Obesity in the elderly

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The prevalence of obesity is increasing in all age groups, including the elderly. Obesity is associated with serious medical complications. In addition, obesity in the elderly can accelerate age-related decline in physical function. Intentional weight loss in the elderly is associated with significant improvements in quality of life, physical function and medical complications associated with obesity. At the same time, weight loss in the elderly is a controversial issue due to some of the health hazards associated with it, such as reduced bone density and fractures. Treatment modalities include lifestyle interventions, pharmacotherapy and surgery, with lifestyle interventions appearing to be the best method of management for the elderly, owing to the increased risks associated with other methods and perhaps as a result of inadequate data. Strength or resistance training rather than endurance exercise may be better in the elderly in whom loss of muscle mass and weakness are prominent deficits. Weight loss therapy that minimizes muscle and bone loss should be encouraged in obese elderly patients who have medical conditions associated with obesity and who have functional impairment and/or loss of quality of life owing to obesity.

The prevalence of obesity is currently increasing in all age groups and has assumed the proportions of an alarming public health problem. The elderly are one of the fastest growing segments of the population. Estimates of the prevalence of obesity in adults aged 60 years and older will increase in the USA from 32% in 2000 to 37.4% by 2010. In numbers this represents an increase from 14.6 to 20.9 million at the expense of a decreasing prevalence of normal-weight adults [1]. Correspondingly the associated medical challenges will likely impact heavily on elder-care resources. Obesity in the elderly is an important and interesting topic.

Definition of obesity

Obesity is defined as a BMI of more than 30 kg/m^2. BMI is calculated as body weight in kg divided by the square of height in meters.

Effects of age on BMI & body composition

National health and nutrition examination survey (NHANES) study has shown that the percentage of people with a BMI of over 30 kg/m^2 increases from 20 years of age with a peak reached between the ages of 50–59 years. Beyond the age of 60 years, this percentage decreases. This holds for both sexes [2]. Attributable causes likely result from the fact that younger and middle-aged obese people have increased premature mortality. Hence, surviving older adults will show a lower BMI. Greater BMI was associated with higher all-cause mortality and cardiovascular disease-induced mortality in both sexes up to 75 years of age. However, the relative risk (RR) associated with greater BMI declined with advancing age. For example, for mortality from cardiovascular disease, the RR associated with an increment of a single unit increase in the BMI was 1.10 for 30–44-year-old men, but was only 1.03 for 65–74-year-old men. For women, the corresponding RR estimates were 1.08 and 1.02 [3].

Loss of lean muscle mass starts at approximately 30–40 years of age and progressively continues with advancing age [4]. By contrast, body fat mass increases throughout life. As a result of this effect, for any given BMI number an older patient has a greater amount of fat and a lower amount of fat-free mass (FFM) than a younger person with the same BMI. Intra-abdominal fat (IAF) accumulates more rapidly than total fat. Loss of lean body mass is mostly due to sarcopenia (loss of muscle mass and muscle strength). Kyle *et al.* found lower FFM and appendicular skeletal muscle mass (ASMM) in older compared with younger individuals with a proportionally greater percentage decrease in ASMM than in FFM. This suggests a greater loss of ASMM than a loss of organ muscle mass [5]. Since the fat mass increases with age at any given BMI, natural changes in elderly body composition would underestimate fatness. The loss of height

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associated with vertebral fractures that are common in the elderly would overestimate the given BMI [6]. Increase in visceral fat plays a major role in the pathogenesis of insulin resistance, which leads to Type 2 diabetes mellitus (DM) in addition to cardiovascular diseases [7].

Pathogenesis of obesity in the elderly

Obesity is a chronic disease in the same sense as hypertension and atherosclerosis with multifactoral etiology. There seems to be complex interaction among factors such as food intake, energy expenditure, genetic, hormonal and environmental influences. Some drugs can also contribute to weight gain. Imbalance between the energy ingested in food and the energy expended seems to be the major contributor [8] to obesity, especially in genetically predisposed people (**Figure 1**).

