



Weight Loss Surgery in the Elderly: Is This the Future?

Marston Hillier, Melanie Dani, Michael B Fertleman, Sanjay Purkayastha and Louis J Koizia*

Department of Bioengineering, Imperial College London, UK

Abstract

The UK population is ageing rapidly, and the proportion of people living with obesity is increasing. Obesity is a risk factor for diabetes, coronary artery disease, stroke and cancer. Older patients are admitted for obesity related complications at a similar rate compared to younger patients. However, the operations for people over 70-years are extremely infrequent. In this scoping review we summarize the recent data on bariatric operations in people over 70-years and the possible risk benefit ratio of bariatric surgery for this population.

Keywords: Bariatric surgery; Frailty; Obesity

Introduction

The UK population is ageing rapidly. The group of adults over 65 years is growing faster than any other age group; with one in six in 1998 to a projected one in every four by 2038 [1]. An ageing population is associated with significantly increased demand for health and social care [2].

Simultaneously, this ageing population is also becoming more overweight. By 2030 approximately 40% of the UK adults are projected to be living with obesity [3]. Obesity, an excessive accumulation of body fat normally defined as a Body Mass Index (BMI) of $>30 \text{ kg/m}^2$, is a recognized modifiable risk factor for the development of type 2 diabetes mellitus, coronary heart disease, stroke, depression, hypertension and obesity related cancers [4-8]. A BMI of greater than 40 kg/m^2 is classified as morbidly obese, with worse health outcomes [9]. Obesity is directly associated with reduced life expectancy, by up to 10 years in those with morbid obesity [10]. In addition to adverse health-related outcomes, obesity is responsible for significant financial costs to both the NHS and to wider society. In 2014-15, an estimated £6.1 billion of the NHS's budget was spent dealing with direct obesity related costs and this amount is expected to increase in the future [11].

Weight-loss options for patients include lifestyle changes (e.g. healthy diet and exercise), education, medications and ultimately bariatric surgery. In older people, these lifestyle changes can become more difficult to instigate than in younger people. Due to the prevalence of diseases such as osteoarthritis and the progressive change in muscle composition and strength, exercises can often be more painful and less impactful for older people. Similarly, with age, the resting metabolic rate decreases - meaning that older people require lower energy intake per day to maintain homeostasis. The combination of these two factors means that older people may have greater difficulty in losing weight relative to younger people. As per current National Institute for Care and Health Excellence (NICE) guidance, to be eligible for bariatric surgery in the UK, patients must have: a BMI $>40 \text{ kg/m}^2$ or BMI $>35 \text{ kg/m}^2$ with disease that would improve with weight loss; have exhausted other measures; be fit enough for general anesthesia; receive tier 3 service (i.e. MDT and specialist assessment) and be committed to long-term follow up [12]. There is no upper age limit on bariatric surgery in the UK. However, the number of bariatric surgical procedures in patients aged older than 70 is extremely low. Between 2006 and 2012 at all NHS hospitals in the UK, only 525 bariatric surgical procedures were undertaken on patients aged over 65; less than 2% of all 26,390 operations performed [13]. Other studies have suggested that for patients older than 70, the rates are even lower, with approximately only 100 operations on patients over 70 years old performed out of 35,886 bariatric surgery operations in England between 2006-2014 [14].

The aim of this scoping review is to identify there are benefits of surgery for older patients, if the surgery is safe, specific risks to older people, potential barriers to offering these interventions, and if more older patients should be considered for surgery.

Methods

We searched PubMed using key words: Bariatric, weight loss, surgery, elderly, frail, older people, metabolic surgery, gastric bypass, sleeve gastrectomy, gastric band. We also excluded studies

OPEN ACCESS

*Correspondence:

Louis J Koizia, Department of Bioengineering, Imperial College London, Cutrale Perioperative and Ageing Research Group, UK, E-mail: louis.koizia05@imperial.ac.uk

Received Date: 05 Jan 2022

Accepted Date: 15 Feb 2022

Published Date: 08 Mar 2022

Citation:

Hillier M, Dani M, Fertleman MB, Purkayastha S, Koizia LJ. Weight Loss Surgery in the Elderly: Is This the Future?. Clin Surg. 2022; 7: 3434.

