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DEPRESSION SEVERITY AS A RISK FACTOR OF SARCOPENIC OBESITY IN MORBIDLY OBESE PATIENTS

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Abstract: *Setting:* Etiopathogenic factors of physical disability in obesity are numerous, underestimated and not sought in the non-geriatric population. Amongst these factors, depression may favor the development of sarcopenic obesity by reducing strength and physical performance even in the absence of overt muscle loss. *Objectives & participants:* To study the link between depression status and muscle functional disorders (dynapenia) in a population of adult subjects with severe and morbid obesity. *Measurements:* Patients were assessed for body composition, grip strength, the Short Physical Performances Battery test (SPPB), for depression according to the Beck II score as well as for metabolic parameters through biological tests. *Results:* In 373 obese subjects (mean age 44 ± 13y and BMI 43 ± 6 kg/m²), the prevalence of depression was 53% with 18% having mild depression, 18% moderate depression and 16% severe depression. Depression was significantly related to dynapenia: 62% of dynapenic (D) patients suffered from depression compared to 50% of non-dynapenic (ND) patients ($p = 0.036$). The Beck questionnaire score for D patients was 20 ± 13 and 15 ± 10 for ND patients ($p = 0.001$). The depression intensity was significantly correlated with dynapenia with D patients having a higher severe depression degree than ND patients (30% versus 11%; $p < 0.0001$). Fat-free to fat mass ratio was also significantly correlated with dynapenia ($p = 0.01$). In multivariate analysis, the presence of depression was twice as likely to be associated with dynapenia. *Conclusions:* Depression is associated with a reduction of muscle function in severe obesity in relation to its severity and to changes in fat to fat-free mass, suggesting that screening and prevention of sarcopenic obesity should be considered in adult obese patients with depression.

Key words: Obesity, muscle, depression, sarcopenia, mobility.

Abbreviations: BED: Binge Eating disorders; BMI: Body mass index; D: dynapenic; DBP: Diastolic blood Pressure; DEBQ: Dutch Eating Behavior Questionnaire; FM: Fat mass; HT: Hypertension; LM: lean mass; MDD: Major depressive disorders; MS: Metabolic syndrome; ND: non dynapenic; SAS: Sleep Apnea Syndrome; SO: Sarcopenic Obesity; SBP: Systolic Blood Pressure; SPPB: Short Physical Performances Battery.

Introduction

Obesity is a chronic multifactorial disease which can lead to numerous complications resulting in a lower quality of life and increased public health costs. Obese patients can suffer from mobility disorders of which the frequency and the impact are largely underestimated (1). There are multiple causes for these disorders: arthropathy, pain, respiratory disorders, muscle dysfunction and fatigability. Sarcopenic obesity (SO) is a new clinical entity conceptually characterized by an excess of fat mass (FM) associated with a reduction of muscle mass and/or function (2). Initially, sarcopenia was defined in older people as a geriatric syndrome characterized by a progressive loss of muscle mass, but more recently it was also associated with a loss of muscle strength and/or performance, thus leading to a reduction of physical abilities, a loss of autonomy and therefore a reduction in the quality of life (3). Obesity and sarcopenia can occur simultaneously in elderly people for whom the appearance of excess weight can aggravate muscle functions (4). The prevalence of SO ranged from 0 to 84% in females and from 0 to 100% in males, depending upon which definition was applied (5). On a metabolic level, lipotoxicity, chronic inflammation, insulin resistance and a low level of physical activity can lead to a progressive reduction of muscle mass and function, and thus leading to SO (6, 7). The consequences of SO are not well known, but studies suggest that SO is a risk factor of frailty, the deterioration of quality of life and mortality (8–11). Nevertheless, the results of these studies are variable, in particular due to the variability of the criteria for assessing this syndrome (5, 6). At the present time, there is no consensus on the definition of SO, in particular with regard to morphological and functional criteria and potential determining factors (6). Moreover before occurring in elderly subjects, SO can develop in younger subjects. The causes are still uncertain while systemic chronic diseases and a sedentary lifestyle are major factors.