Energy intake

There is a physiological decline in food intake with aging. In addition alterations in taste and, more particularly, smell take place. A decline in adaptive relaxation of the fundus of the stomach and an increased rate of antral filling appear to play a role in the early satiation seen in many older persons. Cholecystokinin levels increase with aging while older persons become more sensitive to the satiating effects of this gut hormone. The decline in testosterone levels in older males leads to increased leptin levels and this may further explain the greater decline in food intake with aging in males.

Energy expenditure

Many older persons have mild inflammatory disorders that lead to anorexia. Exercise may increase food intake in older persons [9]. If the energy intake is reduced there must be a disproportionately higher decrease in total energy expenditure for a patient to gain weight. It is well known that the resting basal metabolic rate (BMR) decreases with age. Physical activity also decreases with age. The thermic effect of feeding (metabolic cost of assimilation) has been shown to be 48% lower in older men compared with younger men [10].

Aging is associated with decreased secretion of growth hormone and testosterone, both of which will decrease muscle mass and increase fat mass. Increased fat mass is associated with increased visceral fat, which predisposes patients to develop several metabolic diseases.

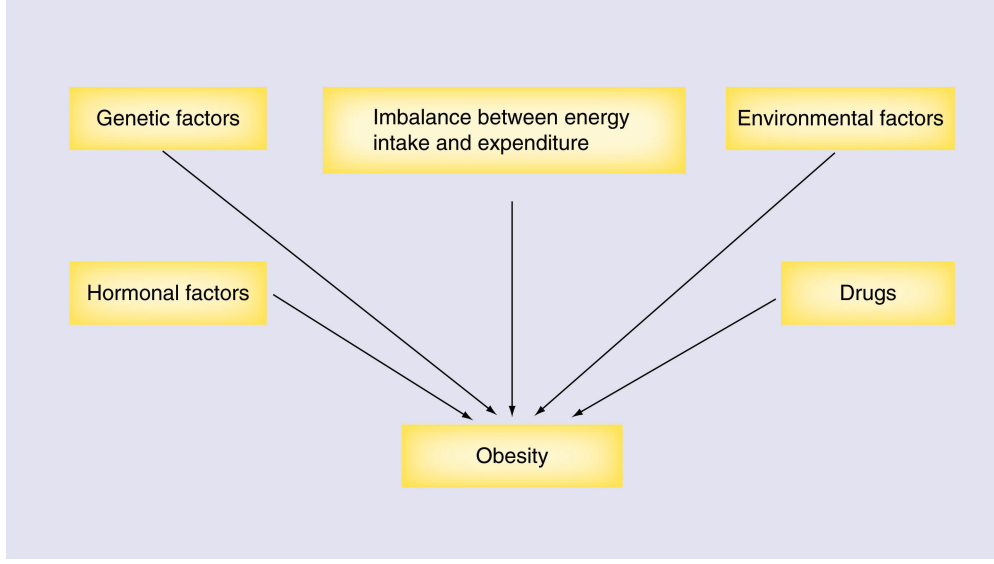
Medical complications associated with obesity

The medical complications associated with obese elderly patients seem to be higher than nonobese elderly.

Diabetes mellitus

According to NHANES III, 20% of men aged over 60 years and approximately 17% of women of the same age group have diagnosed or undiagnosed DM. This is almost one in five, making DM a major health concern in the elderly population [11].

Figure 1. Pathogenesis of obesity in the elderly.



