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Medical complications in 166,601 surgical patients with morbid obesity vary directly with increasing age independent of BMI

Abstract

Objective: To identify the incidence of obesity co-morbidities by age in patients with obesity.

Methods: Pre-operative data on 166,601 patients from the Surgical Review Corporation's BOLD database was analyzed by age. Data: demographics, BMI, and percent of 33 obesity co-morbidities. Statistics: ANOVA for continuous variables; Dichotomous variables by general linear models.

Results: BMI and percent alcohol/tobacco/substance use, PCOS, mental health diagnosis, and pseudotumor cerebri varied inversely by age. Percent hernia, abdominal panniculitis, angina, cholelithiasis, CHF, DVT/PE, fibromyalgia, impaired function, GERD, diabetes, gout, hypertension, ischemic heart disease, dyslipidemia, leg edema, back pain, musculoskeletal pain, obesity hypoventilation, peripheral vascular disease, pulmonary hypertension, stress incontinence, and unemployment (n=23) increased directly with increasing age, peaking in the 60-70 and >70 years cohorts. Asthma, depression, psychologic impairment, and liver disease were highest in the 40-60 decades

Conclusions: In patients with obesity, weight-related medical conditions vary dramatically by age. Younger patients had highest BMI and suffered most from alcohol/tobacco/substance abuse and psychological problems. The major weight-related cardiopulmonary, abdominal/hepatobiliary, endocrine/metabolic, and somatic issues increased progressively with each higher decade of age. This advance knowledge of obesity risks by age may raise clinical index of suspicion, possibly facilitating presumptive management of patients with obesity and improved outcomes.

Keywords: obesity, bariatrics, comorbidities, aging

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Introduction

According to the CDC approximately 42.4% of the US adult population were obese between 2017-2018.[1] Pre-operative clinical characteristics of patients with obesity vary by race, by sex, and by health insurance carrier.[2–4] However, whether or not baseline clinical characteristics of patients with obesity differ by decade of age is not established. While previous authors have studied the distribution of weight, BMI, and some weight-related medical problems comparing older patients with younger groups, the literature lacks more specific and comprehensive evaluations by age. The objective of this study was to identify variation by decades of age in weight, BMI, and the incidence of weight-related medical problems in a large, comprehensive population of patients who were pre-operative for bariatric surgery.

Methods

With the approval of the Data Access Committee of the Surgical Review Corporation and the IRB of Our Lady of Lourdes Medical Center, Camden NJ, pre-operative data on 166,601 patients from the Surgical Review Corporation's Bariatric Outcomes Longitudinal Database (BOLD) who were pre-operative for bariatric surgery was analyzed retrospectively in six groups by age: <30 (n=18,119), 30-40 (n=41,879), 40-50 (n=46,911), 50-60 (n=40,788), 60-70 (n=17,475), >70 (n=1,429).[5] Data included age, weight, BMI, and 31 weight-related medical conditions.

Statistical analysis: Continuous variables were analyzed using an ANOVA. Pair-wise comparisons were performed on the least squares means of the treatments calculated from the ANOVA model to find differences in the treatment groups. Distribution of obesity co-morbidities was examined by using a general linear model with treatment in the model and modified for a binomial distribution to account for dichotomous variables.[6]

Results

Female/male percent varied inversely to age (84/16 <30 to 64/36 >70, p<0.0001). African-American/Caucasian/Hispanic race percent varied from 12.4/67.5/12.6 in the <30 group to 7.0/86.6/2.2 among patients >70 years of age (p<0.0001). BMI varied inversely related to age, ranging from <30 (48+-8), 30-40 (47.3 +/-8.1), 40-50 (46.6+/-8), 50-60 (46+/-7.5), 60-70 (45.3 +/-7) to >70 (44+-6) (p<0.0001). Cardiopulmonary co-morbidities by age are listed in Table 1. Heart failure (CHF), hypertension, obesity hypoventilation, DVT/PE, coronary artery disease (CAD) pulmonary hypertension, angina, asthma, sleep apnea (OSA), and leg edema (n=10) increased directly with age, <30 to 60-70/>70 years (p<0.0001).

