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Neuropsychological Functioning in Older Adults with Obesity: Implications for Bariatric Surgery

Robert M. Roth, PhD[1,2], **Sivan Rotenberg, PhD**[1,2], **Jeremy Carmasin, PhD**[3], **Sarah Billmeier, MD, MPH**[2,4], **John A. Batsis, MD**[2,5,6]

[1]Department of Psychiatry, Geisel School of Medicine at Dartmouth, Lebanon, NH

[2]Dartmouth-Hitchcock Medical Center, Lebanon, NH

[3]VA Maryland Health Care System, Baltimore, MD

[4]Department of Surgery, Geisel School of Medicine at Dartmouth

[5]Department of Medicine, Geisel School of Medicine at Dartmouth, Hanover, NH

[6]The Dartmouth Institute for Health Policy & Clinical Practice, Lebanon, NH

Abstract

Bariatric surgery is the most effective approach to treating morbid obesity, resulting in decreased morbidity, mortality, and improved quality of life. Research on outcomes has generally been restricted to young and middle-aged adults, despite a growing epidemic of obesity in older adults. The use of bariatric surgery has been limited in older individuals, in part due to concerns that pre-existing cognitive dysfunction increases the risk of poor post-surgical outcomes, including cognitive decline. The literature on the relationship between obesity and cognition in older adults is emerging, but fraught by several methodological limitations. While there is insufficient research to determine the nature of cognitive outcomes following bariatric surgery in older adults, the aim of this paper is to review the existing evidence and make the case for further study.

Keywords

Obesity; Older Adult; Bariatric; Neuropsychology; Cognitive

The prevalence of obesity in older adults is a major public health concern. The number of adults aged 65 years of age and older in the United States is increasing, and the prevalence rates of obesity in this population is approaching 40%[1]. Moreover, the number of older adults living with obesity is expected to rise as other chronic diseases are better managed and treated[2]. Yet, the treatment of obesity in older adults is an understudied phenomenon[3]. Obesity has well-established consequences including hypertension, diabetes, coronary artery disease and premature mortality[4]. Furthermore, the impact of weight on biomechanics and the pro-inflammatory state induced by adipose-tissue specific inflammatory markers promote incident functional decline and frailty[5], resulting in a higher risk of

Address correspondence to: Robert M. Roth, PhD, ABPP, Department of Psychiatry, Geisel School of Medicine at Dartmouth / DHMC, One Medical Center Drive, Lebanon, NH 03756. Robert.M.Roth@Dartmouth.edu; Phone: 603-650-5824; Fax: 603-650-0404.

institutionalization[6]. The prevalence rate of functional impairments is much higher in older adults with obesity than those who are of normal weight[7], which can lead to social isolation and depression[8,9].

The rapid increase of older adults with obesity has led to a rise in the number of Medicare beneficiaries in the United States seeking bariatric surgery[10]. Bariatric surgery is an effective means of improving medical co-morbidity and is increasingly recognized as an effective therapeutic strategy in older adults[11–13]. However, in clinical practice, older age has been associated with a lower likelihood of considering bariatric surgery[14]. Consequently, some older adults who could be excellent candidates may not be offered this effective treatment. Batsis and Dolkart suggest that a focus on physiologic rather than chronological age can optimize clinical management of obesity among older adults[15]. A comprehensive geriatric assessment incorporating a geriatrician or a provider with knowledge of issues specific to older adults can markedly improve risk-stratification and pre-operative selection by focusing on frailty, polypharmacy, and co-morbid medical issues[15]. Living situations, food security, and social support are known social determinants of health that predict adverse post-operative outcomes and can easily be addressed. Advanced care planning, a Joint Commission requirement, can proactively allow discussions of patient and family concerns with respect to outcomes.