Gaining and maintaining good glycemic control depends on enhancing insulin availability or secretion while overcoming insulin resistance. Central obesity and physical inactivity leads to hyperglycemia in the elderly and may hasten development of chronic complications. Since skeletal muscle is the largest reservoir for glucose disposal, lean muscle wasting from aging and inactivity exacerbate problems of peripheral glucose uptake. Muscle weakness, decreased muscle mass, decreased activation of glycogen synthase and changes in Type 2b skeletal muscle fiber numbers are related to and may precede insulin resistance, glucose intolerance and Type 2 DM [12]. Sarcopenia occurs predominantly because of testosterone deficiency in men and cytokine excess [13]. The mitochondrial DNA damage that occurs with aging can lead to increased accumulation of triglycerides (TGs) in cells. Increased TG accumulated in the muscle blocks the ability of the insulin receptor to phosphorylase the glucose transporter (GLUT), causing hyperglycemia [14]. As a group, older persons with DM experience not only an increase in mortality but also a decrease in function and quality of life. DM in older persons is also associated with an increase in falls that result in injury and can lead to the development of vascular dementia. In addition, DM appears to aggravate the age-related decline in cognitive ability. Persons with diabetes mellitus are more likely to develop pressure ulcers and congestive heart failure [15]. DM is also associated with urinary incontinence and depression in the elderly, both of which should be screened for.

Hypertension

People who are normotensive at the age of 50 years have 90% lifetime risk of developing hypertension [16]. The predominant cause for hypertension in the elderly is Essential hypertension. Vascular stiffness progressively increases with age [17]. This increases systolic Blood Pressure (BP) more than diastolic. As we know systolic BP rises progressively with age [18] and elderly people with hypertension are at greater risk for cardiovascular disease. In a study carried out to determine the association between BMI and BP in 80 year old subjects, it was found that a close relationship exists between obesity and hypertension, even in very elderly subjects [19].

Dyslipidemia

Obesity is associated with an unfavorable lipid profile. Lipid abnormalities related to obesity include an elevated serum concentration of total cholesterol (TC), low-density-lipoprotein (LDL) cholesterol, very LDL (VLDL) cholesterol, TG and Apo lipoprotein B (Apo B). By contrast, there is a reduction in serum high-density lipoprotein (HDL) cholesterol [20]. The mechanism(s) underlying this dyslipidemia is not fully understood, but involves the combination of insulin resistance and hyperinsulinemia stimulating hepatic TG synthesis driven by increased adipose tissue undergoing enhanced lipolysis. This leads to postprandial hypertriglyceridemia, smaller and denser LDL particles and reduced HDL cholesterol concentrations [21]. Patients with metabolic syndrome have low HDL and high TG. Since the metabolic syndrome is more common in elderly people it is reasonable to believe that these lipid abnormalities occur more frequently in this population. The prevalence of increased serum LDL cholesterol and decreased serum HDL cholesterol has been found to be significantly higher in elderly patients with atherosclerotic vascular disease plus dementia, atherosclerotic vascular disease without dementia and dementia without atherosclerotic vascular disease, than in patients with no dementia or atherosclerotic vascular disease [22].

Metabolic syndrome

The metabolic syndrome was present in 22.8 and 22.6% of US men and women, respectively. This sample consisted of 3305 black, 3477 Mexican–American and 5581 white men and nonpregnant or lactating women aged 20 years and older who participated in the cross-sectional NHANES III [23]. The prevalence of the metabolic syndrome rose with age, reaching peak levels in the sixth decade for men and the seventh decade for women. Prevalence rates declined in the eighth decade for men and women in some ethnic groups [23].

On the basis of recently defined criteria, persons were characterized as having metabolic syndrome if they had at least three of the following conditions [24]:

- Waist circumference greater than 102 cm (40 inches) in men and 88 cm (35 inches) in women;
- Serum TG level of 150 mg/dl (1.7 mmol/l) or greater;
- HDL cholesterol level less than 40 mg/dl (1.0 mmol/l) in men and 50 mg/dl (1.3 mmol/l) in women;
- Blood pressure of 130/85 mmHg or greater;
- Serum glucose level of 110 mg/dl (6.1 mmol/l) or more.

In addition, individuals who reported currently using antihypertensive or antidiabetic medication were counted as meeting the high blood pressure or glucose criterion, respectively. In a study with 3075 nondisabled men and women aged 70–79 years, the overall prevalence of metabolic syndrome was found to be 39%. Women had higher rates than men. Prevalence of metabolic syndrome was higher ($p < 0.01$) in obese (63 and 61%) than overweight (37 and 46%) and normal-weight (12 and 22%) men and women, respectively. When the attributable risk for metabolic syndrome was examined for each of the predictors, higher visceral adipose tissue (AT) was consistent across all BMI groups for both men and women to have the highest attributable risk associated with metabolic syndrome [25]. Patients with metabolic syndrome are at higher cardiovascular risk.