Copyright © 2022 Louis J Koizia. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

published prior to 2010 and if they were not in English. 66 articles were identified.

Benefits of surgery

In younger populations, bariatric surgery is associated with significant benefits such as reduction in weight, improvement in obesity-associated conditions such as type 2 diabetes, and improvements to mental health [15]. We sought to identify if these, or other, benefits had been found in older people.

Smith et al. examined patients over 70 years (from the 2006-2018) undergoing bariatric surgery with cohort aged under 70 years [16]. Resolution or improvement in diabetes, obstructive sleep apnea and hyperlipidemia was similar in both groups. Al-Kurd et al. compared 30 patients over the age of 70 years with 60 controls under 70 years [17]. There was no statistical difference between remission of diabetes or hypertension between the older and younger groups. Interestingly, patients in the over 70 group had a greater improvement in lipid status. In general, studies have identified percentage total body weight loss is similar between older and younger patients. Likewise, rates of resolution of comorbidities such as diabetes, hypertension and gastroesophageal reflux disease were similar.

For older patients, there may be additional benefits, not usually reported in cohorts having bariatric surgery. Polypharmacy, loosely defined as taking more medications than medically necessary, is associated with a number of negative consequences for older patients, such as increased risk of adverse drug events, hospitalization or falls [18,19]. Surgery has been shown to reduce medications, and Chua et al. found a statistically significant reduction in number of daily medications following surgery [20].

Furthermore, there is some evidence that improvements in diet and increasing exercise may have positive impacts on cognition in older people [21]. Keshava et al. has gone a step further to hypothesize that bariatric surgery has the ability to reduce the risk of cognitive impairment by increasing Glucagon-like-peptide 1 which has demonstrated potential neuroprotective and neurotropic effects [22]. McGlennon et al. suggest that bariatric surgery could be a novel treatment for worsening cognitive impairment and dementia in patients with obesity and chronic traumatic brain injuries [23].

Risks and concerns with surgery

There is evidence that older people are at greater risk of complications compared to younger people when undergoing elective surgeries [24].

Pechman et al. analyzed the ACS NSQIP (American College of Surgeons National Surgical Quality Improvement Program) database, assessing outcomes between 1,498 patients over the age of 70 and 161,897 patients under 70 [25]. They identified that three-day mortality in the over 70-year-old group was statistically significantly higher, with greater morbidity. However, the over 70 group was significantly more comorbid, with a higher average ASA grading and significantly poorer functional status at baseline compared to the under 70 group. These results were similar to another analysis of the ACS NSQIP database performed by Arnold et al. [26]. They identified that the over 70 group (n=739) suffered higher rates of minor (OR 1.57, 95% CI 1.15-2.15) and major (OR 2.13, 95% CI 1.46-3.09) complications post procedure compared to patients aged 40-49 (n=24,014). Specifically looking at RYGB they identified a statistically significant higher risk of 30-day mortality in the older group.

In analyses looking at cohorts other than the ACS NSQIP database, Smith et al. identified higher rates of hemorrhage and anastomotic leaks amongst the older cohort [16]. They identified a moderately increased risk of any complication post-surgery for the older cohort (OR 1.47, 1.06-2.04) and an increased likelihood of reoperation compared to 45 to 69-year olds (OR 2.74, 1.50-5.03).

Smaller studies have matched for co-morbidities and have had more promising outcomes. Al-Kurd et al. compared 30 patients over the age of 70 years with 60 controls under 70 years [17]. Despite significant differences in baseline comorbidities, with the older cohort having worse performance statuses, there was no significant difference in post-operative complication rates. Similarly, Parmar et al. similar rates of complications post operatively in groups above 70 and a younger cohort [27].

Overall, the larger studies assessing the ACS NSQIP database identified increased 30-day mortality and morbidity, but the individual patients had typically more comorbidities. In contrast, the smaller studies which attempted to match baseline status between age groups have identified that rates of complication at 30 days are broadly similar. A number of, predictable, age related complications occur more frequently in the older age group, such as intraoperative hiatal hernia repairs (requiring longer surgery), a longer inpatient hospital stay or postoperative atrial fibrillation. That being said, the outcomes and complications are no worse that more commonly offered elective procedures such as cholecystectomy [28].

