (ANOVA) of one factor. As dependent variables we selected: the ability to maintain response and distraction, measured with the failure to maintain the context (WCST), and inhibitory control, measured with the execution time of Stroop (maximum 120 seconds) and the scores of the following subtests of FAB: sensitivity to interference and Go/No Go. In order to analyze the differences observed from the ANOVA, a detailed analysis was carried out with a post-hoc test (Tuckey HSD). The confidence interval was 95%.

3 RESULTS

We found no statistically significant effect between groups for age $F(2,113) = 1.20$; $p \geq 0.05$, educational level $\chi^2(8) = 4.32$; $p \geq 0.05$, marital status $\chi^2(6) = 11.58$; $p \geq 0.05$, professional status $\chi^2(10) = 8.33$; $p \geq 0.05$ and gender $\chi^2(2) = 0.08$; $p \geq 0.05$. We also did not found statistically significant differences between the groups for emotional adjustment $F(2,113) = 0.08$; $p = 0.92$, or mental status $F(2,113) = 2.39$; $p = 0.09$.

Regarding the inhibition capacity and interference resistance, we found a statistically significant group effect $F(2,113) = 5.51$; $p = 0.00$, in the subtest Go/No Go. NW group present the less difficulty ($M = 2.74$; $SD = 0.69$), followed by O-BED ($M = 2.26$; $SD = 1.16$) and with more difficulties the O+BED

group ($M = 1.89$; $SD = 1.37$). In the Tuckey HSD test we found significant differences between NW and O+BED ($p = 0.00$). We did not find significant differences between NW and O-BED ($p > 0.05$) or between the obese groups ($p > 0.05$). In the task sensitivity to interference of the FAB we found statistically significant differences $F(2,113) = 6.91$; $p = 0.01$, between the groups studied. NW group obtain the highest scores ($M = 2.92$; $SD = 0.27$), followed by O+BED ($M = 2.13$; $SD = 1.38$) and with the poorer incomes the O-BED ($M = 2.08$; $SD = 1.30$). In the Tuckey HSD test, we found significant differences between NW and O-BED ($p = 0.00$) and NW and O+BED ($p = 0.00$). We did not found significant differences between the obese group ($p > 0.05$). In the execution time to perform the color-word task of Stroop we found differences $F(2,113) = 5.64$; $p = 0.00$ between groups. It is the NW subjects that lasted less time ($M = 114.50$; $SD = 11.80$), followed by O-BED ($M = 118.55$; $SD = 4.46$) and the O+BED took longer ($M = 119.89$; $SD = 0.51$). In the Tuckey HSD test we found significant differences between NW vs O-BED ($p < 0.05$) and NW and O+BED ($p = 0.00$). We did not find significant differences between the obese group ($p > 0.05$).

Regarding the ability to maintain response and distraction, we found a statistically significant group effect, $F(2,113) = 12.36$; $p = 0.00$, in the failure to maintain the context. NW subjects present less difficulties ($M = 0.36$; $SD = 0.59$), followed by O-BED ($M = 0.82$; $SD = 1.09$) and with more difficulties the O+BED ($M = 1.68$; $SD = 1.61$). In the Tuckey HSD test, we found that there are significant differences between NW and O+BED ($p = 0.00$) and between the obese groups ($p = 0.00$). We found no significant differences between NW and O-BED ($p > 0.05$).

4 DISCUSSION

The aim of this study was to analyze the inhibitory control and the ability to maintain response, in obese patients with and without BED, compared to normal-weight subjects. Our hypotheses assumed that obese patients, with BED and without BED, had poorer performance in inhibitory control and in the ability to maintain the response, than NW. It was also expected that obese patients with BED had lower performance in inhibitory control and poorer ability to maintain the response, than obese patients without BED.

Data from obese patients with and without BED in inhibitory control tasks, reflect their difficulties in the ability to inhibit and resist to interference. The obese participants presented more difficulties in the Go/No Go and sensitivity interference tasks than normal-weight participants. Similarly, obese patients took longer to perform the color-word task of Stroop, an indicator of cognitive interference and decreased inhibitory control. These difficulties were observed in other studies, that also reported difficulties in inhibitory control [19,29,39], low self-control and high levels of impulsivity on obese individuals [18,30,40].