According to the WHO, depression is a common psychiatric pathology. A depressive episode is characterized by the presence of at least five of the following nine symptoms occur daily for at least fifteen days: sadness, a loss of interest or a

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lack of pleasure, feelings of guilt or having a low self-esteem, sleep or appetite disorders, a feeling of tiredness or a lack of concentration. The intensity of a depressive episode is assessed according to 3 levels: mild, moderate or severe (12). Depression is associated with obesity, with a bidirectional link: obese people have a 55% increased risk of developing depression over time, whereas depressive patients have a 58% increased risk of developing obesity (13). Subjects with an atypical depression have an increased risk of obesity compared to melancholic depressive and non-depressive subjects (56.8% compared to 24.3% and 21.1% respectively) (14). In addition, it has been reported that depression leads to reduced physical activity implying an increased risk of developing muscle dysfunction and sarcopenia (15). This link has been highlighted in a mostly normal weight population and elderly people (16), but it has not been established in a young and severely obese population.

Therefore, this study focuses on the relationship between depression, body composition, and muscle functions assessed by a reduction in muscle strength and physical performance, in a population of severely and morbidly obese patients.

Materials

Subjects

This descriptive and retrospective study involved 373 obese patients hospitalized in the Clinical Nutrition Department of the University Hospital of Clermont-Ferrand, France, between July 1, 2014 and June 30, 2016. Participants were admitted for one day hospitalization for a clinical, metabolic and biological checking (resting energy expenditure, body composition, blood biochemistry) where they met an interdisciplinary team (dietician, psychologist, clinical nurse and nutritionist). All the participants were older than 18 years with a body mass index (BMI) ≥ 30 kg/m^2. Data from 373 patients were collected for analysis and interpretation. All the data were taken from available medical records.

Medical history and physical examination

Data on age, sex and age when weight disorders began (childhood, adolescence, adulthood) were collected. A patient history was drawn during a medical interview and reviewed, in particular, cardiovascular disease, diabetes, sleep apnea syndrome (SAS), dyslipidemia, high blood pressure, and smoking.

Weight and height were measured in patients wearing light clothing, and BMI was calculated (kg/m^2). Waist circumference was measured midway between the lowest rib margin and the iliac crest. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using a monitor (Carescape DINAMAP® V100, GE healthcare, France). These clinical data were collected during a medical consultation.

Body composition was estimated using multi-frequency bioimpedance analysis (Bodystat Quadscan 4000, France Medical Concept, France) and according to the equation of Jimenez et al. (17). From these data, the Fat-Free mass to Fat mass ratio and Fat Free Mass Index (FFMI) as FFM/height^2 were calculated.

Blood chemistry

The following parameters were assayed: fasting blood glucose (g/l), serum insulin (mUI/l), triglycerides (mmol/l), C-reactive protein (CRP, mg/l), total cholesterol (mmol/l), HDL-cholesterol (mmol/l), and LDL-cholesterol calculation (mmol/l). A homeostasis model assessment for insulin resistance (HOMA-IR) score was calculated using the formula: fasting blood glucose [mmol/l] × serum insulin [mUI/l]/22.5 (18). Insulin resistance was admitted when the HOMA-IR score was superior to 2.5.

Dynapenia screening and assessment

Dynapenia was diagnosed when a decrease in muscle strength and physical performance was observed (19, 20). Muscle strength was assessed using the handgrip strength test. The mean of three measurements of handgrip strength was retained for the test. Muscle strength was considered to be reduced when the handgrip strength mean was ≤ 30 kg for obese men and ≤ 20 kg for obese women (3).

Finally, physical performance was estimated using the Short Physical Performance Battery (SPPB). The SPPB assessed balance, gait, strength and endurance by examining an individual's ability to stand with the feet together in side-by-side, semi-tandem and tandem positions, the time taken to walk 8 feet and the time taken to rise from a chair and return to the seated position five times (3). Physical performance was considered to be reduced when the SPPB score was ≤ 8 (21). Patients having one of these 2 criteria, i.e. reduced muscle strength or physical performance, were considered to be in a dynapenic obesity state.

