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Running title: Comorbidity in obesity burden

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Abstract

Objective

The association of obesity with a large range of physical conditions and numerous psychiatric disorders has been extensively studied. Our study sought the extent to which physical conditions or psychiatric disorders associated with obesity mediate the association of obesity with unemployment or disability.

Method

Using data from the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III, 2012-2013), we estimated the prevalence of unemployment as a function of obesity taking into account these comorbidities. Data on self-reported height and weight were available for 35,725 respondents. Clinician-diagnosed physical conditions were self-reported and lifetime psychiatric disorders were assessed with a semi-structured interview.

Results

The adjusted prevalence of obesity was 30.4%. Participants with obesity were more likely than participants without obesity to report at least one of the 31 assessed physical conditions (64.46% vs 46.87%; $p<0.001$). Participants with obesity were more likely to report at least one of the 24 assessed psychiatric diagnoses than respondents without obesity (60.57 vs 56.75%; $p<0.001$).

The rates of unemployment were higher in participants with obesity than in those without obesity (15.75% vs 11.26%; $p<0.001$). Similarly, participants with obesity reported higher rates of disability than those without obesity.

While the number of physical conditions and psychiatric disorders partly explains this association, obesity remained significantly associated with unemployment and greater disability when controlling for the number of physical conditions and psychiatric disorders.

Conclusion

Obesity is associated with high rates of unemployment and with high disability. This is not explained solely by the high rate of physical conditions and psychiatric disorders associated with obesity.

Introduction

In 2011 in the United States the prevalence of obesity was 34.9% among adults (Ogden et al., 2013), and obese adults have high rates of a large range of physical (Must and McKeown, 2000; Nowicki et al., 2003) and psychiatric disorders (Chao et al., 2019; Petry et al., 2008; Scherrer et al., 2018). Some of these disorders are directly induced by body weight (osteoarthritis, acanthosis nigricans), some are indirectly associated with obesity through increased cholesterol turnover (e.g gallbladder disease) or insulin resistance (e.g diabetes, hypertension). Obesity is also associated with a high prevalence of psychiatric disorders, obesity being either a characteristic of these disorders, a treatment side effect or a consequence of the psychiatric disorder considered (Boulanger et al., 2018; Hay and Mitchison, 2019; Pisano et al., 2018). Obesity is also linked with important direct and indirect social consequences, including lower income, higher rates of disability and lower rates of employment (Caliendo and Lee, 2013; Jusot et al., 2008; Withrow and Alter, 2011). However, the extent to which the physical conditions or psychiatric disorders associated with obesity mediate the association between obesity and these social consequences is unknown. Therefore, we (i) estimated the association of unemployment and disability with obesity and (ii) measured the extent to which physical and psychiatric disorders associated with obesity contribute to this association.

Materials and methods

Sample

We analysed cross-sectional data from a population based national representative sample, the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III), a face-to-face survey of 36,309 adults (response rate was 60.1%), aged 18 years and older from the civilian non-institutionalized population residing in the United States, conducted by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) in 2012–2013. The NESARC used a multistage stratified design with primary sampling units were stratified according to sociodemographic criteria. The NESARC oversampled Blacks, Hispanics, and Asian respondents. Data were adjusted for oversampling and

household- and person-level non-response. The weighted data were then further adjusted to represent the civilian United States population based on the American Community Survey 2012. For a detailed description of the sampling design, we refer our reader to Grant et al (Grant et al., 2014). Characteristics of interviewers, training and field quality control have been described elsewhere (Hasin et al., 2015). Recruitment and informed consent procedures received full ethical review and approval from the institutional review boards of the National Institute of Health and Westat, and from the French Institute of Medical Research and Health (Comité d'Evaluation Ethique de l'Inserm).

Measures

BMI and obesity

Data on self-reported height and weight were available for 35,725 respondents. BMI was calculated by dividing weight in kilograms by the square of the height in meters. Participants were considered obese if their BMI was 30.0 or greater (n=11,307).

