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Mild Cognitive Impairment is Prevalent in Persons with Severe Obesity

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Abstract

Objective: The current study examines the prevalence of mild cognitive impairment (MCI) in a sample of adults with severe obesity and whether undergoing bariatric surgery reduces the frequency of MCI.

Methods: A total of 171 participants with severe obesity (mean age = 43.07 ± 11.21) completed computerized cognitive testing. A subset of participants underwent bariatric surgery as part of the Longitudinal Assessment of Bariatric Surgery (LABS) project. Mild cognitive impairment (MCI) was operationalized using commonly-used criteria to establish prevalence in the overall sample and to examine possible changes after bariatric surgery.

Results: More than half of the overall sample met criteria for MCI at baseline (53.8%) and MCI was prevalent even in young and middle-aged adults with severe obesity. Within the subset of participants that underwent bariatric surgery, the prevalence of MCI was reduced by 48.9% at 12-month follow-up (from 53.4% to 27.3%).

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Conclusions—Findings suggest that many individuals with severe obesity meet criteria for MCI and that prevalence rates decline after bariatric surgery. A better understanding of the mechanisms linking severe obesity to adverse neurological outcomes is much needed.

Keywords

obesity; cognitive function; prevalence; bariatric surgery

Introduction

More than one-third of adults meet criteria for obesity (BMI>30) and approximately 12% of men and 17% of women have severe obesity (BMI≥35) (1). In addition to risk for multimorbidity (2), research shows that obesity is a risk factor for poor neurocognitive outcomes, including Alzheimer's disease (AD) and other forms of dementia (3-5). Recent work shows severe obesity is also associated with elevated risk for cognitive dysfunction and this risk appears to increase with age (6-8). Despite these findings, no study has examined the prevalence of mild cognitive impairment (MCI) in persons with severe obesity. The present study did so in adults ranging from 16-68 and examined possible changes after bariatric surgery.

Materials and Methods

Participants

Cognitive test performance for 120 surgery candidates and 51 demographically-and medically-similar control participants was extracted from a multi-site National Institutes of Health (NIH) study examining the effects of bariatric surgery on neurocognitive function. Surgical participants were part of the Longitudinal Assessment of Bariatric Surgery (LABS) project. All participants were required to be 18-70 years of age and English-speaking and excluded for a history of a neurological disorder or injury (e.g., dementia, stroke), past/current history of severe psychiatric illness (e.g., schizophrenia), past/current history of alcohol or drug abuse, history of learning disorder or developmental disability, or impaired sensory function. The present study consisted of all participants with complete cognitive data, subjective report of cognitive function, and intact activities of daily living.

The mean age of the combined surgery and control samples (N = 171) was 43.07 ± 11.21, 80.7% female and mean BMI of 44.91 ± 6.70. A total of 88 of the 120 bariatric surgery candidates from baseline had complete follow-up data. Surgery patients with complete data at follow-up were similar to those without, having a mean age of 44.11 ± 10.28, mean BMI of 46.91 ± 6.51, and 81.8% female. These two groups also did not differ on hypertension [$\chi^2(1) = .85$, $p = .36$], sleep apnea [$\chi^2(1) = 1.99$, $p = .16$], or diabetes [$\chi^2(1) = .93$, $p = .34$].

Measures

Neurocognitive Function—The Integneuro computerized neurocognitive battery has been previously described (9) and used in past studies of persons undergoing bariatric surgery. Performance in several cognitive domains was quantified, namely: *Memory*: verbal list learning, verbal list short-delay and long-delay recalls, verbal list recognition; *Attention*:

digit span forward, digit span backward, sustained attention, switching of attention-digits, verbal interference-word; *Language*: letter fluency, animal fluency; *Executive Function*: switching of attention-mixed, verbal interference-color, maze errors, and maze overrun errors.

Criteria for MCI—To promote generalizability to other samples, we utilized the operational definition for objective cognitive impairment in MCI established by Jak and colleagues: ≥ 1 SD below the normative mean on two or more tasks within the same cognitive domain (10). This approach has been used to characterize the severity of cognitive impairment in other samples, including past work in the Alzheimer's Disease Neuroimaging Initiative (ADNI) project (11).

Procedures

Study procedures were approved by the appropriate human subjects protection boards and all participants provided written informed consent prior to study activities. Bariatric surgery patients completed the computerized cognitive battery and questionnaires within 30 days prior to surgery and 12 months post-operatively. Control participants completed the same procedures during a research visit.

Data Analysis

To facilitate interpretation, all raw scores of the neurocognitive measures were converted to *z* scores using existing normative data from the Brain Resource International Database on the basis of age, gender, and estimated IQ. Analyses established the prevalence of MCI and examined possible changes after bariatric surgery. Demographic and medical characteristics were compared using t-tests and chi-squares.

Results

MCI at Baseline in Adults with Severe Obesity

At baseline, 92 of 171 (53.8%) total participants met diagnostic criteria for MCI. Rates ilar across the adult lifespan [$\chi^2(3) = 1.45$, p = .69] (Table 1).

Predictors of MCI in Adults with Severe Obesity

Participants with MCI had a lower BMI (M=43.79 ± 6.15) compared to those without MCI (M=46.20 ± 7.10) [t(169) = 2.38, p = .02] but did not differ on age [t(169) = 1.03, p = .30], sex [$\chi^2(2) = 1.59$, p = .21], or the presence of hypertension [$\chi^2(1) = .85$, p = .36], sleep apnea .[$\chi^2(1) = .00$, p = .99], or diabetes [$\chi^2(1) = .13$, p = .72].