By presenting difficulty in inhibiting responses, the obese patients became more vulnerable to eating unchecked food. Our results are in line with Mobbs *et al.* [20] that claim that obese patients seem to have problems in the inhibitory control and intentional focus. These results are useful to understand the difficulties that these subjects have in inhibit the act of food intake in the face of a situation of exposure to food. Taken together, our data suggest that low capacity of inhibition and resistance to interference, characterizes obesity. Obese patients with and without BED did not differ from each other in relation to this dimension, which indicates that the difficulties in this component are a feature of obese patients, but the presence of BED does not produce changes in the capacity of inhibition.

In the component ability to maintain response and distraction, obese patients with BED had worse outcomes than normal-weight subjects, even if obese patients without BED do not differ from normal-weight subjects. The results of the obese groups show that subjects with BED, compared with subjects without BED, presented more difficulties in this task. This results are in line with those obtained by Mobbs *et al.* [20] who concluded that obese patients with BED, reveal more difficulties in maintaining the response than obese patients without BED, presenting more errors and omissions in the proposed tasks.

Our results seem to be relevant to the understanding of the difficulties presented by obese patients with BED, in focusing on their tasks. Obese patients with BED have difficulties in maintaining the amount of food consumption and the duration of the episode of compulsive ingestion, which seems to be due to difficulties in the ability to maintain response and distraction. Previous literature indicated that obese patients with BED remain in longer periods of restriction and when they have episodes of compulsive intake, they eat more than most people can eat in the same period of time [15]. It is possible that this found is also related to difficulties in the ability to maintain the response, and can in itself be considered as one of the causes of this behavior/disorder.

Our study seems to indicate that the difficulties in these dimensions of executive functions characterize obesity and confirm their relevance in the development and/or maintenance of obesity. Obese patients with BED had worse outcomes in maintaining the response (than normal-weight and obese patients without BED), which seems to confirm the relevance of changes in these dimensions of executive functions in the development and/or maintenance of BED, especially difficulties in anticipating the consequences of behavior, in focusing and performing tasks. If so, these dimensions should be taken into account when addressing specific symptomatology in obese patients with BED.

According to our results and those of other authors [52], deficits in EF play an important role in the development and maintenance of the BED. For some authors [53-55] it is crucial to suspend compulsive eating episodes in order to reduce weight. In addition, a better knowledge of the cognitive profile of obese patients with and without BED, through a neuropsychological assessment, can be very useful for therapeutic approaches, supporting the process of cognitive rehabilitation and psychosocial reintegration of these

patients. It is well known [56] that training and neuropsychological rehabilitation can decrease, and even reverse, cognitive impairment which is very important for successful treatment.

Although there are some conceptual difficulties (obesity is not considered a mental disease), it is important not to forget that subjects with BED are a growing group. Thus, it is essential to develop a global intervention that do not include only bariatric surgeries, medications and psychological interventions.

The main limitation of this study is that it does not contemplate all the dimensions of the executive functioning (Conceptualization and abstraction; Planning; Problem solving and learning; Cognitive flexibility; Verbal fluency), that could promote a more holistic interpretation of the feeding behavior.

Future studies must include the development and validation of tools for stimulation of executive functions, for obese patients without and with BED. In addition, it is also important to make longitudinal studies with obese patients, without/with BED, in order to evaluate the effect of stimulation.

In conclusion, executive functions can play an important role in the characterization of obese patients with/without BED, which is a significant finding because it can be taken into account both in prevention [53-55] as in the treatment of BED (stimulating particularly ability to maintain response) and obesity (stimulating particularly inhibitory control).