Cardiovascular disease

Increased weight in older age is associated with increased cardiovascular disease morbidity and mortality compared with nonobese elderly. This is due to the fact that several risk factors associated with cardiovascular disease (CVD) are increased in older obese patients. As mentioned above, DM, hypertension, hyperlipidemia and metabolic syndrome, which are cardiovascular risk factors, are more common in elderly obese patients than their nonobese counterparts.

Sleep apnea

Obesity is a major risk factor for obstructive sleep apnea (OSA). Over 75% of patients with OSA are reported to be over 120% of the ideal body weight [26]. Among those aged over 60 years, prevalence rates as high as 45–62% have been quoted [27]. Increased fat deposits in tissues surrounding the upper airway in obese patients may directly impinge on the airway lumen [28]. Upper-body fat deposits may increase airway collapsibility and interfere with the function of the inspiratory and expiratory muscles that maintain airway caliber. In addition, increased fatty deposits in muscle may decrease the mechanical efficiency of muscle function. Obesity-induced changes in central mechanisms regulating airway tone or ventilatory control stability may also be implicated. Leptin, for example, which is increased significantly in obese subjects, has important effects on regulation of chemo reflex function and hence breathing control [29]. Impaired pharyngeal sensory discrimination in older subjects also makes them more vulnerable to the occurrence and persistence of airway collapse during sleep [30].

Epidemiological studies have suggested a relationship between OSA and hypertension, stroke and ischemic heart disease [31]. These are thought to result, at least in part, from frequent intense sympathetic stimulation that occurs at the end of each obstructive phase. This type of sleep apnea is also associated with the release of proinflammatory and prothrombotic factors important in the development of atherosclerosis [32].

An important concept, especially for those who care for elderly people, is the notion that OSA can contribute to cognitive impairment, which is likely to be related to frequent oxygen desaturation. Janssens and coinvestigators have even suggested that sleep-disordered breathing be considered during differential diagnosis of reversible dementia in older patients [33]. The OSA-related daytime fatigue caused by fragmented sleep at night may aggravate daytime cognition, alertness and wakefulness, thereby resulting in less energy expenditure that increases net weight-gain.

In a 5-year study to evaluate respiratory disturbance index (RDI), the number of apneas and hypopneas divided by the estimated hours of sleep) it was shown that RDI increased with age and weight. Older, heavier men had the greatest increase in RDI [34].

Gastro-esophageal reflux disease

Overweight state and obesity are strong independent risk factors of gastro-esophageal reflux disease (GERD) symptoms and esophageal erosions [35]. GERD appears to be more common and more severe in the elderly. In the primary care setting in the USA, as many as 20% of older patients report acid reflux [36]. The high prevalence of GERD in the elderly may be explained, at least in part, by certain pathophysiological changes in esophageal function that occur with age, mainly a modification of the esophageal motility, effects on the lower esophageal tone and changes of the epithelial mucosal barrier of the esophagus [37].

Cancer

More than half of new cancers are diagnosed in the elderly [38]. For both men and women, increasing BMI was associated with higher death rates due to cancers of the esophagus, colon, rectum, liver, gallbladder, pancreas, kidney, non-Hodgkins' lymphoma and multiple myeloma.

Men were also at increased risk for death from stomach and prostrate cancer, while women were at increased risk of death from cancers of the breast, cervix, uterus and ovary.

There is growing evidence supporting the progressive decline in mitochondrial function with age. Mutations occurring in the mitochondrial and/or nuclear DNA, may be resulting in tumorigenesis [39].