As such, careful pre-surgical medical and psychological evaluation may allow many older adults with obesity to be considered for weight-loss surgery. However, access to bariatric surgery in such individuals may also be restricted due to concerns about neuropsychological functioning, such as problems with memory and executive functions (e.g., impulse control) contributing to difficulty adhering to pre- and post-surgical guidelines. Some degree of cognitive decline is common during the normal aging process[16], and epidemiological evidence suggests that obesity can promote its acceleration[17]. Despite this concern, there is very little empirical research on the cognitive outcome of bariatric surgery in older adults with obesity, or whether pre-surgical cognitive impairment is predictive of cognitive and other outcomes (e.g., maintenance of weight loss). Although this body literature is growing, much of this work has been conducted with young and middle aged adults[18]. Here, we review the neuropsychological literature pertinent to bariatric surgery in older adults and suggest that further research is needed in this population.

Neuropsychological Functioning in Older Adults with Obesity

Pre-surgical cognitive functioning has been of increasing interest as a factor in predicting adverse surgical outcomes. Pre-surgical cognitive dysfunction in older adults has been associated with higher rates of *non-bariatric surgery* post-operative delirium[19–21] and cognitive decline[22], longer hospital stay[20], and reduced likelihood of being discharged to home[19,20,23]. Determining whether older adults with obesity are at greater risk for cognitive dysfunction has important implications for bariatric surgery, such as informing pre-surgical screening and planning for postoperative care needs.

The relationship between obesity and neuropsychological functioning in adults is an evolving area of investigation. In adults 19–65 years of age, a recent review of 15 cross-sectional and 4 prospective studies concluded that greater body mass is associated with poorer performance on measures of global cognitive functioning, processing speed, semantic and episodic memory, and executive functions[24]. In contrast, in older adults, obesity has not been consistently associated with poorer performance on tests of any cognitive domain, including those most commonly assessed such as executive functions (e.g., impulse control and cognitive flexibility)[25–27], episodic memory[28], verbal working memory[29,30], psychomotor speed[30,31], or overall cognitive ability[32]. A recent study using the Montreal Cognitive Assessment[33], a commonly employed cognitive screening measure, found that 22% of older bariatric surgery candidates, 65 to 80 years of age, scored in the impaired range (< 26/30)[34]. The relevance of impairment on this screening measure to surgical outcome was not reported. This research contrasts to data suggesting that higher BMI may be protective against cognitive decline in older adults[24,31,35]. Such findings raised the so-called “obesity paradox” observed in heart failure[36], whereby obesity may actually be associated with a decrease risk for cognitive and functional decline, as well as mortality, in older adults[25].

Numerous factors may contribute to inconsistent cognitive findings and the obesity paradox. Methodological heterogeneity abounds, such as differences in the specific cognitive tests administered, comprehensiveness of the cognitive evaluation (i.e., screening test or just one or two tests versus larger test battery), and failure to adequately control for potential confounding factors such as obesity-related comorbidities (e.g., diabetes), demographic characteristics (e.g., education, race), and mood. A recent study of adults 60–85 years of age reported poorer psychomotor processing speed in those who were currently inactive, irrespective of current or prior weight status[37]. This is consistent with a burgeoning literature showing a cognitive benefit in older adults with a history of regular exercise[38] suggesting the need to account for level of physical activity. BMI has also been argued to be an inaccurate measure of adiposity in older adults[24,39], rendering the interpretation of relationships between BMI and cognition in older adults problematic.

Few studies have evaluated the relevance of biomarkers to cognitive change in older adults with obesity. An association was observed between higher BMI and poorer overall cognitive functioning on a computerized test battery, an association that was partially accounted for by inflammation (c-reactive protein) and elevated fasting plasma glucose (as a marker of insulin resistance), but not hypertriglyceridemia[40]. Another found no relationship between baseline leptin and the average rate of cognitive decline over 6.2 years in those with a large waist circumference, that is, >35 inches for women and >40 inches for men[41].