REFERENCES

1. WHO. Obesity and Overweight; World Health Organization: Geneva, Switzerland, 2020. <https://www.who.int/news-room/factsheets/detail/obesity>
2. Fontaine, K.R.; Bartlett, S.J.; Barofsky, I. Health-related quality of life among obese persons seeking and not currently seeking treatment. *International Journal of Eating Disorders*, **2000**, 27(1), 101-105.
3. Silva, I.; Pais-Ribeiro, J.; Cardoso, H. Cirurgia de obesidade: Qualidade de vida e variáveis psicológicas antes e depois do tratamento cirúrgico. *Psicologia: Teoria e Prática*, **2009**, 11(2), 196-210.
4. Blume, M.; Schmidt, R.; Hilbert, A. Executive functioning in obesity, food addiction, and binge-eating disorder. *Nutrients*, **2018**, 11, 54.
5. Segura-Serralta, M.; Perpiñá, C.; Ciscar, S.; Blasco, L.; Espert, R.; RomeroEscobar, C.; Domínguez, J. R.; Oltra-Cucarella, J. Executive functions and emotion regulation in obesity and eating disorders. *Nutrición Hospitalaria*, **2019**, 36 (1), 167-172.
6. De Zwaan, M.; Mitchell, J.F.; Howell, L.M.; Monson, N.; Swan-Kremeier, L.; Roerig, J.L.; Kolotkin, R.L.; Crosby, R.D. Two measures of health-related quality of life in morbid obesity. *Obesity Research*, **2002**, 10, 1143-1145.
7. Marcus, M.D.; Wing, R.R.; Lamparski, D.M. Binge eating and dietary restraint in obese patients. *Addictive Behaviors*, **1985**, 10, 163-168.
8. Teixeira, A. & Lopes, R. Funções executivas e compulsão alimentar: revisão sistemática da literatura. *Cuadernos de Neuropsicología / Panamerican, Journal of Neuropsychology*, **2020**, 14(2), 35-50.
9. Spitzer, R.L.; Yanovski, S.; Wadden, T.; Wing, R.; Marcus, M.D.; Stunkarf, A.; Devlin, M.; Mitchell, J.; Hasin, D.; Home, R. Binge eating disorder: Its further validation in a multisite study. *International Journal of Eating Disorder*, **1993**, 13(2), 137-153.
10. American Psychiatric Association. **Manual de diagnóstico e estatística das perturbações mentais (DSM-5)**, 2014. Climepsi Editores.
11. Dahlgren, C. L.; Hage, T. W.; Wonderlich, J. A.; Stedal, K. General and eating disorder specific flexibility: Development and validation of the eating disorder flexibility index (EDFLIX). Questionnaire. *Fronteiras em Psicologia*, **2019**, 10, 663.
12. Díaz, B.B.; Fuentes, R.C.; Coello, S.D.; Cabrera de León, A. Psicoendocrinoneurología de la obesidad. *Revista Española de Obesidad*, **2007**, 5(4), 204-225.
13. Barkley, R.A. Behavioral inhibition, sustained attention and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin*, **1997**, 121, 65-94.
14. García-Molina, A.; Tirapu-Ustároz, J.; Luna-Lario, P.; Ibáñez, J.; Duque, P. Son lo mismo inteligencia y funciones ejecutivas? *Revista de Neurología*, **2010**, 50(12), 738-746.
15. Carnell, S.; Gibson, C.; Benson, L.; Ochner, C.N.; Geliebter, A. Neuroimaging and obesity: Current

knowledge and future directions. *Obesity Reviews*, **2012**, 13(1), 43-56.

