



Original/*Obesidad*

# Are subjects with criteria for adult attention-deficit/hyperactivity disorder doing worse after bariatric surgery? A case-control study

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Abstract

**Introduction:** There is an increasing awareness of the strong associations between obesity and adult attention-deficit/hyperactivity disorder (ADHD), with high rates of ADHD (26-61%) in patients seeking weight loss.

**Aims:** To determine the frequency of ADHD in a bariatric surgery (BS) sample and investigate whether there were any differences among clinical, analytical and psychological parameters in individuals with criteria for ADHD.

**Methods:** Sixty patients (78.3% female, age 46.3±9.8, months since BS 46.28±18.1) who underwent BS, with a minimum follow-up of 18 months, were evaluated cross-sectionally. Initial and current BMI, eating patterns, comorbidity, socio-demographic and biochemical parameters were recorded. For the screening of ADHD, ADHD self rating scale-v1.1 was administered.

**Results:** Nineteen individuals (31.6%) had a positive screening for ADHD. This group had higher levels of HDL-cholesterol (62.8±17.3mg/dl vs 53.5±9.9mg/dl; p=0.011) and Apo-A (177.7±28.4mg/dl vs 154.9±34.7mg/dl; p=0.015), and an increased consumption of lipids (42.2±7.1% vs 36.7±8.3%; p=0.019). Subjects with ADHD symptoms had more difficulties in following visits after BS (52.6% vs 24.3%; p= 0.011). We could not find any differences in achieved BMI, depressive symptoms or quality of life.

**Conclusions:** Patients who met criteria for ADHD face significant difficulties with compliance in follow-up, but we could not find differences in major clinical outcomes. Surprisingly, these patients could have a protective lipid profile.

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Key words: *Adult ADHD. Bariatric surgery. Obesity. HDL cholesterol. Depression.*

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## ¿TIENEN PEORES RESULTADOS LOS INDIVIDUOS CON CRITERIOS PARA TRASTORNO POR DÉFICIT DE ATENCIÓN/HIPERACTIVIDAD TRAS LA CIRUGÍA BARIÁTRICA? ESTUDIO DE CASOS Y CONTROLES.

Resumen

**Introducción:** Hay una creciente concienciación de la fuerte asociación entre la obesidad y el trastorno por déficit de atención/hiperactividad del adulto (TDAH), con elevadas tasas de TDAH (26-61%) en los pacientes que consultan por pérdida ponderal.

**Objetivos:** conocer la frecuencia del TDAH en una muestra de sujetos sometidos a cirugía bariátrica (CB) e investigar si existen diferencias clínicas, analíticas y psicológicas en estos sujetos.

**Métodos:** Sesenta pacientes (78.3% mujeres, edad 46.3±9.8, meses desde la CB 46.28±18.1) sometidos a CB, con un seguimiento mínimo desde ésta de 18 meses, fueron evaluados transversalmente. Se recogieron y analizaron el IMC inicial y en el momento de la evaluación, patrones alimentarios, comorbilidades, y parámetros sociodemográficos y bioquímicos. Para el screening del TDAH se administró la versión española del "ADHD self-rating scale v 1.1".

**Resultados:** Diecinueve individuos (31.6%) tenían un screening positivo para TDAH. Estos sujetos tenían niveles superiores de HDL colesterol (62.8±17.3mg/dl vs 53.5±9.9mg/dl; p=0.011) y Apo-A (177.7±28.4mg/dl vs 154.9±34.7mg/dl; p=0.015), y un consumo mayor de lípidos en la dieta (42.2±7.1% vs 36.7±8.3%; p=0.019). Estos sujetos tenían más dificultades en seguir las visitas protocolizadas tras la CB (52.6% vs 24.3%; p= 0.011). No se evidenciaron diferencias en el IMC alcanzado, síntomas depresivos o calidad de vida.

**Conclusiones:** Los pacientes sometidos a CB con criterios para TDAH presentan más dificultades en la adherencia al seguimiento, pero no se evidenciaron diferencias en resultados clínicos relevantes. Curiosamente, estos sujetos podrían presentar un perfil lipídico protector.