Finally, cognitive reserve may also be of salience. Cognitive reserve reflects individual differences in cognitive processes or neural networks subserving performance of tasks that contributes to resilience in the face of brain damage[42]. As it is a hypothetical construct, cognitive reserve cannot be directly measured. Rather, common proxy indicators include educational attainment, occupational achievement, and performance on word reading test based estimates of premorbid intellectual functioning[42,43]. In a study of adults 65–101 years of age, obesity was no longer associated with poorer verbal ability, processing speed, and cognitive flexibility when cognitive reserve in early to mid-life (i.e., educational attainment, leisure activities, cognitive level and physical demand of job) was taken into account[44]. In contrast, one other study reported that in individuals with higher BMI, greater number of years of education was associated with better executive functioning in younger but not in older adults[27].

Mild Cognitive Impairment and Obesity

There is little research on whether the presence of frank cognitive impairment prior to bariatric surgery is associated with worse cognitive or weight outcomes following surgery. Mild cognitive impairment (MCI) is considered a transitional stage of cognitive impairment that is frequently, albeit not always, intermediate between normal cognition and dementia, and is associated with an increased risk for dementia. It is characterized by subjective concerns about a person's cognitive functioning, objective evidence of cognitive impairment that may include memory and/or other cognitive domains, and generally preserved functional independence, that cannot be accounted for by delirium or a mental disorder such as major depressive disorder[45,46]. The diagnosis of MCI *per se* is non-specific with respect to etiology, but certain biomarkers (e.g., amyloid-beta) may facilitate identification of MCI due to Alzheimer's disease (AD)[46,47].

While the impact of MCI on bariatric surgery outcomes has yet to be examined, an understanding of the association between obesity and cognitive outcome in those with MCI is of relevance, as it would help inform whether pre-existing cognitive impairment should be an exclusion criterion for bariatric surgery in older adults. In a study of 83 older adults with MCI, those with apathy, weight loss, and lower BMI were found to be at greater risk of developing dementia by 24-month follow-up[48]. A recent investigation of 1,394 subjects with MCI pooled from across 14 studies reported that obesity was not associated with progression to dementia[49]. In addition, a multisite longitudinal study involving 6940 older adults (5,061 with normal cognition and 1,879 with MCI) observed that higher late-life BMI was associated with a lower risk of incident MCI and Alzheimer's disease[50]. This held true irrespective of APOE allele 4 status (a gene associated with heightened risk for dementia), but not when rapid weight loss had occurred prior to diagnostic conversion. These findings are consistent with earlier work that found that current obesity level is inversely associated with dementia in older adults[51].

Non-surgical weight loss may be associated with cognitive improvement in MCI. A study of intentional weight loss via caloric restriction for 12 months observed cognitive improvement in 80 patients with MCI (mean age = 68.1 ± 4.9 years of age, BMI = 35.5 ± 4.4 kg/m2, 83.7% women)[52]. Reduction of BMI was associated with improved verbal memory, verbal fluency, executive function, and global cognition even after accounting for education, gender, physical activity, and baseline test scores. The association was strongest for memory and fluency in younger seniors (< 70 years), and for executive function in APOE allele 4 carriers (26.3% of the sample). Changes in insulin resistance, C-reactive protein, leptin and intake of energy, carbohydrates, and fats were associated with greater improvement in cognition. While in need of replication, this suggests that the presence of cognitive impairment, at least when mild, may not hinder the ability to benefit from intervention in terms of weight loss or cognition in older adults.

Neuropsychological Outcome of Bariatric Surgery

The vast majority of research on neuropsychological outcome of bariatric surgery has focused on adults from 18 to approximately 70 years of age. This burgeoning body of research has generally found that cognition remains stable or improves following surgery in domains such as attention, executive function, and memory[18], with longitudinal studies noting improvement in these domains a year or more after surgery[53–55]. Of note, one study reported that the prevalence of MCI dropped from 53.4% pre-surgery to 27.3% at the 12-month follow-up in severely obese (BMI = 46) middle-aged individuals with MCI[56]. Interestingly, poorer pre-surgical cognitive functioning, and failure to show improved memory after surgery, has been reported for adults (mean age = 44.34) with a family history of Alzheimer's disease as compared to those without such a family history[57].