Abdominal/Hepatobiliary and Endocrine/Metabolic co-morbidities by age are tabulated in Table 2. Stress incontinence, abdominal hernia, cholelithiasis, abdominal panniculitis, diabetes, gout and dyslipidemia varied directly with increasing age (p<0.0001). GERD, liver disease and menstrual irregularity were highest in 50-60 years-old cohort.

Table 1 Pulmonary and cardiovascular obesity comorbidities by age

Cardiopulmonary comorbidities											
Age	**CHF**	**HTN**	**ANGINA**	**PVD**	**PULM HTN**	**ASTHMA**	**OSA**	**OHS**	**DVT/PE**	**CAD**	**LEE**
<30	0.4	28.8	1.45	0.26	3.44	17.16	28.73	0.97	1.26	0.61	15.88
30-40	0.7	42.6	1.74	0.39	3.93	16.22	38.37	1.22	1.86	1.26	22.67
40-50	1.4	59.3	2.34	0.87	4.29	17.08	46.69	1.54	2.66	3.01	27.6
50-60	3	74.4	3.47	1.67	5.03	18.05	51.08	2.21	3.72	6.41	32.4
60-70	5.6	82.2	4.42	2.81	5.71	18.21	52.13	3.39	4.59	12.3	36.24
>70	6.6	84.8	3.64	3.36	5.53	16.24	48.29	3.43	5.18	18.33	35.62

All columns were significant at p<0.0001 Comorbidities are expressed as percent incidence.

CHF, congestive heart failure; HTN, hypertension; PVD, peripheral vascular disease; PULM HTN, pulmonary hypertension; OSA, obstructive sleep apnea; OHS, obesity hypoventilation syndrome; DVT/PE, deep venous thrombosis/pulmonary embolism; CAD, coronary artery disease; LEE, lower extremity edema

Table 2 Abdominal/ hepatobiliary and endocrine/metabolic obesity comorbidities by age

Abdominal/hepatobiliary and endocrine/metabolic comorbidities												
Age	**ABD hernia**	**Chole lithiasis**	**Gerd**	**ABD paniculitis**	**Liver disease**	**Stress incont.**	**DM**	**GOUT**	**Menstrual irregularity**	**Dysli pidemia**	**PCOS**	**Pseudo tumor**
<30	1.58	11.1	37.3	5.82	4.66	12.59	14.2	1.18	19.56	17.8	12.19	2.56
30-40	3.35	16.88	43.96	6.09	5.38	19.26	22.6	2.22	19.17	27.9	8.87	2.44
40-50	5.18	19.55	47.57	6.19	6.35	23.86	33.7	3.1	22.57	41.59	3.76	1.82
50-60	6.82	22.71	49.9	7.31	6.85	26.82	46.3	4.7	24.65	55.28	1.41	1.26
60-70	8.14	25.53	48.5	7.67	5.89	28.59	55.7	6.64	24.56	64.17	0.68	0.8
>70	7.42	24.28	44.44	6.09	3.99	30.65	57.7	8.19	23.65	64.73	0.35	0.49

All columns were significant at p<0.0001 Comorbidities are expressed as percent incidence.

ABD, abdominal; STRESS INCONT, stress incontinence; DM, diabetes mellitus; PCOS, polycystic ovarian syndrome

Psychological/Behavioral and Somatic co-morbidities are displayed in Table 3. Alcohol, drug, and tobacco use varied inversely with increasing age (p<0.0001). Mental health diagnosis was most common at 30-40 years, depression and psychological impairment at 50-60 years of age, and fibromyalgia at 60-70 years. Back pain, impaired function and musculoskeletal pain varied directly with increasing age (p<0.0001).