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Palabras clave: *TDAH del adulto. Cirugía bariátrica. Obesidad. HDL-colesterol. Depresión.*

## Introduction

The prevalence of obesity is increasing worldwide and so are individuals who undergo bariatric surgery. In selected candidates, bariatric surgery offers positive effects on weight as well as on comorbidities related to obesity. However, the Swedish Obese Subjects study showed that 8.8% of the participants had lost less than 5% of their pre-surgery weight ten years after bypass surgery<sup>1</sup>. Nowadays, risk factors which could contribute to unsuccessful weight loss or regaining of weight after bariatric surgery are poorly defined. Psychiatric disorders, with eating disorders and depression being the most evaluated ones, were early identified as potential risk factors for failed weight loss after bariatric surgery<sup>2-6</sup>. However, there have been contradictory results regarding the impact of psychiatric illness on the outcomes of obesity surgery. It has been suggested that psychiatric disorders directly related to obesity tend to improve or even resolve after weight loss is achieved. In contrast, psychiatric comorbidities not related to weight issues usually persist after surgery<sup>7,8</sup>.

Patients with a greater number or moderate to severe intensity of psychiatric illness who have undergone bariatric surgery can face more difficulties in following recommendations and complying with prescribed drugs as well as with the follow-up visits<sup>9</sup>.

Attention-deficit hyperactivity disorder (ADHD) is a common, inherited neurological disorder, with onset in childhood that consists of signs of distractibility, impulsiveness and inattention<sup>10</sup>. Traditionally, it has been thought to be a childhood disorder, but it has been shown to persist into adulthood in up to 30 to 60 percent of the cases<sup>11</sup>. In adults, however, the core symptoms are inattention, mood lability, hot temper, disorganization, stress sensitivity, restlessness and impulsivity<sup>12</sup>. ADHD may coexist with a host of other psychiatric conditions, such as major depression, generalized anxiety and bipolar disorder<sup>13</sup>. In recent years, research has suggested that there is a link between obesity and ADHD<sup>14,15</sup>. The first two studies highlighting this association were published in 2002. Both studies found a significantly higher than expected proportion of ADHD among adults seeking treatment for obesity, with a prevalence of 27.4%, a rate six-fold greater than reported for the general population. This prevalence increased up to 42.6% among those with class III obesity<sup>16</sup>.

Although results in the literature regarding pathways through which psychiatric conditions can negatively affect the outcomes after bariatric surgery are inconsistent, it is usually mandatory to assess for the presence of eating disorders and major depressive disorder before considering such intervention. However, other psychiatric problems, such as ADHD, can be overlooked. Moreover, ADHD has also been associa-

ted with altered eating patterns such as binge eating disorder and bulimia nervosa and substance abuse<sup>13,17</sup>.

There are, at present, limited data regarding the potential negative effect of adult ADHD on post-operative compliance with recommendations and treatment and, as a result, weight loss maintenance.

## Objectives

The aim of our study is to investigate whether there are any differences among psychological, metabolic, dietary and weight variables in individuals with ADHD symptoms when compared with subjects without criteria for ADHD, in a sample of obese patients who have undergone bariatric surgery.

## Methods

### Subjects

Patients with a minimum follow-up of twelve months after undergoing bariatric surgery were consecutively invited to participate in this study and a total of sixty subjects were included. The study was approved by the ethics committee of the hospital. Written informed consent was obtained from all patients prior to study participation.

### Assessment of attention-deficit hyperactivity disorder symptomatology

Adult ADHD was assessed using standard self-report screening instruments. Participants rated current adult ADHD symptoms with the ADHD self-rating scale (ADHD-S), which includes the 18 DSM-IV items of inattention, hyperactivity and impulsivity on a four-point Likert-scale (0-3, "not at all" to "severe")<sup>18</sup>. The recommended cut-off of  $\geq 15$  was used to indicate that subjects met criteria for adult ADHD. This cut-off has a sensitivity of 77% and a specificity of 76% for adult ADHD<sup>19</sup>.