Diagnostic interview

Lifetime DSM 5 psychiatric disorders were assessed with the National Institute on Alcohol Abuse and Alcoholism's Alcohol Use Disorder and Associated Disabilities Interview Schedule 5 (AUDADIS-5). In the present study, we report lifetime prevalence for mood disorders, including major depressive episode, bipolar disorder (type I or II) and dysthymia. We also report lifetime prevalence for anxiety disorders, including panic disorder, specific phobia and generalized anxiety disorder. Post-traumatic stress disorder was assessed and included within the anxiety disorder cluster. Eating disorders included anorexia, bulimia and binge eating disorder. Lifetime personality disorders included schizotypal, borderline and antisocial disorders. Lifetime substance use disorders required at least 2 of 11 criteria within a single year. Substances of abuse assessed included alcohol, nicotine and other drugs, including cannabis, club drugs, cocaine, amphetamine, hallucinogen, heroin, opioid, sedative, tranquilizer, solvent or inhalant. Test-retest reliability of AUDADIS-5 diagnoses were fair to excellent (k range, 0.35-0.87) (Hasin et al., 2015).

Possible psychotic disorder was indicated by asking respondents whether they had been told by a doctor or other health professional that they had schizophrenia or a psychotic illness or episode.

Physical conditions

The NESARC-III examined past-year prevalence of 31 physical conditions including cardiovascular conditions (arteriosclerosis, diabetes, hypertension, angina, tachycardia, myocardial infarction, other heart disease, stroke), liver diseases (cirrhosis, other liver disease), dyslipidaemia/diabetes (including hypercholesterolemia, hypertriglyceridemia and diabetes), digestive diseases (stomach ulcer, pancreatitis or any bowel disease), cancers, (breast, liver, mouth or other cancers, lung problems), nervous disease (seizure, reflex sympathetic dystrophy or complex regional pain syndrome, fibromyalgia, other nervous disease), osteoporosis, lung problems or tuberculosis, HIV or AIDS, sexually transmitted diseases, traumatic brain injury, arthritis and anaemia. When administered the survey, participants were provided with nontechnical descriptions of the physical condition. Respondents were asked whether a physician or other health-care professionals diagnosed the condition.

Unemployment and disability

Participants were considered unemployed whatever the reason for being out of the labour force (e.g: looking for work or not, permanently disabled or not). Participants were considered as a part of the labour force if they were available to work (e.g: not retired, full-time or part-time student or full-time homemakers). Disability was determined using the 12-items Short Form Health Survey (SF-12), a reliable and valid measure of current impairment used in population surveys. The SF12-V2R included Physical Component Summary (PCS), Mental Component Summary (MCS) and eight subscales exploring eight health concepts (physical function, role-physical, pain, general health, vitality, social health, role-emotional, mental health). Each norm-based disability score has a mean of 50, SD of 10, and ranges from 0 to 100. A lower score reflects greater disability.

Other measures

We considered sociodemographic characteristics, including sex, race, nativity, age, educational level, individual income, marital status, urbanicity and region of residence.

Race/ethnicity was categorized into: (i) White, (ii) Black, (iii) Asian/Native Hawaiian/Pacific Islander, (iv) Hispanic/Latino, and (5) American Indian/Alaska Native. Nativity was categorized into (i) U.S.-born and (ii) foreign-born. Age at interview was categorized into: (i) 18–29, (ii) 30–44, (iii) 45–64 and (iv) ≥65 years old. Educational level was classified into: (i) less than high school, (ii) high school graduate, and (iii) some college or higher. Individual income was classified into: (i) $0–19,999, (ii) $20,000–34,999, (iii) $35,000–69,999, and (iv) $70,000 or greater. Marital status was categorized into: (i) married or common law, (ii) widowed, (iii) divorced or separated, (iv) never married. Urbanicity was classified into: (i) rural or (ii) urban. Region of residence was classified into: (i) Northeast, (ii) Midwest, (iii) South, and (iv) West.

Statistical analyses

Weighted estimates and standard errors (SEs) were computed using SUDAAN, version 11.01 (Research Triangle Park, NC). The NESARC-III used a multistage sampling design with an oversampling for Hispanic, black, and Asian individuals; and data were adjusted to represent the US population based on the 2012 American Community Survey (Hasin et al., 2015).

