Obesity Surgery
https://doi.org/10.1007/s11695-024-07211-7

ORIGINAL CONTRIBUTIONS

Bariatric Surgery Is Highly Effective and Underutilized in Patients with ADHD: A 5-Year Retrospective Cohort Study

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Received: 6 August 2023 / Revised: 23 March 2024 / Accepted: 28 March 2024

Abstract

Introduction Obesity and ADHD have become increasingly common diagnoses. In the last decade, research has found that there is a high prevalence of obesity in patients with ADHD. The mainstays of management in the general population include lifestyle modifications, pharmacotherapies, and/or bariatric surgery. However, there is a lack of understanding of appropriate management of patients with both ADHD and obesity.

Methods We identified those with obesity for at least five consecutive years (BMI > 30) in the TriNetX database before separating into two groups based on the presence or absence of ADHD. We assessed both the distribution of treatment modalities and the change in average BMI over time in each of our four groups across 5 years.

Results Average BMI decreased over time in all groups, with the smallest change seen in the ADHD Pharmacology cohort (− 0.366 kg/m^2) and the largest in the ADHD Surgery group (− 8.532 kg/m^2). Average BMIs at the 5-year mark were significantly different.

Conclusion Our research found that pharmacological management of individuals with ADHD was only half as effective for individuals with ADHD than our control. Though surgical management of patients with ADHD is roughly 20 times more effective in managing obesity, it was not used as frequently in comparison to medication for management of weight.

Keywords Bariatrics · Surgery · ADHD

Kaitlyn Dickinson, Pritika Parmar, Amy Beth Reyes and Elijah W. Hale have contributed equally to this work.

Key Points

- Obesity and ADHD have become increasingly prevalent in the last few decades.
- Pharmacotherapies for obesity are only half as effective for individuals with ADHD than for individuals without ADHD in helping them lose weight.
- Patients with both ADHD and obesity who underwent surgery lost over 20 times more weight compared to the ADHD Pharmacology group; however, surgery is used only a ninth as often as medication.

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Introduction

Obesity has been one of the most common diagnoses in the past few decades, with nearly two in five Americans having an elevated body mass index (BMI) [1]. BMI was established in 1916, as a metric to assess body fat and disease risk and defines obesity as a BMI ≥ 30 kg/m^2 [2]. However, this measurement has its limitations, as it cannot accurately distinguish between excess fat, muscle, or bone mass [3]. While not the perfect method, it still serves as an important tool for screening individuals and can be useful in combination with a patient's clinical picture. Managing obesity is correlated with reductions in the severity of other comorbidities including diabetes, hyperlipidemia, high blood pressure, and other various metabolic disorders [4]. The mainstay of treatment for patients with obesity is lifestyle management comprising of diet changes and exercise. Beyond this, with collaborative decision making between patients and their healthcare team, other therapies such as pharmacotherapies or surgical management can also be considered.

Published online: 15 April 2024

Bariatric surgery and metabolic surgery involves procedures that alter the digestive system to promote weight loss. Eligibility for this type of surgery is based on BMI and the presence of comorbid conditions [5, 6]. Patients are typically considered candidates for bariatric surgery if they have a BMI > 40, 35-40 with high-risk comorbid conditions such as hypertension or hyperlipidemia, or 30–34 with uncontrolled diabetes [5, 6]. Once a patient is identified as a potential candidate, shared decision-making occurs between the surgeon and the patient to select the appropriate surgical technique, with options including gastric sleeves, bypasses, or duodenal switches. Although reports in the last few decades have shown favorable outcomes with significant weight loss, it involves operative risks [7–9]. Postoperative patients face not only the typical procedural risks, such as infection or wound evisceration, but also gastric motility issues and nutritional deficiencies [10–12].

Interestingly, a recent article suggested a positive correlation between patients diagnosed with attention-deficit hyperactivity disorder (ADHD) and higher BMI [13]. Compared to the general population, there is a 70% increase in the prevalence of obesity in adults with ADHD. Various mechanisms for this association have been proposed, including some research suggesting that the symptoms associated with ADHD, including difficulties following schedules and erratic sleeping habits, may contribute to the higher prevalence of obesity in this population compared to neurotypical counterparts [13–16].