Table 3 Psychological/ Behavioral and Somatic Comorbidities compared by different age groups

Psychological/ behavioral and somatic comorbidities										
Age	**ETOH use**	**Tobacco use**	**Drug use**	**Psych impairment**	**Mental hx dz**	**Depression**	**Fibromyalgia**	**Back pain**	**Impaired function**	**Msk pain**
<30	32.71	9.2	0.65	14.58	10.12	28.48	0.84	43.28	0.63	29.88
30-40	32.97	7.75	0.43	16.1	11.04	32.43	1.98	46.33	1.04	36.32
40-50	31.48	6.9	0.43	16.6	10.77	34.91	3.36	47.3	2.35	42.82
50-60	28.63	5.15	0.36	16.94	10.31	38.04	4.68	49.27	4.46	49.99
60-70	25.83	3.43	0.17	14.71	8.01	34.88	4.79	51.51	7.61	53.34
>70	24.14	3.5	0.28	11.41	0.45	27.5	3.29	50.73	9.8	53.88

All columns were significant at p<0.0001 Comorbidities are expressed as percent incidence.

ETOH USE, alcohol use; MENTAL HX DZ, mental health disease; MSK PAIN, musculoskeletal pain

Discussion

The results of this study identify dramatic variation by decade of age in the pre-operative clinical characteristics of patients with obesity. BMI, alcohol, tobacco, substance use, PCOS, mental health diagnosis, and pseudotumor cerebri (n-6) were inversely proportional to increasing age. Caucasian race and most major cardiopulmonary, abdominal/hepatobiliary, endocrine/metabolic, and weight-induced somatic issues increased directly with advancing age. Although BOLD did not capture the length of time each patient was obese, for the most life-threatening weight-related complications these results suggest the concept of obesity years, with entrenched co-morbidities accumulating the longer patients carry excess weight. Our review of the literature indicates that the clinical variations inversely and

directly by decade of age in the percentage incidence of obesity co-morbidities observed here have not been reported previously and are important findings of this investigation.[7–9]

BMI and weight varied inversely with age. Higher BMIs were found in younger patients which could be due to hormonal changes in the body and decreased activity with aging affirming the results of Bhaskar et al.,[9] who reported that obesity (BMI>30) varied inversely with age, from 21.7% at 30 years to 1.3% >80 years. Weight-related cardiopulmonary problems correlated directly with increasing age, and in the overall population cardiopulmonary comorbidities varied directly with age as well.[7,10] Excess work required to sustain adequate systemic perfusion in patients with obesity puts ever increasing stress on the cardiovascular system. As that system ages, the adverse effects worsen in individuals with obesity. Hypertension,[11–17] increased with obesity to maintain perfusion, secondarily encourages gout by damaging the glomerular arterioles.[18] Decreased chest compliance from excess weight and increased neck girth cause increased work of breathing and obstructive sleep apnea. As the body ages and becomes weaker, compensating for this increased weight and work becomes more difficult, leading to more pronounced comorbidities.[11]

The prevalence of abdominal, hepatobiliary and metabolic/endocrine obesity co-morbidities also varied directly with increasing age. Stress incontinence affected >70-year-olds with obesity at the highest levels. Two mechanisms have been proposed: urethral hypermobility and a weak urinary sphincter exacerbated by increased abdominal girth increasing intrabdominal pressure.[12]

The incidence of type II diabetes, gout and dyslipidemia increased directly with age. Synergistic with hypertension, increased gout may be influenced also by increased insulin resistance leading to impaired renal urate excretion [18].

As a patient age, an increased sedentary lifestyle causes dyslipidemia, showing an upward trend with age[21]. Enlarged adipocytes leads to infiltration of macrophages and imbalance between pro/anti-inflammatory cytokines causing multiple obesity related metabolic processes including dyslipidemia.[19]

PCOS and pseudotumor cerebri varied inversely with age. Obese patients seen with PCOS with half of the patients having insulin resistance leading to subsequent endocrine derangements.[17] As shown in the data here, BMI is inversely related to age, causing PCOS to be inversely related as well. Pseudotumor cerebri has a strong link to obesity. Daniels found that moderate weight gained at a fast rate in both the obese and BMI<30 category was associated with higher rates of pseudotumor cerebri.[17]