We sought to identify empirical papers that addressed the neuropsychological outcome of bariatric surgery in older adults. We conducted a literature search for papers published between January 1, 2000 and July 1, 2018 using PubMed and the Cochrane Library. Search terms included bariatric, cognitive, neurologic, older adult, and elderly. The reference sections of the papers identified were subsequently reviewed for further potentially relevant reports.

One study was identified that included older adults and ascertained whether age was predictive of cognitive change following bariatric surgery[58]. The sample included 95 adults (89.5% women) ranging from 20–70 years of age (mean age = 43.2, SD = 10.8), of whom 18.9% were 55 years of age or older (mean age for this subsample was not reported). The participants completed a cognitive test battery before surgery, as well as 12 weeks and 12 months after surgery (94 had Roux-en-Y gastric bypass, 1 had gastric banding). Cognitive testing included computerized adaptations of the Trail Making Test and the Austin Maze to assess attention and executive functions, letter and animal fluency to assess language, and a verbal list learning task to assess memory. In the overall sample, memory and attention/executive functions were improved at both follow-up time points. Regression analyses, controlling for baseline BMI, found that age was not a predictor of postsurgical change in cognition. However, neither this nor any other study that included older adults reported analyses specifically addressing whether the subset of older participants experienced cognitive change following bariatric surgery.

The dearth of studies examining the neuropsychological outcome of bariatric surgery in older adults is surprising given the prevalence of post-operative cognitive dysfunction (POCD) in older adults who have undergone a variety of non-bariatric surgical procedures. POCD, the deterioration of cognition temporally associated with a surgical procedure, may occur after any type of surgery, and is seen in all ages, though especially in older adults[59,60]. The incidence of POCD in older adults has ranged from 10 to 38% within the first 2–3 months after *non-bariatric* surgery, and 3 to 24% at 6–12 months[61]. Others have reported POCD may occur in up to 65% of older adults[62]. Furthermore, POCD has been associated with a heightened risk for the development of dementia in some[63] though not other[64] studies.

A recent meta-analysis identified only six studies that examined the relationship between obesity, BMI and/or weight and POCD that also met inclusion criteria for the analysis[61]. These consisted of 1432 older adults in total (mean age of 62 years or older), followed for 24 hours to 12 months after *non-bariatric* surgery (e.g., CABG, total hip replacement). The authors demonstrated a non-significant higher risk (relative risk of 1.27) of POCD in persons with BMI > 30 kg/m^2 versus those with BMI ≤ 30 kg/m^2. In contrast, BMI and body weight, when used as continuous predictors, were unrelated to cognitive outcome.

Neurologic Outcome of Bariatric Surgery

In contrast to cognitive dysfunction, a variety of neurological complications have been observed subsequent to bariatric surgery. These may involve the brain, spinal cord, peripheral nerves, or muscles[65]. These have been attributed largely to micronutrient malabsorption. The rate of such complications may be as high as 5–10% of cases, with the majority involving the peripheral nervous system[65,66]. As with neuropsychological outcomes, there is a dearth of information pertaining to the neurological outcome of bariatric surgery in older adults. One study examined 1005 older adults (65 years and older, 30.8% male), 84.6% of whom had laparoscopic gastric bypass (RYGB) and 15.4% sleeve gastrectomy (SG)[67]. The rate of neurological complication (defined as present or absent, of any type) was small and did not differ between RYGB (0.2%) and SG (0%) at 30-days post-surgery. The onset of Wernicke's encephalopathy has been observed subsequent to bariatric surgery, though literature reviews have only reported identifying cases up to age 55 years[68,69]. It is unclear whether that is because Wernicke's encephalopathy is rare in older obese adults following bariatric surgery, and/or there has been limited use of the surgery in older adults thus restricting the likelihood of observing the rare complication. Whether such neurological complications in young or older adults is associated with cognitive changes has yet to be determined.