Despite ADHD being first reported back in the late eighteenth century, nearly 87% of the literature has only been published in the last two decades [17]. The increasing prevalence of ADHD in adolescent psychiatry raises an important question about how patients with comorbid diagnoses of ADHD and obesity should be managed. Typically, lifestyle modification and pharmacologic treatment are the first steps before considering surgical management. However, stimulant medications used to treat ADHD have been shown to suppress appetite and promote weight loss, suggesting that these medications could potentially be used as a weight loss intervention [18]. Despite meticulous protocols to keep patients healthy following bariatric surgery, patients with ADHD still experience significantly greater postoperative complications than the general population [19, 20]. To date, there has been little research investigating the prevalence and outcomes of treatment plans in patients with ADHD and metabolic disorders. Therefore, this study will focus on elucidating the most effective management plan for these patients, including considerations of bariatric surgery versus pharmacological treatment.

Methods

Our study utilized aggregate data from the TriNetX database, which contains electronic medical records from large healthcare organizations and is compliant with privacy and security regulations [21]. TriNetX has shown utility in previous studies focused on the intersection between surgery and ADHD [22]. Using the patients' BMIs, we identified those with obesity (BMI > 30) in the TriNetX database and selected those with at least 5 consecutive years of data after their BMI was recorded as ≥ 30. Patients were excluded if they did not have at least 1 BMI recorded per year across the 5 years. We then separated these patients into two groups based on presence or absence of ADHD (ICD-10: F90).

We performed an initial analysis on these two groups to examine the unadjusted rates of bariatric surgery and anti-obesity medications (AOMs). Then, to eliminate confounding, we matched individuals in the ADHD cohort to peers in the No ADHD cohort based on age, sex, race, ethnicity, and BMI using nearest-neighbor matching to a difference between propensity scores < 0.1 [17]. The identified characteristics utilized in nearest-neighbor matching, as well as pre- and post- matching *t*-test values for these characteristics, are presented in Supplementary Table S1. The outcome of this methodology was that each patient within the "ADHD Pharmacology" group had a peer in the "No ADHD Pharmacology" cohort who had no significant difference based on age, sex, race, or ethnicity. We then examined prevalence of different medications within each group and calculated odds ratios based on the respective medication prevalence. Results of this analysis are presented in Table 1 and Fig. 1a and b.

Each of the two groups identified based on the presence or absence of ADHD was further divided into two subgroups based on the therapies used. The first set of groups, referred to as "ADHD Pharmacology" and "No ADHD Pharmacology," included patients who received pharmacological therapies for weight loss (including orlistat, benzphetamine, phendimetrazine, diethylpropion, phenmetrazine, semaglutide, liraglutide, phentermine and topiramate, naltrexone, and bupropion). The second set of groups, referred to as "ADHD Surgery" and "No ADHD Surgery," included patients who underwent surgical procedures endorsed by the American Society of Metabolic and Bariatric Surgery (ASMBS) including adjustable gastric banding, sleeve gastrectomy, Roux-en-Y gastric bypass, BPD/duodenal switch, single anastomosis duodeno-ileostomy with sleeve, bariatric re-operative procedures, one anastomosis gastric bypass) [23]. Endoscopic surgeries were excluded. Patients in the Pharmacology groups could not undergo surgery during the study period. We then conducted an overtime on these groups.

Table 1 Rates and odds ratios for different treatment modalities, unmatched and matched