Cost implications

Bariatric surgery is recognized in younger people to be an economically worthwhile endeavor, with significant cost savings in the long term due to resolution of comorbidities and reduced healthcare demand. In the United States, some have estimated that the cost savings from bariatric surgery are recouped within 4 years of open bariatric surgery or two years if performed laparoscopically [29-31]. We were unable to find any data investigating the cost implications of bariatric surgery in specifically older patients. However, extrapolating from previous work suggests that these financial benefits are not limited to younger patients - similar rates of resolution of comorbidities post-surgery are seen in older patients compared to younger patients, as described above. Some may argue that patients over the age of 70 have a limited life expectancy but based on information from the Office for National Statistics, current 70 year olds remaining life expectancy is 15 years (male) and 17 years (female).

Why is bariatric surgery not routinely offered?

Currently, only a very small percentage of bariatric surgeries are performed on patients over 70 years. The reasons for this are unclear. We were unable to find any data exploring patients' preference, details on referral to secondary care for patients over 70 years or studies exploring what proportion of patients over 70 years referred to secondary care are offered weight loss surgery. The low number of operations, despite the number of patients over 70 years who are suitable for weight loss surgery, suggests that some as yet unquantified factor is preventing these patients from accessing surgery.

Older patients may be perceived as higher risk candidates for bariatric surgery [32]. There is relatively little data on safety and outcomes in older people, in comparison to younger. Identifying if older people are at greater risk from bariatric surgery is compounded by the bariatric literature defining "elderly" or "older person" variably.

There is no set definition for these terms, with some authors even using age 55 years as a cut off for “older” people [33,34]. This makes direct comparisons between different age groups difficult. In addition, early guidance in the form of the National Institute of Health Consensus Development on GI Surgery for Severe Obesity, published in 1991, stated that the ideal age range for bariatric surgery was between 18 and 60 years old [35]. This may have been a precipitant for the current paucity of data, as surgeons may have been unwilling to offer surgery to people outside this demographic.

But is there an element of ageism? Ageism is a form of prejudice that has a negative impact on older adults. This form of prejudice has been seen in other forms of surgery and can have a negative impact on older adult's health and well-being [36]. Even compared to other invasive elective laparoscopic surgical procedures, such as cholecystectomy, the rates of bariatric surgery are much lower in older people. This may be due to bariatric surgery being seen by some as a “cosmetic” surgery and less so as a surgery which can have a significant impact on day-to-day life or feeling that older people may not benefit from such a procedure.

There is also a perception that patients themselves would not be keen for bariatric surgery. This is an area for future study. In other elective procedures, such as hip or knee replacement, older people over 70 represent the majority of patients undergoing such surgery [37]. This could be for numerous reasons. Hip and knee replacements, when performed for osteoarthritis, aim to resolve pain and increase functional status. Similarly, bariatric surgery is aimed to improve functional status. The difference in rates of operations being performed could be due to lower awareness amongst referrers it is routine for primary care to refer to orthopedics to consider replacement of arthritic joints, however, much less routine to refer for bariatric surgery. This represents a potential intervention and further education may increase the rates of bariatric surgery.

Obesity paradox

In a large, community study of men and women aged 65 and above, the lowest hazard ratio for mortality were seen in individuals with BMI 25 to 30 [41]. General consensus is that BMI <25 and >35 kg/m² is associated with higher mortality [42]. This is further complicated by the concept of sarcopenic obesity. Sarcopenia, a loss of skeletal muscle, is related to frailty, functional dependence and worse outcomes. Sarcopenic obesity is a situation when elderly patients have increased adiposity with additional decrease in muscle mass. Sarcopenic obesity has been related to an increased risk of disability, above and beyond sarcopenia, or obesity alone [43].

This also highlights the fact that BMI may not be a good indicator of obesity in older adults because it does not take into account the loss of muscle mass with increasing age. And those losses of muscle mass and increasing visceral fat have opposing effects on mortality. Therefore, muscle mass may need to be taken into account when assessing the effects of obesity in older adults.

Which patients should be chosen?