Change in MCI from Baseline to 12 Months Post-Surgery

Of the 88 surgery patients with complete data at baseline and 12 months post-operative follow-up, 47 (53.4%) met criteria for MCI at baseline. Rates of MCI were similar at baseline across age bands [$\chi^2(3) = 1.06$, p = .79].

At 12-month post-operative follow-up, just 24 individuals met criteria for MCI (27.3 %), reflecting a 48.9% decrease from baseline [$\chi^2(1) = 11.03$, p = .001]. Rates of MCI were again similar across ages at 12 months post-surgery [$\chi^2(3) = .39$, p = .94] (Table 2).

Medical Predictors of MCI change from Pre- to Post-Bariatric Surgery

When comparing the subset of bariatric surgery patients that had stable MCI (i.e. both at baseline and 12 months; N = 24) to those that no longer met criteria at 12 months (N = 64), no differences in resolution rates were found for hypertension [$\chi^2(1) = 2.54$, p = .11], sleep apnea[$\chi^2(1) = 0.02$, p = 0.90], or type 2 diabetes [$\chi^2(1) = 0.51$, p = .47]. The groups also did not differ in age [t(45) = .43, p = .67], BMI at baseline [t(45) = −.75, p = .46], or BMI change from baseline to 12 months [t(31) = −.08, p = .94].

Discussion

The current study shows that MCI was present in a sample of adults with severe obesity and at a rate much higher than the general population (e.g. 54% vs. 6% in persons 51-59 years of age; 12). This finding emerged using established MCI criteria and is consistent with the growing evidence for an association between obesity and adverse neurological outcomes, including stroke, AD, and other forms of dementia (3-5,13). However, given the relatively young age in the current sample and post-operative reduction in MCI prevalence, the extent to which meeting diagnostic criteria for MCI in this population specifically reflects a prodromal stage of AD or other neurological condition is unclear. Prospective studies with extended long-term follow-ups are much needed to elucidate the long-term cognitive benefits of bariatric surgery.

Although persons with severe obesity with and without MCI were generally similar in demographic and medical characteristics, participants with MCI had a lower BMI at baseline. This finding requires clarification, as past work suggests higher BMI is typically associated with greater impairment (14-15). However, the difference in BMI was small in the current study between these groups (43.79 ± 6.15 vs. 46.20 ± 7.10) and the extent of its clinical meaningfulness is unclear.

Notably, the prevalence of MCI declined sharply after bariatric surgery and resolution of common comorbidities was not associated with these cognitive improvements. Although there is a growing body of research showing that obesity is associated with poor neurocognitive outcomes, the mechanisms underlying this relationship and the cognitive improvements exhibited after bariatric surgery are unclear. More sophisticated assessments of known risk factors for poor cognitive outcomes (e.g. ambulatory beat-to-beat blood pressure, oral glucose tolerance testing) would provide a better understanding of their contribution. Future studies are also needed to clarify the role of other likely contributors, including metabolic and hormonal dysregulation, systemic and central inflammation, and disruption of the blood-brain barrier (5,16,17,18).

The current findings are limited in several ways. First, medical characteristics were obtained using self-report and chart review and direct assessment of these possible contributors will help to clarify outcomes. Similarly, very few studies have utilized advanced neuroimaging in persons with severe obesity and examination of amyloid uptake and patterns of cerebral perfusion may provide key insight into the high rates of cognitive impairment found in this sample. Finally, though we found a lower prevalence of MCI at 12-month follow-up than baseline and cognitive improvements are known to last at least 2 years post-bariatric surgery (19), studies with extended follow-up visits (e.g. 10+ years) are needed to clarify whether these cognitive benefits persist into older adulthood.

In summary, the current findings demonstrate that a majority of adults with severe obesity meet criteria for MCI and that this prevalence is reduced following bariatric surgery. More work is needed to elucidate the mechanisms for cognitive impairment in this population and the extent to which weight loss may delay or even prevent development of conditions like AD.

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Study Importance

- Obesity is associated with elevated risk for accelerated cognitive decline and Alzheimer's disease.
- The current findings show a majority of adults with severe obesity meet diagnostic criteria for mild cognitive impairment (MCI), even young and middle-aged individuals.
- The prevalence of MCI declines after bariatric surgery.

Table 1.

Prevalence of Mild Cognitive Impairment in Severely Obese Individuals

Baseline: Surgery Candidates and Controls Combined					
Age (years)	**Total n**	**# w/ MCI**	**% w/ MCI**	χ^2	**p**
18-29	21	11	52.4%		
30-39	46	28	60.9%		
40-49	47	25	53.2%		
50+	57	28	49.1%		
Total	171	92	53.8%	1.45	0.69[a]

MCI = mild cognitive impairment

[a]Prevalence of MCI was not significantly different across age bands.

Table 2.

Prevalence of Mild Cognitive Impairment Pre- and Post-Bariatric Surgery

		Baseline				12 months			
Age (years)	**Total n**	**# w/ MCI**	**# w/ MCI**	χ^2	**p**	**# w/ MCI**	**% w/ MCI**	χ^2	**p**
18-29	6	2	33.3%			1	16.7%		
30-39	25	14	56.0%			7	28.0%		
40-49	24	13	54.2%			7	28.0%		
50+	33	18	54.6%			9	27.3%		
Total	88	47	53.4%	1.06	.79[a]	24[b]	27.3%	.39	.94[a]

MCI = mild cognitive impairment

[a]Prevalence of MCI was not significantly different across age bands at either baseline or 12 month follow-up.

[b]Rates of MCI declined significantly from pre- to post-bariatric surgery [$\chi^2(1) = 11.03$, $p = .001$].