### Assessment of comorbidity and quality of life

In order to rule out other psychiatric comorbidities, two further scales were used. The patients rated the severity of depressive symptoms by using the Spanish version of the Beck Depression Inventory (BDI)<sup>20</sup>. The Spanish version of the Revised Questionnaire of Eating and Weight patterns was also self-administered to screen for binge eating disorder and other abnormal eating patterns<sup>21</sup>. In order to assess how changes after bariatric surgery had affected quality of life in these subjects, we used the SF-36 Health Survey Spanish version<sup>22</sup>.

## Assessment of dietary habits and complications after bariatric surgery

In order to determine the proportion of macronutrients as well as the energy intake, a weekly dietary survey, including one weekend, was completed by all participants. A semi-structured interview regarding food intolerances was also performed by a nutritionist. Common problems after bariatric surgery, such as constipation, irregular menses, dumping syndrome, nausea or vomiting, dizziness, hair loss, nail frailty and early fullness were also registered.

## Height and weight

Height and weight were measured while each participant was wearing indoor clothing without shoes. Body mass index (BMI) was calculated as weight divided by height squared.

## Metabolic profile

Blood samples were drawn for the following analyses: fasting glucose, glycated hemoglobin (HbA1c), total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides, apolipoproteins, ionogram, plasma creatinine, microalbuminuria, hepatic profile, albumin, 25OH vitamin D, Vitamins A, E, B1, B12, C and folic acid, serum cortisol, leptin, insulin and homocysteine. All measurements were made after an overnight fast (at least 8 hours fasting).

## Other assessments

Initial weight and BMI were obtained from computerized medical history. Comorbidities related to obesity prior to surgery, such as diabetes, hypertension, dyslipidemia, sleep apnea syndrome, hyperuricemia,

as well as other psychiatric conditions were also recorded from computerized medical history.

## Statistical Analysis

Data were analyzed using SPSS v.16 statistical software (SPSS Inc., Chicago, IL, USA). The estimated prevalence rates of adult ADHD were calculated using the suggested cut-off score of  $\geq 15$  for the ADHD-S scale. Differences between ADHD groups were compared using non parametric tests (Mann-Whitney U-tests) for continuous variables and chi-squared tests for categorical variables. A p-value  $< 0.05$  on the two-tail was considered to indicate statistical significance.

## Results

All sixty participants had undergone a laparoscopic Roux-en-Y gastric bypass. Forty-seven participants (78.3%) were female. The mean age of the patients was  $46.35 \pm 9.9$  years and the mean follow-up after bariatric surgery was  $46.48 \pm 28.21$  months. The mean pre-surgical BMI was  $48.35 \pm 7.46$  kg/m<sup>2</sup> and, at the time of the evaluation, the mean BMI had decreased to  $33.67 \pm 6.15$  kg/m<sup>2</sup>. Forty-seven out of sixty (78.3%) patients were married. In terms of employment status, 48.3% of the total sample had a stable job and the remaining 51.7% were unemployed or retired. Only five participants (8.3%) had a university degree.

Nineteen (31.6%) of the sixty subjects met criteria for ADHD. No significant differences in gender, age, mean follow-up since bariatric surgery, initial BMI, type of bariatric surgery, labor situation, marital status or educational level were found between patients who met criteria for adult ADHD and patients without this condition. These data are summarized in table I.

In addition, no differences were seen in terms of comorbidities related to obesity, such as type 2 Diabetes,

**Table I**  
*Comparison of demographic characteristics between the group with criteria for ADHD and the group without this comorbidity*

	Adult ADHD (n= 19)	No ADHD (n=41)	P value
Gender (% female)	78.9	78	NS
Age (years)	46.8 $\pm$ 8.6	46.1 $\pm$ 10.5	NS
Type of bariatric surgery (% Roux-en-Y)	94.74	78.81	NS
Months since bariatric surgery	50.95 $\pm$ 16	44.41 $\pm$ 19	NS
Presurgical BMI (kg/m <sup>2</sup> )	45.84 $\pm$ 4.39	49.51 $\pm$ 8.31	NS
Employment status (% unemployed)	68.42	53.9	NS
Marital status (% married)	68.42	82.93	NS
Educational level (% university degree)	10.53	7.32	NS

hypertension, dyslipidemia, sleep obstructive apnea or hyperuricemia.