The review of the literature identifies benefits of bariatric surgery for over 70-year-old patients, and acceptable complications rates. Therefore, age alone should not be a barrier to offering bariatric surgery to older patients. However, given the higher prevalence of comorbidities known to affect post-surgical outcomes and the other challenges associated with offering major surgery to older patients, it will be very important going forward to develop robust selection

criteria for older patients. As of yet, no formal selection criteria for geriatric bariatric surgery has been generated, though Batsis et al. attempted to lay the groundwork for such, highlighting the importance of function and physiology rather than chronological age [38]. The UK NICE criteria only stipulate that the patients need to be fit for general anesthesia [12].

Selecting older patients who are most likely to benefit from bariatric surgery therefore represents a significant target for further research. Factors which must be taken into account include: Patient factors, such as intrinsic motivation or anesthetic risk; healthcare-associated factors, such as clinician appetite for risk and prioritization. Studies in younger people identify that the desire to control current medical problems are the main driver for wanting to undergo bariatric surgery [39]. There are no studies identifying the motivations for specifically older people who wish to have bariatric surgery, and this represents a target for future study.

If surgery was offered; which operation?

There is some evidence, derived from studies analyzing the ACS-NSQIP database and smaller retrospective cohort studies, that the choice of procedure may have an effect on safety and outcomes in older patients. Arnold et al. suggested that sleeve gastrectomy had a more favourable early complication rate for older people [26]. Patients older than 55 (though none over 70), suggest while bypass surgery may be more efficacious, sleeve gastrectomy may be more suitable due to the lower risks of complications [40]. Further research is needed specifically in septuagenarians to identify if there is a more appropriate operation for this cohort.

Alternatives to surgery?

For those considered not fit enough, or for older people who do not wish to have invasive surgery, there are a number of other options available. These range from calorie restriction diets, tailored exercise programs, medications and endoscopic procedures. There are very few tailored regimes for older people; most weight loss programs do not differ by age. In older people, studies have suggested that a combined calorie restrictive diet and exercise program is more effective than either exercise or diet alone in older people for promoting weight loss [44]. Extreme weight loss diets may be contraindicated in the elderly due to the risk of developing or exacerbating existing gallstones, for which age also is already a significant risk factor [45,46].

As of 2021, there is only one licensed medication used for the treatment of obesity in the United Kingdom. Orlistat, a pancreatic lipase inhibitor, reduces the absorption of dietary fat from the gastrointestinal system. This reduction in dietary fat absorption then reduces calorie intake and hence can facilitate weight loss. It is not particularly effective at weight loss when used as a monotherapy, however, is recommended to be used as an adjunctive therapy for patients already on a diet and exercise program. In older people, the risks of using such a medication may outweigh the benefits [47]. Orlistat is not commonly prescribed due to significant gastrointestinal side effects like abdominal pain or steatorrhea. It may also interfere with the absorption of other, fat soluble drugs of note being warfarin and fat soluble vitamins, such as vitamin D which a large proportion of older people are deficient in. Vitamin D deficiency is associated with increased risk of neck of femur fractures, which carry a high mortality rate and significant morbidity [48]. Furthermore, the vast majority of studies looking at safety and efficacy of pharmacological agents do not occur in over 70 years old, thus meaning an insufficient level of data available in our population group.

Overall situation

Overall, there is evidence that bariatric surgery in older people is an effective intervention for reducing weight and the impact of associated obesity related diseases. However, this must be in the context of adjustment for comorbidities and functional status. Very little bariatric surgery is happening in older people, for unclear reasons. We identify that further study is needed to evaluate the factors preventing older people from having access to bariatric surgery and to identify the longer-term risks and benefits from surgery in this population [49,50].

Due to the unique physiological status of older people, there may be a role for greater multidisciplinary team working in selection of suitable patients. Geriatricians are increasingly becoming a part of surgical MDTs through their roles such as a surgical liaison, with improved outcomes for patients and shorter hospital stays [51]. In the future there may also be a bariatric geriatrician who helps surgeons select and manage older people who wish to undergo bariatric surgery.