Osteoarthritis

There is a marked increase in osteoarthritis in the obese elderly. It is most common in the knees and the ankles, which may be a consequence of trauma related to the excess body weight over a lifetime. The prevalence increases significantly with age, with as many as 68% of women and 58% of men aged 65 years or older having radiological evidence of disease. With an aging population, osteoarthritis (OA) will represent an increasingly significant healthcare burden [40].

Urinary incontinence

In a large study (7939 women) of community-dwelling women, aged 69 years or over, the self-reported incidence of urinary incontinence was 41%. Although incontinence does not cause death, it causes substantial morbidity and functional impairment [41]. There are anatomical (detrusor instability, detrusor laxity, outflow tract obstruction, loss of bladder-urethral angle, pelvic floor muscle laxity and detrusor–sphincter dyssynergia) and functional (psychological, physical and environmental) causes for urinary incontinence in elderly [42]. Weight reduction is desirable for obese women with urinary incontinence and may obviate the need for further incontinence therapy [43].

Dementia

Gorospe *et al.* did a systematic review of the literature and found eight population-based studies on increased BMI and dementia. These studies covered 1688 cases of dementia from 28,697 participants. After adjusting for age, smoking, comorbidities and other confounders, four studies showed significantly increased risk of dementia with increased BMI. Long-term studies to examine the mechanism underlying this relationship are needed [44].

Cataracts

Cataracts are commonly seen in the elderly. Cataracts causing visual impairment may be observed in up to 20% of the people over 65 years. In a 5-year follow-up study of apparently healthy 40–84-year-old physicians it was found that BMI was a determinant of incident cataract (defined as a self-report, confirmed by medical record review, first diagnosed after randomization, age-related in origin and responsible for a decrease in best corrected visual acuity to 20/30 or worse), although the precise mechanism is unclear [45].

Physical function & quality of life

Obesity can accelerate the age-related decline in physical function. Frailty is defined as diminished ability to perform the important practical and social activities of daily living (ADLs). ADLs include grooming, eating, bathing, shopping, climbing stairs and so forth [46]. Obesity is an important cause of frailty in older men and women. Frailty is an important problem in the older population because it leads to loss of independence and to increased morbidity and mortality. Obesity increases the risk of functional disability in older persons because of having to carry excess weight, along with age-related decreases in muscle mass and strength. Increased incidence of OA further decreases physical function. Physical frailty is common in community-living obese older adults, [47] and obesity is associated with increased nursing care facility admissions [48].

Beneficial effects of obesity

A low body weight is associated with low bone mass and an increased risk of fractures, whereas obesity is associated with increased bone mass and reduced bone turnover and loss. The reported higher risk of falling in the obese (particularly in those with greater abdominal fat) compared to lightweight individuals does not result in an increased risk of fracture due to higher bone mineral density (BMD) and the cushioning effect of the fat surrounding crucial areas such as the hip. Potential hormonal mechanisms regulating bone loss during weight loss may be decreases in estrogen, leptin, glucagon-like peptide-2, growth hormone and IGF-1, or an increase in cortisol. By contrast, the rise in adiponectin and ghrelin with weight reduction should not be detrimental to bone [49]. In postmenopausal women, high BMD associated with high BMI may be related to less pronounced estrogen deficiency owing to increased peripheral conversion of androgen to estrogen in adipose tissue of obese women [50].

Weight loss in the elderly obese

There are two types of weight loss: intentional and unintentional. Elderly obese people can have unintentional weight loss due to serious medical conditions.

Benefits of weight loss

In 6-month randomized, controlled trial with 40 elderly obese patients, it was demonstrated that diet-induced weight loss and exercise training improves physical function and ameliorates frailty in the obese older adult. Moreover, the improvements in objective measures of function, such as endurance, strength, gait and balance, were accompanied by subjective improvements in the ability to function. These findings demonstrate that weight loss and regular exercise have important beneficial effects in frail obese older adults by improving functional status and health-related quality of life [51].

Analysis of data from over 65-year-olds from the Nurse's Health Study showed that weight gain especially over 9 kg was associated with decreased physical functioning. Weight loss was associated with significant improvements in physical function among women with a BMI of over 30 kg/m^2 [52].