HDL cholesterol levels were significantly greater in subjects who screened positive for ADHD (62.84±17.35mg/dl vs 53.59±9.92mg/dl; p=0.011). Furthermore, apolipoprotein A levels were also higher in this group (177.79±28.48mg/dl vs 154.94±34.77mg/dl; p=0.015). No differences in other biochemical parameters were found. Data are shown in table II.

Subjects with a positive screening for ADHD consumed a greater proportion of lipids in their diet (42.2±7.12% vs 36.76±8.34%; p=0.019) and a lesser percentage of carbohydrates (36.99±9.48% vs 44.43±9.75%; p=0.009). Moreover, the proportion of mono and polyunsaturated lipids was significantly greater in people with ADHD (66.56±13.44% vs

43.9±16.49%; p<0.001). Subjects with ADHD were more likely to consume alcoholic beverages (p=0.003). The mean time used in main meals intake was lower in the group with an abnormal ADHD test (13.89±9.99 minutes vs 20.49±11.55 minutes; p=0.036). Subjects with ADHD were also more prone to graze (63.2% vs 34.1%; p= 0.035). Data are shown in table III.

However, there were no significant differences in either terms of food intolerances or in problems directly related to bariatric surgery.

Before bariatric surgery, individuals with ADHD had a more frequent personal history of psychiatric illnesses (84.2% vs 48.8%: p= 0.009), with major depressive disorder (n=12) and anxiety (n=5) being the most prevalent. Furthermore, after bariatric surgery, there was a greater tendency to develop eating disorder

**Table II**

*Comparison of biochemical characteristics between the group with criteria for ADHD and the group without this comorbidity*

	Adult ADHD (n= 19)	No ADHD (n=41)	P value
Fasting glucose (mg/dl)	86.95±10.33	95.49±28.8	NS
HbA1c (%)	5.38±0.51	5.68±0.99	NS
Total cholesterol (mg/dl)	178.58±42.88	171.56±26.17	NS
LDL-cholesterol (mg/dl)	96.05±38.86	97.98±22.08	NS
HDL-cholesterol (mg/dl)	62.85±17.35	53.51±9.92	p=0.011
Tryglicerides (mg/dl)	97.84±31.8	104.7±52.87	NS
Apolipoprotein A (mg/dl)	177.79±28.48	154.94±34.77	P= 0.015
Apolipoprotein B (mg/dl)	85.25±26.23	90.63±23.91	NS
Lipoprotein a (mg/dl)	31.57±30.5	28.68±26.73	NS
Homocysteine (mMol/l)	13.39±3.95	14.66±5.78	NS
Ultrasensible CRP (mg/dl)	0.18±0.2	0.44±0.96	NS
Leptin (ng/ml)	38.54±20.58	41.18±24.56	NS
Albumin (g/dl)	4±0.79	4±0.32	NS

**Table III**

*Comparison of dietary habits and current BMI between the group with criteria for ADHD and the group without this comorbidity*

	Adult ADHD (n= 19)	No ADHD (n=41)	P value
% lipids in diet	42.2±7.12	36.76±8.34	p=0.019
% carbohydrates in diet	36.99±9.48	44.43±9.75	p=0.009
% mono/ polyunsaturated fat	66.56±13.44	43.9±16.49	P<0.001
Alcohol intake ≥3 times per week (% people)	36.8	17	p=0.003
Minutes used for mail meals intake	13.89±9.99	20.49±11.55	p=0.036
% individuals with grazing	63.2	34.1	p= 0.035
Current BMI (kg/m <sup>2</sup> )	32.19±7.14	34.36±5.59	p=0.205

ders in the group with ADHD (52.6% vs 21.9%;  $p=0.059$ ).

However, patients with ADHD did not have more depressive symptoms when compared with individuals without criteria for ADHD.

On the other hand, when assessing quality of life in these group of individuals with ADHD, general health was the only domain with a lower score compared with non-ADHD individuals ( $59.63\pm 24.05$  vs  $72.87\pm 21.44$ ;  $p=0.037$ ).