Successive multivariable logistic regression models with different adjustment factors were used : (i) socio-demographic characteristics including sex, race, nativity, age, education, income, marital status, urbanicity and region, (ii) sociodemographic characteristics and for the number of psychiatric disorders, (iii) sociodemographic characteristics and for the number of physical disorders and (iv) sociodemographic characteristics and for the number of physical and psychiatric disorders. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs), unstandardized linear regression coefficients and SEs are presented to reflect association strength and significance.

Results

Prevalence and sociodemographic correlates

In our sample, the estimated prevalence of obesity was 30.26% (SE:0.46), with no gender difference. Obesity was more common among Black, Native American or Hispanic participants and less common in Asian than in white participants (Table 1). Odds of obesity were greater in participants born in the US than in participants born outside the US. Rates of obesity were greater in participants aged 30 years or older than among those who were younger. Respondents with post-secondary education had lower odds of obesity than those with lower educational level. The association with income was inconsistent. The prevalence of obesity was higher in never married or widowed participants than in those currently married or living with a partner. The prevalence of obesity was higher among respondents living in rural areas than in those living in urban areas, and higher in the Midwest and in the South than in the Northwest (Table 1).

Comorbidity with physical conditions

Participants with obesity were more likely than participants without obesity to report at least one of the 31 physical conditions assessed in the AUDADIS 5 (64.46% vs 46.87%; $p<0.001$; Table 2). Obesity was associated with higher odds of hypertension, angina, tachycardia or other heart disease, as well as dyslipidemia or diabetes, pancreatitis or bowel disease, fibromyalgia, nervous system diseases, lung problems, arthritis and anemia. Obesity was negatively associated with osteoporosis, with an OR of 0.76 ($p<0.001$). The prevalence of these physical conditions differs widely, from a low of 0.37% for hepatic cirrhosis to a high 37.87% for hypertension in participants with obesity. Obesity is strongly related with high rates of physical conditions. While the proportion of participants reporting exactly one physical condition did not significantly differ between participants with and without obesity, the strength of the association with obesity increases with the number of comorbidities, ranging from an OR of 1.25 ($p<0.001$) for participants reporting exactly two physical conditions to an OR of 2.24 for participants reporting four or more physical conditions ($p<0.001$).

Comorbidity with psychiatric disorders

Participants with obesity were more likely to report at least one of the AUDADIS-5 psychiatric diagnoses than respondents without obesity (60.57 vs 56.75%; $p<0.001$), with an odds ratio of 1.11 after controlling for sex, race, nativity, age, education, income, marital status, urbanicity and region (Table 3). Obesity was significantly associated with 3 out of 4 assessed mood disorders (including major depressive episode, bipolar type I and dysthymia), all assessed anxiety disorders (including panic disorder, social anxiety disorder, specific phobia, generalized anxiety disorder, post-traumatic stress disorder) and with post-traumatic stress disorder, and binge eating disorder with odds ratio ranging from 1.11 to 3.86 (all significant $p<0.001$). Obesity was negatively associated with alcohol use disorder with an OR of 0.93 ($p<0.001$), and anorexia nervosa with an OR of 0.40 ($p<0.001$). The proportional elevation in the prevalence of psychiatric disorder among participants with obesity as compared with those without obesity did not vary systematically with the number of comorbid disorders.

Unemployment and disability

The rates of unemployment were higher in participants with obesity than in those without obesity (15.75% vs 11.26%; $p<0.001$; Table 4). When considering only participants in the labor force, the prevalence of unemployment remains higher in participants with obesity than in those without (21% vs 16%; $p<.0.001$) (Table 4). This is reflected in an unadjusted OR of 1.47 in the full NESARC sample and an unadjusted OR of 1.39 in the labor force subsample (n=24,531). When controlling for sociodemographic factors including sex, race, nativity, age, education, income, marital status, urbanicity and region, the odds ratio decreased to 1.32 and 1.30 in the full sample and in the labor force subsample respectively (all $p<.0.001$). While the strength of the association remains stable after adjustment for the number of psychiatric disorders (OR of 1.31 and 1.31 in the full sample and in the labor force subsample respectively, all $p<.0.001$), this association decreased to OR ranging from 1.11 to 1.16 (all $p<.0.001$) when controlling for the number of physical conditions, irrespectively of the addition of the number psychiatric disorder to the model.