Effect of lifestyle intervention on metabolic CHD risk factors in obese older adults

McTigue KM *et al.* analyzed studies discussing older obese adults from 1980–2005 available on Medline. Intensive counseling strategies incorporating behavioral, dietary and exercise components promote a weight loss of 3–4 kg over 1–3.3 years. The loss is linked with improved glucose tolerance, improved physical functioning, reduced incidence of diabetes and a combined hypertension and cardiovascular end point [53].

Villareal *et al.* carried out a randomized, controlled trial of 27 elderly obese patients to examine the effects of lifestyle intervention (diet and exercise therapy) on CHD risk factors. Their findings showed that diet-induced weight loss and exercise training improved almost all of the obesity-related metabolic CHD risk factors simultaneously, including waist circumference, BP, circulating inflammatory markers, oral glucose tolerance, insulin resistance plasma glucose, TG and free fatty acid concentrations. Therefore, these data demonstrate that long-term CHD risk factors are reversible in obese older adults. Lifestyle therapy can improve or normalize the metabolic risks of CHD in older adults, as has been shown in young and middle-aged adults [54].

Body composition changes with weight loss associated with dieting

A total of 14 healthy postmenopausal women over the age of 55 years and with a BMI greater than 30 kg/m^2 were studied to evaluate body composition changes with dieting. The focus of this study was to quantify body composition effects in an elderly cohort of obese women after ingestion of a hypocaloric diet. They were advised not to exercise. The study was carried out over 16 weeks but the patients were followed up for 2 years. The findings suggest that a small fraction of weight loss consists of soft lean tissues including FFM and skeletal muscle (SM), whereas the majority of observed weight loss is from fat. This shows that women who diet experience body composition changes that are generally recognized as beneficial, even in the absence of vigorous exercise training [55].

A group of 61 obese elderly men were studied to assess at body composition changes with diet and exercise compared with matched control subjects. The results suggest that in older obese men, hypocaloric dieting combined with aerobic training does not attenuate the loss in fat-free mass that occurs during weight loss by hypocaloric dieting alone [56].

Treatment of obesity in the elderly population

Weight loss is expected to improve the medical conditions associated with weight gain. However, weight loss is usually associated with muscle and bone loss. Therefore, goals of weight loss therapy may differ in the elderly population. Improving quality of life and physical functions are the most important aims.

The optimal BMI for older individuals may be different from that of younger subjects. Management strategies should attempt to optimize the nutritional status of older individuals. Age *per se* cannot be used as a justification for denying medical management of obesity to elderly individuals. Individualized programs with the goal of achieving modest weight reduction in obese patients are likely to result in immediate (e.g., alleviation of arthritic pains and reduction of glucose intolerance) and possibly long-term (e.g., reduction in cardiovascular risk) healthcare benefits. Management should

emphasize lifestyle modifications that are less costly than medications and are free from adverse effects.

Treatment options available are the same as for younger adults. These include therapeutic lifestyle changes (e.g., diet and exercise), pharmacological interventions and surgery.

Lifestyle interventions

Hypertension, cholesterol, hearing, vision, DM and cancer screening are well integrated into health promotion programs. Unfortunately, nutrition promotion programs are not as well integrated. Reluctance to develop health promotion programs for older adults exist because of a misconception that they would not follow such plans nor change their lifestyles accordingly. However, the reality shown in longitudinal studies is that health promotion activities extend the number of years of health in older people, although the relationship weakens as age progresses. Changes in diet and exercise patterns are most effective in the prevention of nutrition-related conditions when they are instituted early in life, but positive benefits can occur at any age. If nutritional interventions are instituted early, a substantial reduction in healthcare expenditures may result from a decrease in the incidence or a delayed onset of these conditions. The use of a variety of adult education programs and models will enhance behavioral changes that lead to more healthy habits and enable a health educator to be successful in effecting change [57].