	Group	Total *N*	Outcome *N*	Risk	Odds ratio (95% CI)
Unmatched	*Pharmacotherapy*				
	ADHD	53,740	15,483	28.81%	1.651507155
	Not ADHD	943,189	185,641	19.68%	(1.62, 1.684)
	Surgery				
	ADHD	53,740	1616	3.01%	1.499814819
	Not ADHD	943,189	19,102	2.03%	(1.424, 1.579)
	Orlistat				
	ADHD	53,740	444	0.83%	2.295935652
	Not ADHD	943,189	3410	0.36%	(2.079, 2.536)
	Phentermine-topiramate				
	ADHD	53,740	8626	16.05%	1.902946303
	Not ADHD	943,189	86,117	9.13%	(1.858, 1.949)
	Naltrexone-bupropion				
	ADHD	53,740	2763	5.14%	2.31913734
	Not ADHD	943,189	21,540	2.28%	(2.227, 2.415)
	GLP-1 agonists				
	ADHD	53,740	5476	10.19%	1.220442052
	Not ADHD	943,189	80,226	8.51%	(1.186, 1.256)
	Short-term stimulants				
	ADHD	53,740	4127	7.68%	1.368802567
	Not ADHD	943,189	54,035	5.73%	(1.324, 1.415)
Matched	*Pharmacotherapy*				
	ADHD	53,711	15,479	28.82%	1.735272126
	Not ADHD	53,711	10,161	18.92%	(1.686, 1.786)
	Surgery				
	ADHD	53,711	1616	3.01%	1.575661259
	Not ADHD	53,711	1037	1.93%	(1.456, 1.705)
	Orlistat				
	ADHD	53,711	444	0.83%	1.92976378
	Not ADHD	53,711	231	0.43%	(1.645, 2.263)
	Phentermine-topiramate				
	ADHD	53,711	8623	16.05%	1.787968239
	Not ADHD	53,711	5190	9.66%	(1.723, 1.855)
	Naltrexone-bupropion				
	ADHD	53,711	2762	5.14%	2.160033022
	Not ADHD	53,711	1315	2.45%	(2.02, 2.309)
	GLP-1 agonists				
	ADHD	53,711	5476	10.20%	1.555696872
	Not ADHD	53,711	3653	6.80%	(1.489, 1.625)
	Short-term stimulants				
	ADHD	53,711	4127	7.68%	1.366346139
	Not ADHD	53,711	3084	5.74%	(1.302, 1.434)

Our time analysis examined the change in average BMI over time in each of our four groups, beginning at the first date they met the criteria for their respective cohort and at 1-year intervals for the next 5 years. Change in average BMI at each year was calculated as the difference between the values at that year and the initial value. Intergroup comparison of average BMI was completed using a *t*-test. The results of this analysis are compiled in Table 1 and presented graphically in Fig. 2. Significance level for the study was set at $p < 0.05$. The study was designated as non-human research not requiring approval by the Colorado Multiple Institutional Review Board (COMIRB).

Results

Data were extracted from the TriNetX database on February 1st, 2024. We identified 53,740 individuals with both ADHD and a BMI > 30 kg/m^2 and 943,189 individuals without ADHD and a BMI > 30 kg/m^2. In our unmatched analysis, we found 28.8% of individuals with ADHD received pharmacotherapy for weight loss and 3.01% received bariatric surgery, compared to 19.68% and 2.03%, respectively, for individuals without ADHD. Orlistat was the least commonly used AOM, used in 0.83% of ADHD cases and 0.36% of Not ADHD cases. Phentermine-topiramate was the most commonly used AOM, used in 16.05% of ADHD cases and 9.13% of Not ADHD cases. In our matched analysis, we created 53,711 matched pairs with no significant differences in age, sex, race, ethnicity, or BMI. Each pair had one patient with ADHD and the other without. Compared to matched peers, patients with ADHD were more likely to receive all treatments, including pharmacotherapy (OR, 1.73) and surgery (OR, 1.57). Further details from this analysis are presented in Table 1 and Fig. 1a and b.

In our analysis over time, we identified 41,685 patients who had at least 5 years of AOM use without receiving bariatric surgery, with 2977 having ADHD and 38,708 not. We also identified 15,069 patients who had bariatric surgery at least 5 years ago and at least 1 weight per year for 5 years, 1152 with ADHD and 13,917 without. Initial average BMIs were significantly different between all groups and ranged from 36.2 kg/m^2 in the ADHD Pharmacology cohort to 42.4 kg/m^2 in the ADHD Surgery group. Average BMI decreased over time in all groups, with the smallest change seen in the ADHD Pharmacology cohort (−0.366 kg/m^2) and the largest in the ADHD Surgery group (−8.532 kg/m^2). Average BMIs at the 5-year mark were significantly different between the surgical and pharmacological cohorts ($p < 0.001$). The final average BMI was lowest in the ADHD Surgery group (33.87 +/− 7.1 kg/m^2), and the highest average BMI was the No ADHD Pharmacology group (36.49 +/− 6.4 kg/m^2). Complete results are shown in Table 2 and Fig. 2.