Participants with obesity reported significant impairment in both Physical Component Summary (PCS) and Mental Component Summary (MCS), as well as in all the eight subscales, as reflected by the unstandardized linear regression coefficients (Table 5). When controlling for sociodemographic factors, these coefficients became slightly smaller but all remained significant, as when adding the number of psychiatric disorders to the model. When controlling for the number of physical disorders, seven out of the ten associations remained significant, regardless of the addition of the number psychiatric disorder to the model.

Discussion

Main findings

Characteristics of obese adults as compared with the scientific literature

The 30.7% prevalence of obesity in 2012-2013 in the NESARC-III is within the 30.5-37.9% range reported in other samples of American adults (Fakhouri et al., 2012; Ogden et al., 2013, 2012, 2006; Seidell and Halberstadt, 2016). Associations of obesity with several sociodemographic factors are in line with previous studies. The absence of association with gender has been consistently shown (Fakhouri et al., 2012; Ogden et al., 2013). Similarly, the higher prevalence of obesity in Black, Native American and Hispanic ethnicity, and the lower prevalence among Asian compared to white adults has been emphasized in other US surveys (Ogden et al., 2013). The lower prevalence of obesity in immigrant compared to US born adults has been the focus of various studies (Akresh, 2008; Gong et al., 2019; Oza-Frank and Cunningham, 2010). For instance, according to Akresh et al., Foreign-born Hispanic people were less obese than U.S born people (Akresh, 2008). In several studies in U.S population, better health outcomes have been described among immigrants: it is called "immigrant paradox " (Boen and Hummer, 2019; Oh et al., 2015; Salas-Wright et al., 2018). Noteworthy, this association seems to be reversible, as suggested by a systematic review showing a positive relationship between BMI and duration of residence in the US (Oza-Frank and Cunningham, 2010).

We can hypothesize that changes in way of life, nutrition, physical activity as well as social factors, are involved in the increase of BMI over the years pasted in the country.

The educational and socio-economic disparity of obesity has been identified with findings similar to those of the present studies, the prevalence of obesity converging in the population without a college degree or with lower income (Samouda et al., 2018; Schoenborn et al., 2013; Sobal et al., 1992). In the present study, only participants with higher education (college or higher) or in the highest income category had prevalence rates of obesity lower than the reference group. The higher rate of obesity in married adults relative to adults in other marital status group has been shown, particularly in men (Samouda et al., 2018; Sobal et al., 1992). The association between urbanicity and obesity has been described elsewhere, although the geographic risk factors of obesity are complex and should take into account multiple factors, including built environment, poverty level, and prevalence of fast-food restaurants for example (Wang et al., 2013).

Obesity and psychiatric disorders

The generally significant association between obesity and mood disorders (including major depressive episode, bipolar type I disorder and dysthymia), anxiety disorders (including panic disorder, social anxiety disorder, specific phobia and generalized anxiety disorder) and post-traumatic stress disorder is consistent with the existing literature (Bartoli et al., 2015; Petry et al., 2008). The magnitude of the differences found in mood and anxiety disorders in obese and non-obese people are similar to those found by other cohorts (Atlantis and Baker, 2008; Ma and Xiao, 2010; Pan et al., 2012; Rajan and Menon, 2017; Simon et al., 2006). For instance, Simon et *al*. found that depression concerned 18% of non-obese and 22% of obese in an sample of 9125 U.S adult; which is really near than 19.25% vs 22.67% of depression in our sample (non-obese and obese respectively). The same type of results were found for generalized anxiety disorders: 7.11% vs 9.06% in the obese in our sample and 5.4% vs 6.5% in the obese in the study by Simon et *al*. (Simon et al., 2006). The absence of association with substance use disorders, as well as the negative association

with some substance use disorder has also been described (Le Strat and Le Foll, 2011; Simon et al., 2006).

Obesity was significantly associated with any psychiatric disorder, although the difference between the two groups was not so high (56% vs. 60%). The fact that the results were inhomogeneous, positive association with mood disorders, anxiety and binge eating and negative association with alcohol and drug use disorders, may contribute to limit the gap.