The optimal combination of diet and exercise for control of body weight and reduction in adipose tissue has been controversial. Hypocaloric dieting results in losses in weight, fat, central adiposity and lean mass in obese elderly men and women. Endurance exercise alone may reduce central adipose stores, but has only small effects on overall body composition. Adding aerobic exercise to an energy-restricted diet does not prevent the loss of lean tissue or markedly augment the fat losses. By contrast, resistance training during hypocaloric dieting augments lean mass while further reducing fat mass [58].

Data indicate that overweight and obesity can be associated with inadequate intake of desirable nutrients and unhealthy dietary patterns in rural older adults. It appears that overweight and obese women represent a nutritionally vulnerable group in need of targeted nutritional interventions to improve dietary patterns through increased consumption of nutrient-dense foods. Because older adults are a very heterogeneous group, further investigations are needed to discern the health consequences of different amounts of nutrient intake in obese older women. A better understanding of factors that are associated with adverse health outcomes, such as weight status and diet, may play a role in decreasing the use of healthcare services and improving the quality of life for older adults [59].

Although endurance exercise has been the more traditional means of increasing cardiovascular fitness, strength or resistance training is currently recommended by the American College of Sports Medicine as an important component of an overall fitness program. This is particularly important in the elderly, in whom loss of muscle mass and weakness are important deficits.

Studies in recent years show that strength training can reverse the loss of muscle function and the deterioration of muscle structure associated with advanced age [60]. Strength training improves functional ability and health, not only by increasing muscle mass, strength and power but also by improving BMD. Strength training also improves balance. Sarcopenia, osteoporosis and reduced balance are the main risk factors for falls and osteoporotic fractures [61]. Strength training may therefore prevent osteoporotic fractures, one of the main sources of physical disability and obstacles to independent living among elderly people [62]. Epidemiological studies (case–control and prospective cohort follow-up studies) consistently show that both past and current physical activity do protect against hip fracture, reducing the risk by up to 50% [63].

Most studies on strength training have used high-intensity, progressive resistance training protocols similar to those used by athletes, focusing on large muscle groups (hip and knee extensors). Trial subjects have trained with resistance of 80% of the maximal load the subject can fully lift once only and resistance has been increased as strength improves. For maximal effect, strength training should be performed 3 days a week for at least 3 months. Each muscle group should be exercised in three sets of eight repetitions each session. High-intensity strength training can be performed at home or in a group, but requires skilled instruction at the start [64].

Elderly obese patients will have improvements in cardiac risk factors with exercise. In addition, exercise will improve physical function and quality of life, which is very important in elderly obese patients.

Intervention should focus on moderate weight reduction through the modification of diet, exercise and behavior. Improvements in health and quality of life can be achieved with moderate weight reduction [65].

Pharmacotherapy

The safety and efficacy of currently approved drug therapies have not been sufficiently evaluated in elderly patient populations.

Sibutramine blocks the neuronal reuptake of norepinephrine, dopamine and serotonin and acts at a central level. It causes weight loss by increasing satiety, thereby reducing food intake. Common side effects include insomnia and constipation, which are not favorable effects for the elderly. Palpitations and increase in blood pressure are other complications that are concerning given the higher CVD risk of elderly obese patients.

Orlistat is a gastrointestinal lipase inhibitor. It causes weight loss by blocking the digestion and absorption of dietary fat. Its main side effects are gastrointestinal and include flatulence, fecal incontinence and diarrhea. Older patients with anorectal dysfunction may not tolerate this drug very well.

Surgery

Bariatric surgery is the most rapid and efficacious way to reduce weight. Indications include a BMI of more than 40 kg/m^2 or of 35–40 kg/m^2 with comorbid conditions such as DM, hypertension, sleep apnea and so forth [66]. No age limit was mentioned. There seems to be a higher morbidity and mortality associated with bariatric surgery in patients over the age of 65 years [67]. Bariatric surgery in the elderly represents 2.7% of all bariatric operations being performed at academic centers. Compared with nonelderly patients, elderly patients who underwent bariatric surgery had more comorbidities, longer lengths of stay and more overall pulmonary, hemorrhagic and wound complications. The in-hospital mortality rate was also higher in the elderly age group [68]. Patients aged 65 years or older seem to have substantially higher risk of death within the early postoperative period (fivefold increased risk in the first 90 days) compared with younger patients [69]. In contrast to the above information in a study carried out with 80 patients (60 ± 3 years) it was found that bariatric surgery was effective for older patients with a low morbidity and mortality. Older patients had more pre- and post-operative comorbidities and less weight loss than younger patients. However, the weight loss and improvement in comorbidities in older patients were clinically significant [70].