16. Elias, M.F.; Elias, P.K.; Sullivan, L.M.; Wolf, P.A.; D'Agostino, R.B. Lower cognitive function in the presence of obesity and hypertension: The framingham heart study. *International Journal of Obesity*, **2003**, 27, 260-268.
17. Miller, J.; Kranzler, J.; Liu, Y.; Schmalfuss, I.; Theriaque, D.W.; Shuster, J.J.; Hatfield, A.; Mueller, O.T.; Goldstone, A.P.; Sahoo, T.; Beaudet, A.L.; Driscoll, D.J. Neurocognitive findings in prader willi syndrome and early-onset morbid obesity. *Journal of Pediatrics*, **2006**, 149(2), 192-198.
18. Gruzca, R.A.; Przybeck, T.R.; Cloninger, C.R. Prevalence and correlates of binge eating disorder in a community sample. *Comprehensive Psychiatry*, **2007**, 48(2), 124-131.
19. Lokken, K.E.; Boeka, A.G. Evidence of executive dysfunction in extremely obese adolescents: A pilot study. *Surgery for Obesity and Related Diseases*, **2009**, 5(5), 547-552.
20. Mobbs, O.; Iglesias, K.; Golay, A.; Van der Linden, M. Cognitive deficits in obese persons with and without binge eating disorder. Investigation using a mental flexibility task. *Appetite*, **2011**, 57(1), 263-271.
21. Narimani, M.; Esmaeilzadeh, S.; Pesola, A.J.; Azevedo, L.; Moradi, A.; Heidari, B.; Moghadam, M. Impact of obesity on control processing time rather than overall reaction time in young adult men. *Journal of Eating Disorders*, **2019**, 24(6), 1051-1061.
22. Rigoli, D.; Piek, J.P.; Kane, R.; Oosterlaan, J. An examination of the relationship between motor coordination and executive functions in adolescents. *Developmental Medicine and Child Neurology*, **2012**, 54 (11), 1025-1231.
23. Martín-Martínez, I.; Chirisa-Ríos, L.; Reigal-Garrido, R.; Hernández-Mendo, A.; Juárez-Ruiz-de-Mier, R.; Guisado-Barrilao, R. Efectos de la actividad física sobre las funciones ejecutivas en una muestra de adolescentes. *Anales de Psicología*, **2015**, 31, 962-971.
24. Boeka, A.G.; Lokken, K.E. Neuropsychological performance of a clinical sample of extremely obese individuals. *Archives of Clinical Neuropsychology*, **2008**, 23(4), 467-474.
25. Campoy, C.; Martín-Matillas, M.; López-Belmonte, G.; Martín-Bautista, E.; Marcos, A.; Verdejo, A.; Pérez-García, M.; Cruz-Quintana, F. Alteraciones de las funciones ejecutivas y de impulsividad en adolescentes obesos. *Revista Española de Endocrinología Pediátrica*, **2011**, 1, 87-92.
26. Duchesne, M.; Mattos, P.; Appolinario, J.C.; Freitas, S.R.; Coutinho, G.; Santos, C.; Coutinho, W. Assessment of executive functions in obese individuals with binge eating disorder. *Revista Brasileira de Psiquiatria*, **2010**, 32(4), 381-388.
27. Davis, C.; Levitan, R.D.; Muglia, P.; Bewell, C.; Kennedy, J. Decision-making deficits and overeating: A risk model for obesity. *Obesity Research*, **2004**, 12, 929-935.
28. Pignatti, R.; Bertella, L.; Albani, G.; Mauro, A.; Molinari, E.; Semenza, C. Decision-making in obesity: A study using the Gambling Task. *Eating and Weight Disorders*, **2006**, 11, 126-132.
29. Eneva, K. T.; Artl, J. M.; Yiu, A.; Murray, S. M.; Chen, E. Y. Assessment of executive functioning in binge-eating disorder independent of weight status. HHS Public Access - Author manuscript,

International Journal Eating Disorders, **2017**, 50(8), 942–951.

30. Eichen, D. M.; Matheson, B. E.; Appleton-Knapp, S. L.; Kerri N. Boutelle, K. N. Neurocognitive treatments for eating disorders and obesity. *Current Psychiatry Reports*. HHS Public Access Author manuscript, **2017**, 19(9), 62.
31. Farah, J. F. S.; Castanho, P. Dimensões psíquicas do emagrecimento: por uma compreensão psicanalítica da compulsão alimentar. *Revista Latino Americana de Psicopatologia Fundamental*, **2018**, 21(1), 41-57.
32. Dingemans, A. E.; Vanhaelen, C. B.; Aardoom, J. J.; Van Furth, E. F. The influence of depressive symptoms on executive functioning in binge eating disorder: A comparison of patients and non-obese healthy controls. *Psychiatry Research*, **2019**, 274, 138-145.
33. Mang, L.; Ridout, N.; Dritschel, B. The influence of mood and attitudes towards eating on cognitive and autobiographical memory flexibility in female university students (vol. 269). *Psychiatry Research*, **2018**, 269.
34. Solano-Pinto, N.; De-la-Peña, C.; Solbes-Canales, I.; Bernadéu-Brotóns, E. Perfiles neuropsicológicos em anorexia y bulimia nerviosa. *Revista de Neurologia / Formacion Online*, **2018**, 67, 355-364.
35. Bradley, S.J.; Taylor, M.J.; Rovet, J.F.; Goldberg, E.; Hood, J.; Wachsmuth, R.; Azcue, M.P.; Pencharz, P.B. Assessment of brain function in adolescent anorexia nervosa before and after weight gain. *Journal of Clinical and Experimental Neuropsychology*, **1997**, 19, 20-33.
36. Spinella, M.; Lyke, J. Executive personality traits and eating behavior. *Internacional Journal of Neurosciene*, **2004**, 114(1), 83-93.
37. Marcus, R.N.; Katz, J. Inpatient care of the substance-abusing patient with a concomitant eating disorder. *Hospital and Community Psychiatry*, **1990**, 41, 59-63.
38. Wilson, G.T.; Nonas, C.A.; Rosenbaum, G.D. Assessment of binge-eating in obese patients. *International Journal Eating Disorder*, **1993**, 13(1), 25-33.
39. Córdova, M. E. *Perfil nutricional e neuropsicológico das funções executivas no transtorno da compulsão alimentar periódica* [Master's thesis, Universidade Federal de Ciências da Saúde, Porto Alegre, Brasil], 2014.
40. Kollei, I.; Rustemeier, M.; Schroeder, S.; Jongen, S.; Herpertz, S.; Loeber, S. Cognitive control functions in individuals with obesity with and without binge-eating disorder. *International Journal Eating Disorders*, **2018**, 51(3), 233-240.
41. Greeno, C.G.; Marcus, M.D.; Wing, R.R. Diagnosis of binge eating disorder: Discrepancies between a questionnaire and clinical interview. *International Journal of Eating Disorders*, **1995**, 17(2), 153- 160.
42. Garner, D.M.; Olmsted, M.P.; Boher, Y.; Garfinkel, P.E. Eating attitudes test: Psychometric features and clinical correlates. *Psychology Medicine*, **1982**, 12, 871-878.
43. Nunes, M.A.; Bagatini, L.F.; Abuchaim, A.L.; Kunz, A.; Ramos, D.; Silva, J.; Somenzi, L.;