Limitations

There are a number of limitations of our review. As previously mentioned, bariatric surgery in patients aged older than 70 years is performed very rarely compared to other age groups. It is unclear what, if any, reasons why these 70 year olds were chosen for surgery and others were not, given that a large number of people over 70 are overweight. This in itself is likely to skew the data towards patients who are motivated and fit for surgery in the first place, which may result in overstating the benefits of surgery in the over 70s.

Conclusion

Overall bariatric surgery is an effective treatment of obesity in people aged 70 years or older. There may even be significant specific impacts on this cohort such as reduction in frailty or polypharmacy. The risks profile is similar, albeit slightly higher when compared to younger patients. The paucity of data for this population means that further study is needed to characterize suitable patient selection criteria to minimize risks to patients and identify patients most likely to benefit from bariatric surgery. Furthermore, further study into the most appropriate surgical procedures and study into factors preventing patients from accessing bariatric surgery are needed, given the increasingly aged and obese population.

Acknowledgment

The authors would like to thank Dr Yanna Argiriov for her assistance with the project.

References

- Coates S, Tanna P, Scott-Allen E. Overview of the UK population: August 2019.
- Caley M, Sidhu K. Estimating the future healthcare costs of an aging population in the UK: Expansion of morbidity and the need for preventative care. *J Public Health (Oxf)*. 2011;33(1):117-22.
- Wang YC, McPherson K, Marsh T, Gortmaker SL, Brown M. Health and economic burden of the projected obesity trends in the USA and the UK. *Lancet*. 2011;378(9793):815-25.
- Al-Goblan AS, Al-Alfi MA, Khan MZ. Mechanism linking diabetes mellitus and obesity. *Diabetes Metab Syndr Obes*. 2014;7:587-91.
- Artham SM, Lavie CJ, Milani RV, Ventura HO. Obesity and hypertension, heart failure, and coronary heart disease - Risk factor, paradox, and recommendations for weight loss. *Ochsner J*. 2009;9(3):124-32.
- Kernan WN, Inzucchi SE, Sawan C, Macko RF, Furie KL. Obesity: A stubbornly obvious target for stroke prevention. *Stroke*. 2013;44(1):278-86.
- Jiang SZ, Lu W, Zong XF, Ruan HY, Liu Y. Obesity and hypertension. *Exp Ther Med*. 2016;12(4):2395-99.
- Basen-Engquist K, Chang M. Obesity and cancer risk: Recent review and evidence. *Curr Oncol Rep*. 2011;13(1):71-6.
- Pi-Sunyer X. The medical risks of obesity. *Postgrad Med*. 2009;121(6):21-33.
- MacMahon S, Baigent C, Duffy S, Rodgers A, Tominaga S, Chambless L, et al. Body-mass index and cause-specific mortality in 900 000 adults: Collaborative analyses of 57 prospective studies. *Lancet*. 2009;373(9669):1083-96.
- Public Health England. Health matters: Obesity and the food environment. 2017.
- NICE. Obesity: Identification, assessment and management. (Accessed 15 July 2020).
- Sun S, Borisenko O, Spelman T, Spelman T, Ahmed AR. Patient characteristics, procedural and safety outcomes of bariatric surgery in England: A retrospective cohort study—2006–2012. *Obes Surg*. 2018;28(4):1098-108.
- Dhalwani NN, Zaccardi F, Waheed H, Mytton J, Papamargaritis D, Webb DR, et al. Cardiovascular, cancer and mortality events after bariatric surgery in people with and without pre-existing diabetes: A nationwide study. *J Diabetes*. 2019;11(4):265-72.
- Arterburn DE, Telem DA, Kushner RF, Courcoulas AP. Benefits and risks of bariatric surgery in adults. *JAMA*. 2020;324(9):879-87.
- Smith ME, Bacal D, Bonham AJ, Varban OA, Carlin AM, Ghaferi AA, et al. Perioperative and 1-year outcomes of bariatric surgery in septuagenarians: Implications for patient selection. *Surg Obes Relat Dis*. 2019;15(10):1805-11.
- Al-Kurd A, Grinbaum R, Mordechay-Heyn T, Asli S, Abubeih A, Mizrahi I, et al. Outcomes of sleeve gastrectomy in septuagenarians. *Obes Surg*. 2018;28:3895-901.
- Maher RL, Hanlon J, Hajjar ER. Clinical consequences of polypharmacy in elderly. *Expert Opin Drug Saf*. 2014;13(1):57-65.
- Herr M, Robine JM, Pinot J, Arvieu JJ, Ankri J. Polypharmacy and frailty: Prevalence, relationship, and impact on mortality in a French sample of 2350 old people. *Pharmacoepidemiol Drug Saf*. 2015;24(6):637-46.
- Chua S, Arthur L, de Beaux A, Tulloh B, Lamb P. Bariatric surgery produces significant and sustained reduction in polypharmacy dependency in obese patients - A retrospective review of post-operative outcomes in NHS Lothian. *Int J Surg*. 2014;12(S3):S98.
- Jackson PA, Pialoux V, Corbett D, Drogos L, Erickson KI, Eskes GA, et al. Promoting brain health through exercise and diet in older adults: A physiological perspective. *J Physiol*. 2016;594(16):4485-98.
- Keshava HB, Mowla A, Heinberg LJ, Schauer PR, Brethauer SA, Aminian A. Bariatric surgery may reduce the risk of Alzheimer's diseases through GLP-1 mediated neuroprotective effects. *Med Hypotheses*. 2017;104:4-9.
- McGlennon TW, Buchwald JN, Pories WJ, Yu F, Roberts A, Ahnfeldt EP, et al. PART 3 bypassing TBI: Metabolic surgery and the link between obesity and traumatic brain injury-a review. *Obes Surg*. 2021;31(2):477-80.
- Fagard K, Casaer J, Wolthuis A, Flamaing J, Milisen K, Lobelle JP, et al. Postoperative complications in individuals aged 70 and over undergoing elective surgery for colorectal cancer. *Colorectal Dis*. 2017;19(9):O329-38.
- Pechman DM, Munoz Flores F, Kinkhabwala CM, Salas R, Berk RH, Weithorn D, et al. Bariatric surgery in the elderly: Outcomes analysis of patients over 70 using the ACS-NSQIP database. *Surg Obes Relat Dis*.