Discussion

Our study is the first longitudinal analysis comparing individuals with ADHD to neurotypical individuals along two obesity treatment methods. While both therapies were proportionally more common in the ADHD groups, pharmacology was utilized over 9 times more often than surgery for individuals with ADHD. Interestingly, the long-term efficacy of pharmacology was lower in the ADHD group. The ADHD Pharmacology cohort had the highest average BMI at the end of the study.

Pharmacologic treatment of obesity shares several similarities with ADHD treatment, including the use of some of the same medications. The most effective medications for ADHD, such as dextroamphetamine, work by stimulating the central nervous system (CNS) to reduce symptoms. Likewise, many obesity medications also work by stimulating the CNS to reduce appetite [24]. For example, bupropion, a norepinephrine-dopamine reuptake inhibitor (NDRI), has been shown to be effective not only for weight loss but also to have utility in treating ADHD on its own [25, 26]. One possible explanation for the differences in frequency of pharmacological therapies utilized between our cohort of patients with ADHD and patients without ADHD is that the use of stimulants and bupropion in ADHD treatment may lead providers to select similar medications to treat comorbid obesity. For example, if a patient with ADHD were already taking bupropion, adding naltrexone to enhance the weight loss effect could be a relatively straightforward change.

Though many of the medications are similar, our data suggests that the pharmacotherapies for obesity are nearly half as effective for individuals with ADHD than for individuals without ADHD as seen in Table 2. In practice, these medications are often paired with other strategies including exercise, healthy eating habits, and routine follow-up with a medical provider. However, these strategies have been shown to be more difficult for patients with ADHD in comparison to their neurotypical peers [27, 28]. Additionally, medication adherence itself can be a challenge for individuals with ADHD; the very symptoms of the disorder, such as forgetfulness, impulsivity, and disorganization, make it difficult to remember to take medications as prescribed [29]. Inconsistency in administration could greatly reduce the efficacy of weight loss medications. Despite these known challenges, our data found patients with ADHD were nearly twice as likely to be prescribed weight loss medications than their matched peers. Though the reasoning behind this trend is unknown, it may be due to a hesitancy to refer patients with ADHD because of the higher postoperative risks [12]. As our group recently found, patients with ADHD were at higher risk to face operative complications such as malignant hyperthermia or postoperative infections [20].