People with psychiatric disorders, had markedly premature mortality (Walker et al., 2015). More than half of the death attributed to natural causes, and cardiovascular disease and diabetes are the leading causes (Crump et al., 2013b, 2013a; Ringen et al., 2014). Higher rates of obesity among patients with psychiatric disorders could be implicated in this early mortality.

Obesity and physical conditions

Our findings of significant comorbidity of obesity with several physical conditions are convergent with those of surveys conducted in the US or in other countries. Interestingly, we found that the number of physical comorbidities increases the strength of the association with obesity. The strongest associations showed with cardiovascular conditions, dyslipidemia and diabetes are consistent with existing studies (Mokdad et al., 2003). The only statistically significant negative association of obesity with a physical condition, osteoporosis, is in line with previous findings suggesting that obesity is associated with greater bone density and could be a protective factor for osteoporosis (Albala et al., 1996; Leslie et al., 2018; Zhao et al., 2007). These findings on the high prevalence of physical conditions associated with obesity are convergent with the elevated cost associated with obesity, which accounts for about 12% and 20% higher than normal weight individuals of the total health expenditure in the US (Leung et al., 2017), and between 0.7% and 2.8% of the total health expenditure outside US (Van Nuys et al., 2014).

Obesity and lack of employment

A new finding of our study is the importance of controlling for sociodemographic factors as well as for the number of psychiatric and physical conditions when examining the association between obesity and unemployment. Our finding of an unadjusted OR of 1.39 between obesity and unemployment is consistent with previous studies (Caliendo and Lee, 2013; Jusot et al., 2008; Tunceli et al., 2006). The importance of physical and psychiatric comorbidities associated with obesity on worker's compensation payments has been emphasized as a reason for unemployment in previous studies. Workers with obesity benefit more frequently from medical care and income replacement (indemnity) than workers without obesity (Kleinman et al., 2014; Ostbye et al., 2007; Van Nuys et al., 2014), and the high rate of comorbidities might contribute to the lower rate of employment in adults with obesity. However, the finding that the OR between obesity and unemployment were reduced but remained significant when controlling for psychiatric and physical comorbidities was unexpected. This highlights that obesity has important negative effect on employment by itself. The exact mechanisms of this direct association of obesity with unemployment remained unclear, and this association does not necessarily imply causation. Among many plausible explanations for the association between obesity and unemployment, two hypotheses could be mentioned. First, obesity may be associated with a decreased chance of employment because of the associated stigma. Indeed, a bias against job applicants with obesity by human resource professionals has been described (Giel et al., 2012; Pingitore et al., 1994). An alternative hypothesis is that participants with obesity may internalize stigma and may be less likely to apply for jobs. However, this last hypothesis is less likely, since obesity is associated with more employment applications and a higher involvement in job training programs (Caliendo and Lee, 2013).

Furthermore, unemployment might be specific to some sociodemographic groups, and for example has not been shown in youth (Laitinen et al., 2002). The design and interview of the NESARC does not allow for definitive conclusion, but this findings warrants further investigation.

The finding that obesity is positively associated with disability in all SF12 subscales is consistent with previous findings (Alley and Chang, 2007; Ul-Haq et al., 2013). All but three out of ten measures

remained associated with obesity after controlling for the number of psychiatric disorder and the number of physical conditions, suggesting that obesity is associated with various impairments by itself even if the strength of the associations with the outcomes considered in our work became smaller when psychiatric disorders and physical conditions were taken into account.

Our results should be interpreted in the context of several limitations. First, information on height and weight were based on self-reports and was not confirmed by direct measurement. Self-reports tend to underestimate BMI (Connor Gorber et al., 2007; Stommel and Schoenborn, 2009) but are unlikely to influence conclusions about associations with unemployment, even if the last is also reported by participant. Furthermore, the adjustments for sociodemographic characteristics made in our study further decreased the risk of misclassification (Le Strat and Le Foll, 2011).

Second, the cross-sectional design of the NESARC as well as the absence of data on the onset of obesity and unemployment preclude any conclusion on the temporal association between these two conditions.

Despite these limitations, our study shows that obesity is associated with unemployment, and emphasizes that this association is not solely explained by the higher rate of psychiatric disorder or physical conditions associated with obesity.

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