The midrange ages suffered most from psychological comorbidities, abdominal hernias, cholelithiasis, GERD, liver disease, panniculitis, and menstrual irregularity. To our knowledge this is the first report of psychological comorbidities affecting 40-60-year-olds with obesity more than <30 and <70 years. The mechanism for this middle age obesity disparity for depression, other mental health diagnoses, and psychological impairment is not clear from the literature. It may be that the Collins and Bentz loop of depression driving eating, furthering depression and again overeating from the depression becoming entrenched in middle age is a factor.[16]

Abdominal hernias are commonly seen in older populations due to decreased integrity of the abdominal wall. In this study, hernias were more common in the 40-60 age group.[20–23] The excess weight on the abdominal wall due to obesity increases the hernia rate in the older population due to the weaker abdominal wall versus in the younger population, causing more hernias in the older age groups despite BMI being higher in younger age groups.

Additionally, the data presented shows GERD highest in the 40-60 age group, when BMI is highest in the <30 age group. GERD increasing with age is reported, commonly due to esophageal dysmotility and decreasing lower esophageal sphincter tone.[13] This is exacerbated by the increased intrabdominal pressure from obesity.

Cholelithiasis and liver disease have increased prevalence in the obese population. Kharga and co-workers observed that for each numeric increase in BMI, the risk of gallstone related disease increased by 7%.[14] The data report here shows the presence of cholelithiasis highest in the 40-60 age range. This is support by Tanno et al who correlated cholelithiasis increasing by age in the obese population with >80% of operations happening over age 40.[24]

Non-alcoholic fatty liver disease (NAFLD) is well documented in obese patients related to increased adiposity and resistance to insulin progressing to non-alcoholic steatohepatitis, cirrhosis, and possibly hepatocellular carcinoma [15]. It can be speculated, that even though BMI and alcohol use is highest in <30 age group, the prolonged effects of obesity on the liver may be the cause of NAFLD being highest it the 40-60 age range.

Among patients with obesity, somatic comorbidities including back pain, musculoskeletal pain, and impaired functional status varied directly with increasing age linearly seen in the data presented. Zdziarski et al.,[20] purposed a pain cycle. Obesity is proinflammatory, so the increased wear and tear on the body from the excess weight is magnified by proinflammation processes leading to exaggerated pain leading patient to move less increasing weight gain propagating the cycle. This cycle is exacerbated over decades the patient has obesity.[20] Advance knowledge of direct age variation in somatic issues should raise index of suspicion for pain management and impaired function in elderly patient with obesity.

In younger populations, alcoholism and drug abuse is growing at faster rate in the younger population, supporting the data presented here with alcohol, drug, and tobacco use inversely related to age. According to the NSDUH, 52.5% of college students drank in the past month with 33% reporting binge drinking. With the excess calories of alcohol contributing to obesity, it causes and inverse relationship with age.[22] Ten percent of patients requesting bariatric surgery reported alcohol or illicit drug abuse likely caused by obese patients being negatively viewed by society putting them at risk for substance and alcohol abuse.[10,16]

There are limitations to this study. It carried the usual retrospective investigation confounders. BOLD database patients self-selected bariatric surgery, therefore the findings may not apply to all patients with obesity. Co-morbidities in BOLD were defined by clinical criteria only.

Conclusion

In 166,601 adults with morbid obesity, clinical characteristics varied significantly by age. BMI, and the percentage incidence of PCOS and pseudotumor cerebri increased linearly in inverse proportion to increasing age. Conversely, the major cardiopulmonary, abdominal/hepatobiliary, endocrine/metabolic, and somatic diseases increased directly with increasing age. While some of these conditions occur more frequently in older segments of the general population, our review of the literature indicates that the direct association among patients with obesity of such important medical maladies directly with increasing decade of age within such a large database

has not been reported previously. Although the exact length of time each patient had obesity was not recorded in BOLD, these findings suggest the concept of obesity years, in which the longer one has obesity, the more weight-related medical problems one accumulates. This advance knowledge of obesity co-morbidities that vary directly, inversely, and significantly non-linearly with age can raise the index of suspicion for underlying diseases among physicians of all disciplines, hopefully leading to objectively targeted interventions, presumptive management and possibly improved outcomes of medically fragile patients with obesity.

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Conflicts of interest

The authors declare there are no conflicts of interest.

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