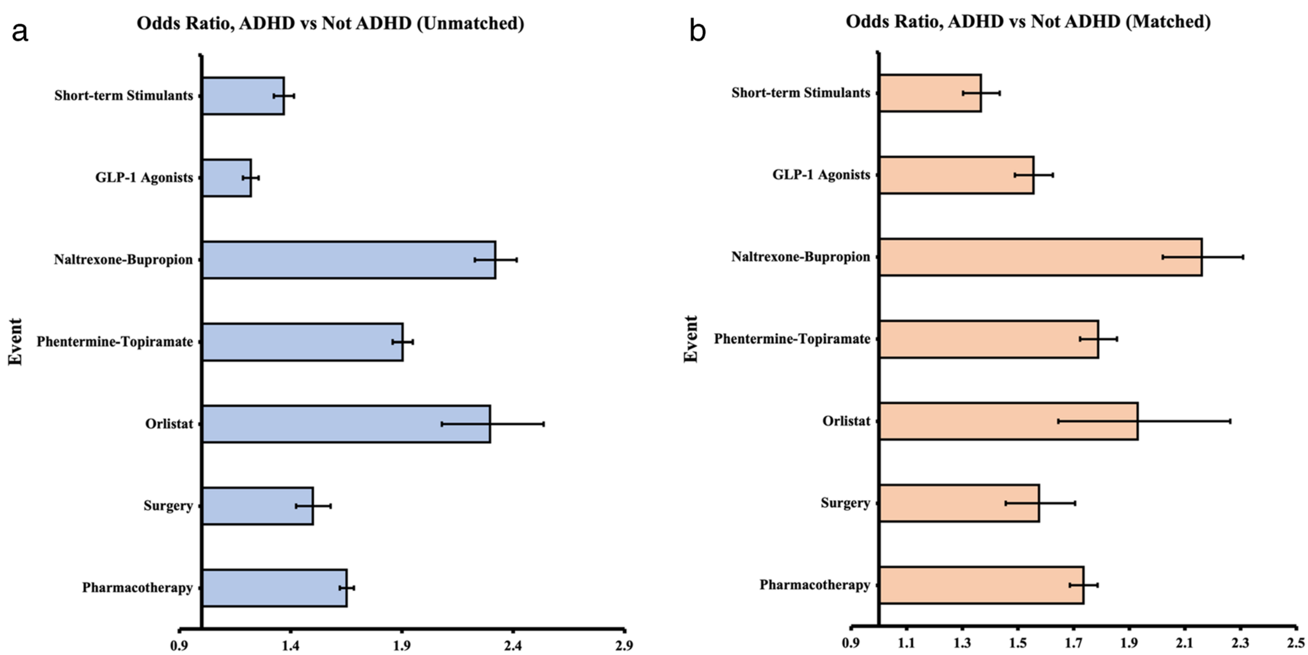

Fig. 1 Odds ratio for different treatment modalities: **a** unmatched **b** matched

While pharmacologic treatment for ADHD is shown to be highly effective, pharmacological treatment for obesity is less consistently effective for long-term weight loss when compared to bariatric surgery [30, 31]. Patients with ADHD managed by pharmacotherapy had the second highest average BMI at the end of the study, while the ADHD Surgery group had the lowest average BMI, with a loss of 8.5 kg/m^2. This is consistent with studies of neurotypical individuals, where bariatric surgery has been shown to be more effective than medications in achieving sustained weight loss and improvement in comorbidities, and ultimately reduces healthcare costs [32]. In our data, the decrease in average BMI was roughly ten times greater for the No ADHD Surgery group compared to the No ADHD Pharmacology group as reflected in Table 1. In comparison, the ADHD Surgery group lost over 20 times more weight compared to the ADHD Pharmacology group. Furthermore, our results suggest that individuals with ADHD may experience up to 20% greater weight loss with surgery than neurotypical patients. However, our study found that medications are used nearly nine times more frequently than that of bariatric surgery in the ADHD groups.

Bariatric surgery is an underutilized treatment option as seen by the high proportion of eligible patients who don't undergo surgery [9, 12, 33]. This is also high in patients with ADHD, with only 3.01% of patients receiving bariatric surgery. It is difficult to know whether this low percentage of population is due to lack of referral or lack of interest by patients; however, our findings support increasing utilization

Fig. 2 Change in average BMI between ADHD and No ADHD patient groups receiving surgical versus pharmacological management

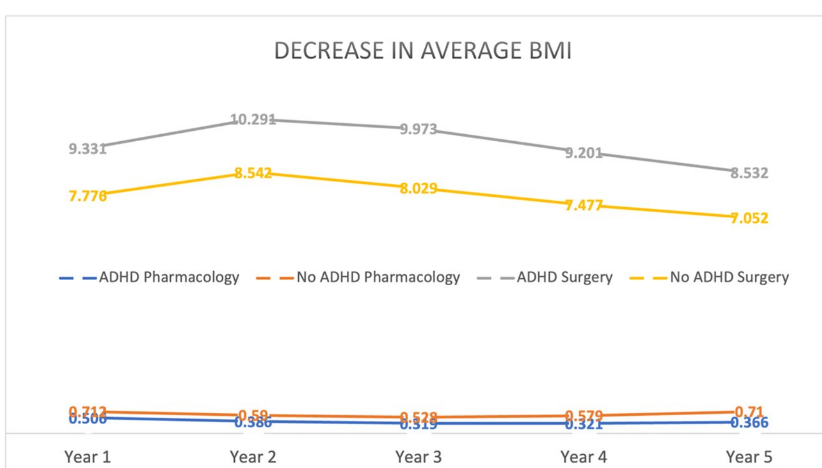

Table 2 Comparison of BMI in ADHD and No ADHD patient groups treated medically versus surgery