- 2019;15(11):1923-32.
26. Arnold MR, Schlosser KA, Otero J, Prasad T, Lincourt AE, Gersin KS, et al. Laparoscopic weight loss surgery in the elderly: An ACS NSQIP study on the effect of age on outcomes. *Am Surg*. 2019;85:273-9.
 27. Parmar CD, Mahawar KK, Boyle M, Carr WRJ, Jennings N, Schroeder N, et al. Mini gastric bypass: First report of 125 consecutive cases from United Kingdom. *Clin Obes*. 2016;6(1):61-7.
 28. Kamarajah SK, Karri S, Bundred JR, Evans RPT, Lin A, Kew T, et al. Perioperative outcomes after laparoscopic cholecystectomy in elderly patients: A systematic review and meta-analysis. *Surg Endosc*. 2020;34(11):4727-40.
 29. Sussenbach SP, Padoin AV, Silva EN, Benzano D, Pufal MA, Barhouch AS, et al. Economic benefits of bariatric surgery. *Obes Surg*. 2012;22(2):266-70.
 30. Klein S, Ghosh A, Cremieux PY, Eapen S, McGavock TJ. Economic impact of the clinical benefits of bariatric surgery in diabetes patients with BMI ≥ 35 kg/m². *Obesity (Silver Spring)*. 2011;19(3):581-7.
 31. Cremieux P-Y, Buchwald H, Shikora SA, Ghosh A, Yang HE, Buessing M. A study on the economic impact of bariatric surgery. *Am J Manag Care*. 2008;14(9):589-96.
 32. Goldberg I, Yang J, Nie L, Bates AT, Docimo S, Pryor AD, et al. Safety of bariatric surgery in patients older than 65 years. *Surg Obes Relat Dis*. 2019;15:1380-7.
 33. Huang CK, Garg A, Kuao HC, Chang PC, Hsin MC. Bariatric surgery in old age: A comparative study of laparoscopic Roux-en-Y gastric bypass and sleeve gastrectomy in an Asia centre of excellence. *J Biomed Res*. 2015;29:118-24.
 34. Giordano S, Victorzon M. Laparoscopic Roux-En-Y gastric bypass is effective and safe in over 55-year-old patients: A comparative analysis. *World J Surg*. 2014;38:1121-6.
 35. Hall H. Gastrointestinal Surgery for Severe Obesity. *Obes Surg*. 1991;1(3):257-65.
 36. Seymour DG, Garthwaite PH. Age, deprivation and rates of inguinal hernia surgery in men. Is there inequity of access to healthcare? *Age Ageing*. 1999;28:485-90.
 37. Goudie EB, Robinson C, Walmsley P, Brenkel I. Changing trends in total knee replacement. *Eur J Orthop Surg Traumatol*. 2017;27(4):539-44.
 38. Batsis JA, Dolkart KM. Evaluation of older Adults with obesity for bariatric surgery: Geriatricians' perspective. *J Clin Gerontol Geriatr*. 2015;6(2):45-53.
 39. Munoz DJ, Lal M, Chen EY, Fischer S, Roehrig M, Sanchez-Johnsen L, et al. Why patients seek bariatric surgery: A qualitative and quantitative analysis of patient motivation. *Obes Surg*. 2007;17(11):1487-91.