The only two subjects in our sample who met criteria for Night Eating Syndrome also screened positive for ADHD.

After bariatric surgery, ADHD subjects had more difficulties in following the standardized visits according to our hospital's protocol for bariatric surgery (52.6% vs 24.3%;  $p=0.011$ ). Despite this, however, there were no differences between the two groups in achieved BMI ( $32.19\pm 7.14$  kg/m<sup>2</sup> vs  $34.36\pm 5.59$  kg/m<sup>2</sup>;  $p=0.205$ ). Data are summarized in table IV.

## Discussion

The prevalence of individuals with a positive screening for ADHD in our sample of 60 obese subjects who underwent bariatric surgery was 31.6%. We found that this group of patients was significantly associated with psychiatric comorbidity, both pre- and post-surgery. Moreover, these individuals were more prone to graze, consume alcohol regularly and were less able to follow the scheduled visits established for this type of intervention. Despite this, we found no association between the presence of ADHD and clinical outcomes such as the lowest BMI achieved. On the other hand, patients with a positive screening for ADHD had higher proportion of lipids in their diet, specifically mono and polyunsaturated fats. Moreover, these sub-

jects had greater levels of HDL cholesterol and apolipoprotein A.

In our study, the proportion of individuals who screened positive for ADHD was comparable with the results of other studies that have assessed this condition in a clinical setting. These studies reported prevalence rates of adult ADHD between 27.4% and 38.2%, finding even greater rates in patients with BMI  $\geq 40$ kg/m<sup>2</sup> (42.6%)<sup>16</sup>.

In the current study, there was a strong association between adult ADHD and different disordered eating patterns, either BED or bulimia nervosa or non-specific eating disorders such as grazing or night eating syndrome. When taking into account eating disorders separately, there was a higher proportion of BED in the ADHD group (36.8% vs 14.6%;  $p<0.05$ ). General population studies have found clear associations between BED and adult ADHD, suggesting that dysregulated eating could be a potential pathway between ADHD and obesity<sup>14,17</sup>.

Since all the studies published so far which point to an association between obesity and ADHD are cross-sectional, this important factor has restricted exploring an explanation of the causality between ADHD and obesity<sup>14-16, 23, 24</sup>. It has been suggested that obesity and ADHD share biological mechanisms such as the "reward deficiency syndrome". This condition is characterized by an insufficient dopamine-related natural reward that leads to the use of "unnatural" immediate rewards such as substance use and inappropriate eating. Different studies have found dysfunctions of the dopamine receptor D2 and D4 in both obese and ADHD patients. It has therefore been suggested that food could be used as a form of self-medication in subjects with ADHD<sup>17, 25</sup>. The "reward deficiency syndrome" mentioned above could also explain the greater alcohol consumption in this population.

As depressive disorder is well known to occur more often in obese individuals and might be erroneously

**Table IV**  
*Comparison of psychological features between the group with criteria for ADHD and the group without this comorbidity*

	Adult ADHD (n= 19)	No ADHD (n=41)	P value
Presurgical psychiatric comorbidities (% subjects)	84.2	48.8	$p=0.009$
% individuals with postsurgical positive eating disorder criteria	52.6	21.9	$p=0.059$
% individuals with positive screening for depression (BDI $\geq$ 16)	26.3	24.4	NS
General health (SF-36)	$59.63\pm 24.05$	$72.87\pm 21.44$	$p=0.037$
Mental health (SF-36)	$51.58\pm 13.96$	$60.59\pm 23.61$	NS
Bodily pain (SF-36)	$64.79\pm 25.35$	$71.15\pm 23.78$	NS
Vitality (SF-36)	$60.79\pm 22.1$	$65\pm 24.44$	NS
Social Functioning (SF-36)	$76.18\pm 27.23$	$81.65\pm 25.77$	NS
% subjects with adherence to protocol	52.6	24.3	$p=0.011$

misdiagnosed as ADHD, we also screened for depression. We found no differences in the prevalence rate of depressive symptoms between the groups in our study and, therefore, the observed symptoms of ADHD could not be explained. Furthermore, we could not find differences between the groups in terms of quality of life. To our knowledge, there are no studies addressing this issue between both populations.