Group		ADHD Pharmacology	No ADHD Pharmacology	ADHD Surgery	No ADHD Surgery
Start	N	2977	38708	1152	13917
	Avg BMI	36.2 +/− 6.4	37.2 +/− 6.1	42.4 +/− 5.6	41.9 +/− 6
	p value	< 0.001		< 0.001	
Year 1	Avg BMI	35.69 +/− 6.2	36.49 +/− 6	33.07 +/− 6.2	34.12 +/− 6.4
	Change	− 0.506	− 0.712	− 9.331	− 7.776
	p value	< 0.001		< 0.001	
Year 2	Avg BMI	35.81 +/− 6.4	36.61 +/− 6.2	32.11 +/− 6.6	33.36 +/− 6.7
	Change	− 0.386	− 0.59	− 10.291	− 8.542
	p value	< 0.001		< 0.001	
Year 3	Avg BMI	35.88 +/− 6.6	36.67 +/− 6.3	32.43 +/− 6.8	33.87 +/− 6.8
	Change	− 0.319	− 0.528	− 9.973	− 8.029
	p value	< 0.001		< 0.001	
Year 4	Avg BMI	35.88 +/− 6.6	36.62 +/− 6.3	33.2 +/− 7.1	34.42 +/− 6.9
	Change	− 0.321	− 0.579	− 9.201	− 7.477
	p value	< 0.001		< 0.001	
Year 5	Avg BMI	35.83 +/− 6.8	36.49 +/− 6.4	33.87 +/− 7.1	34.85 +/− 7
	Change	− 0.366	− 0.71	− 8.532	− 7.052
	p value	< 0.001		< 0.001	

of this important therapy, particularly within the ADHD patient population. Further research will be needed to investigate what barriers may exist to result in such low utilization.

Although our methodology controlled for common confounders such as age, sex, race, and BMI through matching, the study does have certain limitations, largely stemming from the de-identification of data in the database. The data from TriNetX database however limits the confidence in quality of the study as the database has not been formally validated. Without identifying information, we were unable to analyze individual changes in BMI, verify the administration of medications, differentiate provider types, and examine potential confounders such as ADHD symptomatology or social determinants such as socio-economic status and their relationship to bariatric surgery. The study also lacks the specifics of the surgical methods utilized in in each of the cases limiting the generalizability to current surgical practices. Furthermore, while a retrospective cohort study is an effective means of investigating treatment effects, we cannot definitively establish causality due to the aforementioned limitations.

Both ADHD and obesity are increasingly prevalent in the United States, and the coexistence of ADHD and obesity presents numerous challenges for affected individuals [22, 34–36]. For instance, those with ADHD may struggle with impulse control, leading to overeating and weight gain [37–40]. Conversely, obesity can exacerbate ADHD symptoms, such as reduced energy levels, decreased motivation, and heightened stress levels [41]. A patient with both comorbidities can face a heightened challenge to manage both comorbidities with medication alone. To tackle the issue of overlapping ADHD and obesity, healthcare providers must take a multi-disciplinary approach. Though, in current clinical practice, this includes a combination of medication, therapy, diet, and exercise, our study highlights the underutilization of bariatric surgery in this population. With careful consideration of all available treatments, an increase in the utilization of bariatric surgery could lead to sustained weight loss and improved quality of life for individuals with ADHD and obesity.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11695-024-07211-7.

Data Availability The original data presented in the study are included in the article, further inquiries can be directed to the corresponding author. The data that support the findings of this study are available from TriNetX. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from https://trinetx.com/with the permission of TriNetX.

Declarations

Ethics Approval and Consent to Participate This article does not contain any studies with human participants or animals performed by any of the authors. For this type of study, formal consent is not required.

Conflict of Interest The authors declare no competing interests.

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