 40. Shenoy SS, Gilliam A, Mehanna A, Kanakala V, Bussa G, Gill T, et al. Laparoscopic sleeve gastrectomy versus laparoscopic Roux-en-Y gastric bypass in elderly bariatric patients: Safety and efficacy—a systematic review and meta-analysis. *Obes Surg*. 2020;30(11):4467-73.
 41. Al Snih S, Ottenbacher KJ, Markides KS, Kuo YF, Eschbach K, Goodwin JS. The effect of obesity on disability vs. mortality in older Americans. *Arch Intern Med*. 2007;167(8):774-80.
 42. Winter JE, MacInnis RJ, Wattanapenpaiboon N, Nowson CA. BMI and all-cause mortality in older adults: A meta-analysis. *Am J Clin Nutr*. 2014;99(4):875-90.
 43. Cauley JA. An overview of Sarcopenic obesity. *J Clin Densitom*. 2015;18(4):499-505.
 44. Villareal DT, Chode S, Parimi N, Sinacore DR, Hilton T, Armamento-Villareal R, et al. Weight loss, exercise, or both and physical function in obese older adults. *N Engl J Med*. 2011;364(13):1218-29.
 45. Johansson K, Sundström J, Marcus C, Hemmingsson E, Neovius M. Risk of symptomatic gallstones and cholecystectomy after a very-low-calorie diet or low-calorie diet in a commercial weight loss program: 1-year matched cohort study. *Int J Obes (Lond)*. 2014;38(2):279-84.
 46. Shaffer EA. Epidemiology and risk factors for gallstone disease: Has the paradigm changed in the 21st century? *Curr Gastroenterol Rep*. 2005;7(2):132-40.
 47. Finer N, James W, Kopelman P, Lean ME, Williams G. One-year treatment of obesity: A randomized, double-blind, placebo-controlled, multicentre study of orlistat, a gastrointestinal lipase inhibitor. *Int J Obes Relat Metab Disord*. 2000;24(3):306-13.
 48. Bryson DJ, Nichols JS, Ford AJ, Williams SC. The incidence of vitamin D deficiency amongst patients with a femoral neck fracture: are current bone protection guidelines sufficient? *Acta Orthop Belg*. 2013;79(4):470-3.
 49. Vermeiren S, Vella-Azzopardi R, Beckwee D, Habbig AK, Scafoglieri A, Jansen B, et al. Frailty and the prediction of negative health outcomes: A meta-analysis. *J Am Med Dir Assoc*. 2016;17(12):1163.e1-1163.e17.
 50. Gondal AB, Hsu C-H, Zeeshan M, Hamidi M, Joseph B, Ghaderi I. A frailty index and the impact of frailty on postoperative outcomes in older patients after bariatric surgery. *Surg Obes Relat Dis*. 2019;15(9):1582-8.
 51. Shipway D, Koizia L, Winterkorn N, Fertleman M, Ziprin P, Moorthy K. Embedded geriatric surgical liaison is associated with reduced inpatient length of stay in older patients admitted for gastrointestinal surgery. *Futur Healthc J*. 2018;5(2):108-16.