We also observed a greater proportion of individuals in the ADHD group who had difficulties in following the standardized program according to our hospital's protocol for bariatric surgery. Nonetheless, despite all these findings, we could not prove any differences in terms of clinical outcomes such as achieved BMI, post surgical complications or nutritional deficiencies. There are, at present, no studies assessing the potential disruptive effect of adult ADHD on post-operative compliance and weight loss maintenance among bariatric patients.

On the other hand, when we analyzed the dietary habits, we found that the group with ADHD consumed a greater proportion of lipids in their diet, particularly mono and polyunsaturated fats. In the eighties, some investigators observed signs of fatty acid deficiency in children with ADHD<sup>26</sup>; thereafter, some other studies showed lower omega-3 PUFA levels in children with ADHD compared with controls. There is evidence that this molecule is required for nerve cell myelination and is thus critical for neural transmission<sup>27</sup>. Randomized controlled trials have found controversial results that can be explained by differences in selection criteria, sample size, dosage and nature of the omega-3 PUFA supplement as well as duration of this supplementation<sup>28-30</sup>. As far as we know, there are no studies assessing the effects of omega-3 PUFA supplementation in adults with ADHD. This eating pattern could respond to an unconscious way to supply a deficit of a molecule, as a natural self-medication. Consecutively, the greater consumption of mono and polyunsaturated fats and, probably, the higher proportion of alcohol intake, could be a reasonable explanation for the higher levels of HDL-cholesterol in this group of patients. However, more studies are needed before establishing conclusions regarding this theory.

This is the first study assessing post-bariatric surgery outcomes on patients with a positive screening for ADHD after a bariatric surgery. However, there are limitations to acknowledge. The cross-sectional nature of our data precludes causal conclusions; however, temporal precedence of ADHD over obesity is likely. We did not assess retrospectively a positive childhood diagnosis, although we assume it to be a disease of childhood onset which persists into adulthood. Another limitation is the use of self-report instruments which have a sensitivity and specificity of 75-88%, resulting in the possibility of identifying false-negative and false-positive cases. However, the assessment

methods used in this study have been validated extensively and have been used in other clinical and community-based samples.

The comorbidity between severe obesity and adult ADHD, alone or in combination with another psychiatric disorder, might have important clinical implications. As there is sufficient evidence for impaired weight loss of individuals with adult ADHD in non-surgical weight loss treatments, the assessment of adult ADHD in subjects presenting for bariatric surgery should be taken into account. The dietary regime after this type of surgery requires major changes in lifestyle and eating patterns to ensure proper weight loss and minimize the risk of nutritional deficiencies. Patients with adult ADHD may find difficulties in following severe dietary regimens, behavioral recommendations, medical treatment or programmed medical visits. Although it is mandatory to assess and help patients with psychiatric problems before surgery, it may be even more important to plan for prolonged follow-up and support after surgery, in order to improve clinical and psychological aspects. In this way, in order to offer successfully a proper and individualized follow-up after the intervention, we believe that adult ADHD should be ruled out before bariatric surgery as a part of the psychological evaluation.

In conclusion, this study showed that the prevalence of adult ADHD in a bariatric surgery sample is considerable enough to take into account its screening before surgery. A substantial number of patients with adult ADHD present with abnormal eating patterns as well as difficulties in following scheduled clinical visits; however, we could not find any differences in post-surgery clinical outcomes among patients with or without ADHD. On the other hand, we demonstrated higher levels of HDL cholesterol that could be related to the greater amount of mono and polyunsaturated lipids in the diet of patients with ADHD. More research regarding the effect of adult ADHD after bariatric surgery and the role of omega-3 PUFA on this type of psychiatric disorder is warranted.

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#### Conflict of interest

Joana Nicolau declares no conflict of interest.  
Luisa Ayala declares no conflict of interest.  
Carla Frances declares no conflict of interest.  
Salvador Pascual declares no conflict of interest.  
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