Future perspective

Obesity in the elderly is a growing field. In the next 5–10 years there should be a better understanding of this subject with emphasis on prevention of obesity and early detection of complications associated with obesity in the elderly. Preventive strategies should be started at a younger age and continued. There should be more healthcare coverage available for the elderly for management of obesity and related diseases. More emphasis should be placed on improvement of quality of life. This is more easily said than done. All these should be done with the help of a multidisciplinary team including healthcare providers, especially primary care providers and geritricians, dieticians, exercise physiologists, pharmacists and nurses.

Expert commentary

Obesity in the elderly is currently an underappreciated and hitherto a relatively poorly studied problem.

To compound the issue, present trends in the demographic imperative of an imploding baby boom generation, increasingly entering the golden years with higher than healthy BMIs, will necessarily strain the healthcare infrastructure already burdened by colossal healthcare expenditures from competing priorities of all age groups.

The increasing average life expectancy across the globe will undoubtedly mean the compression of multiple comorbidities towards the latter parts of life, which will be amplified and further aggravated for the obese elderly person. On the contrary, the benefits of obesity by reducing chance of hip fracture in the event of a fall are known.

Proactive, therapeutic lifestyle adaptations optimizing diet and exercise as key factors, started at the earliest opportunity in life and systematically consolidated through interdisciplinary interventions, represent the best hope for prevention of obesity in the elderly.

In the already obese, weight loss monitored safely by qualified healthcare personnel, gradually accomplished through a systematic validated multimodal process, is likely to achieve the greatest success.

There is yet a scarcity of good studies that validate the benefit and safety of weight-loss drugs in the elderly. However, in selected individuals, preferentially as an adjunct to a team approach,

Executive summary

- The prevalence of obesity (defined as a BMI of 30 kg/m^2 or more) is increasing in all age groups including the elderly.
- Etiology of obesity is multifactorial. The imbalance between energy intake and expenditure plays a major role.
- An older patient has a greater amount of fat and a lesser amount of fat-free mass than a younger person with the same BMI.
- The medical complications of obese elderly patients include medical complications owing to obesity and medical complications owing to age.
- Some of the medical complications associated with obesity include diabetes mellitus, hypertension, dyslipidemia, metabolic syndrome, cardiovascular disease, gastro-esophageal reflux disease, cancer, osteoarthritis, urinary incontinence, dementia and cataract.
- Obesity accelerates the age-related decline in physical function. Obesity is an important cause of frailty in older men and women.
- Obesity in associated with increased bone mass and reduced risk of fractures.
- Treatments of obesity in the elderly include lifestyle interventions, pharmacotherapy and bariatric surgery. Resistance or strength training is an important component of lifestyle intervention.
- Prevention of obesity and early detection of complications associated with obesity is very important. Preventative measures should be started at a younger age.

clearly tailored drugs to individual need are likely to achieve maximum benefits with minimal adverse outcomes.

Given the inherent and amplified perioperative surgical complications in the obese elderly, notwithstanding the abundant pre-existing comorbidities, make bariatric surgery a highly risky venture, at least for now, except in highly selected cases. Nevertheless, once sufficient expertise with increasing critical mass develops to support the availability of this procedure, it can be reasonably expected to benefit a larger percentage of the elderly obese population.

In summary, whatever the means applied to arrive at successful, safe and optimal weight reduction, the potential benefits of increased quality of life through reduced medical complications, concurrent with improved functional outcomes, certainly stand out to be the major accomplishment at an individual level.

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