Future Directions

Bariatric surgery is an effective treatment for obesity even in older adults. While concern has been raised about cognitive functioning in older adults with obesity, which could impact decision-making with regards to candidacy for bariatric surgery, no consistent relationship has been observed between cognitive test performance and obesity in older adults. There is also a dearth of empirical research directly addressing whether pre-surgical cognitive impairment is associated with worse post-surgical outcomes, or whether bariatric surgery per se has any effect on cognition, positive or negative, in older adults.

The American College of Surgeons and the American Geriatrics Society have recommended pre-operative cognitive screening for older adults prior to surgical interventions[20]. A standardized neuropsychological test battery for pre- and post-surgical evaluation of bariatric surgery candidates has been proposed[18]; however whether that battery would adequately address salient clinical questions in older adult surgery candidates remains to be determined. In addition, further research examining the utility of brief cognitive screening tests such as the MoCA for predicting outcome and tracking cognitive change would be helpful, given the frequent use of such measures in primary care and other health care settings.

Gaining an understanding of post-bariatric surgery cognitive functioning in older adults may yield additional benefits for post-surgical care. For example, better post-surgical cognitive functioning has been associated with a higher percent total weight loss and lower BMI in a sample of adults with a mean age of 43.65[70], as well as greater adherence to postoperative guidelines within a 4–6 week period after surgery[71] in adult samples having mean ages in the 40s. Further research will be essential to determine whether such findings generalize to older obese adults.

It is important to note that there is also a paucity of clinical trials of non-surgical weight loss interventions for obesity in older adults that also address the potential relevance of cognitive functioning. As noted above, weight loss via caloric restriction was associated with cognitive improvement in older adults with MCI and obesity[52]. Other work has found that postmenopausal women with obesity who completed a 12-week calorie restriction program showed amelioration of cognitive functioning[72]. Combined dietary and exercise interventions are notably lacking. Specifically, performance improved on measures of memory, processing speed, executive functions immediately upon completion of treatment. These changes were largely sustained to the end of a 4-week weight maintenance period. The study also noted that completion of the program was associated with increased inferior frontal gyrus and hippocampus gray matter volume, as well as increased hippocampal resting-state functional connectivity, though effects were reduced over time. Such findings indicate that non-surgical weight loss interventions could also have cognitively beneficial effects, potentially by altering underlying brain structure and functional connectivity.

We suggest that carefully selected older adults should be considered for bariatric surgery. Longitudinal studies will be essential to fully elucidate whether pre-existing cognitive dysfunction (e.g., MCI) affects post-surgical outcomes (e.g., weight loss, adherence to postoperative guidelines, cognitive change). As the sensitivity of cognitive screening tools to post-bariatric surgical cognitive change has yet to be established, studies would benefit from inclusion of a sufficiently comprehensive neuropsychological assessment. This should consist at minimum of measures of memory, attention, and executive functions, as these cognitive domains have been commonly associated with obesity and reported to change after bariatric surgery in some studies.

It is unknown whether some older adults with obesity are more like to show cognitive change, or to have a lesser cognitive benefit, following bariatric surgery or other weight loss interventions. This information would be essential for surgical planning. Future studies of older adults would therefore benefit from examining the impact of individual differences on cognitive outcome. This may include factors such as cognitive reserve, various biomarkers (e.g., inflammation, insulin resistance, and genetic markers related to risk and resilience for cognitive decline in older adults,), as well as family history of dementia among other potential predictors.

A comprehensive evaluation program of research that includes pre-surgical medical, psychological, and neuropsychological assessment in large samples of older adults is needed to address these key issues and inform future avenues for intervention. Such work should ideally follow patients longitudinally over several years, given evidence in younger samples that cognition may continue to change after the post-acute bariatric surgical period. Incorporation of appropriate control samples will also be essential given the natural course of cognitive change in older adults, to ensure that any changes observed are due to the intervention rather than other factors associated with normal aging.

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Take Away Points

- Obesity in older adults is not consistently associated with cognitive problems.
- There is a paucity of research evaluating the neuropsychological outcome of bariatric surgery in older adults.
- A comprehensive program of research that includes pre-surgical medical, psychological, and neuropsychological assessment in large samples of older adults is needed.