Pinheiro, A. Distúrbios da conduta alimentar: Considerações sobre o teste de atitudes alimentares (EAT). *Revista ABPAPAL*, **1994**, 16(1), 7-10.

44. Baptista, A. *A génese da perturbação de pânico* [Doctoral Dissertation, Instituto de Ciências Biomédicas Abel Salazar da Universidade do Porto, Portugal], **1994**.

45. Guerreiro, M.; Silva, A.P.; Botelho, M.A.; Leitão, O.; Castro-Caldas, A.; Garcia, C. Avaliação breve do estado mental. In A. Mendonça, C. Garcia, & M. Guerreiro (Eds.). *Escala e testes na demência* (pp. 27-32). Grupo de Estudos de Envelhecimento Cerebral e Demência, 2003.

46. Dubois, B.; Slachevsky, A.; Litvan, I.; Pillon, B. The FAB. A frontal assessment battery at bedside. *Neurology*, **2000**, 55, 1621-1626.

47. Lima, C.F.; Meireles, L.P.; Fonseca, R.; Castro, S.L.; Garrett, C. The frontal assessment battery in parkinson's disease and correlations with formal measures of executive functioning. *Journal of Neurology*, **2008**, 255, 1756-1761.

48. Trenerry, M.R.; Crosson, B.; DeBoe, J.; Leber, W.R. *Stroop Neuropsychological Screening Test manual*. PAR, 1988.

49. Spreen, O.; Strauss, E. *A compendium of neuropsychological tests: Administration, norms, and commentary*. Oxford University Press, 1998.

50. Heaton, R.K.; Chelune, G.J.; Talley, J.L.; Kay, G.; Curtiss, G. *Wisconsin card sorting test manual*. Revised and Expanded. PAR, 1993.

51. Ord, J.S.; Greve, K.W.; Bianchini, K.J.; Aguerrevere, L. Executive dysfunction in traumatic brain injury: The effects of injury severity and effort on the wisconsin card sorting test. *Journal of Clinical and Experimental Neuropsychology*, **2010**, 32, 123-140.

52. Duchesne, M.; Mattos, P.; Fontenelle, L.F.; Veiga, H.; Rizo, L.; Appolinario, J.C. Neuropsicología dos transtornos alimentares: Revisão sistemática da literatura. *Revista Brasileira de Psiquiatria*, **2004**, 26(2), 107-117.

53. Agras, W.S.; Telch, C.F.; Arnow, B.; Eldredge, K.; Marnell, M. One-year follow-up of cognitive-behavioral therapy for obese individuals with binge eating disorder. *Journal of Consulting and Clinical Psychology*, **1997**, 65(2), 343-347.

54. Eldredge, K.L.; Agras, W.S.; Arnow, B.; Telch, C.F.; Bell, S.; Castonguay, L.; Marnell, M. The effects of extending cognitive-behavioral therapy for binge eating disorder among initial treatment nonresponders. *International Journal of Eating Disorders*, **1997**, 21, 347-352.

55. Shelley-Ummenhofer, J.; MacMillan, P. Cognitive-behavioural treatment for women who binge eat. *Canadian Journal of Dietetic Practice and Research*, **2007**, 68(3), 139-142.

56. Roehrich, L.; Goldman, M.S. Experience-dependent neuropsychological recovery and the treatment of alcoholism. *Journal of Consulting and Clinical Psychology*, **1993**, 61 (5), 812-821.