Assessment of depression

The Beck Depression Inventory-II (BDI-II) was used to assess the presence of depression. More precisely, BDI-II measures the severity of self-reported depression in adolescents and adults. The symptom content of the BDI-II reflects the diagnostic criteria for major depressive disorders (MDD) that are described in the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, fourth Edition (DSM-IV) (22).

Patients with a total BDI-II score < 14 were not considered to be depressive. Patients with a total BDI-II score between 14 and 19 were considered to be in a mild depressive state, between 20 and 28 in a moderate depressive state, and between 29 and 63 in a severe depressive state (23).

Assessment of eating behavior

Their dietary consumption was collected by a dietician and a nutritionist during a face to face interview on the day of their hospitalization. The presence of the following behaviors was

systematically checked during this interview:
- Hyperphagia, i.e. a per-prandial food intake beyond satiation,
- Tachyphagia, i.e. a quick food intake (less than 15-20 min),
- Snacking, i.e. an extra-prandial food intake without any feeling of hunger, in moderate quantities and without loss of control,
- Compulsion, i.e. an episode of loss of food intake control without any feeling of hunger,
- Restrictive behaviors or restrictive thoughts and belief in the concept of cognitive restriction.

The presence and history of eating disorders, binge eating disorders and bulimia nervosa, were systematically sought by doctors on the basis of the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, fifth Edition (DSM-V).

Finally, the Dutch Eating Behavior Questionnaire (DEBQ) was used to assess each patient's restrained, emotional, and external eating behavior. Specific questions were asked with regard to each behavior and the answers were scored from 0 to 5. A mean score to answers ≥ 3/5 defines the positivity threshold for the corresponding eating behavior (24).

Assessment of metabolic syndrome

Metabolic syndrome was defined according to the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) definition (25), which requires at least three of the following five criteria:
- Elevated waist circumference (≥ 102 cm in men; ≥ 88 cm in women),
- Elevated fasting triglycerides (≥ 1.50 g/l and/or use of medication for elevated triglycerides),
- A history of hypertension (Systolic blood pressure > 130 mmHg or diastolic blood pressure > 85 mmHg) and/or use of antihypertensive drug treatment,
- Elevated fasting plasma glucose (≥ 1.00 g/l and/or known diabetes),
- Reduced HDL-Cholesterol (< 0.4 g/l in men and < 0.5 g/l in women).

Statistical analysis

All analyses were performed using Stata software (Version 13, StataCorp, College Station, TX) and R 3.3.3 (http://cran.r-project.org/) for a two-sided Type I error of $\alpha = 5\%$. Patient characteristics were expressed as mean ± standard-deviation (SD) or median [interquartile range] for continuous data (assumption of normality was assessed by using the Shapiro-Wilk test) and as numbers and associated percentages for categorical parameters. Quantitative variables were compared between independent groups by ANOVA, or the Kruskal-Wallis test if ANOVA conditions were not met (normality, and homoscedasticity were analyzed using the Bartlett test). When pertinent, post-hoc tests were performed taking into account multiple comparisons (Tukey-Kramer post ANOVA or Dunn after Kruskal-Wallis). Comparisons between independent groups were carried out using the Chi-squared or Fischer's exact test for categorical variables. When pertinent, a post-hoc test was used (Marascuillo procedure). In order to determine factors associated to dynapenia, a multivariable logistic regression model was carried out using the stepwise approach (backward and forward) on covariates fixed according to univariate results ($p<0.05$) and clinical relevance. Special care was paid to the study of multicollinearity and interactions between covariates. Relationships between quantitative variables were assessed using correlation coefficients (Pearson or Spearman depending on the statistical distribution). Results were expressed as odds-ratios and 95% confidence intervals (95%CI). Forest plots and polar histograms were employed to present the results.

Results

Population description

Anthropometric, clinical and biological characteristics, metabolic syndrome

Among the 373 patients, 109 were men and 264 were women (71%). The average age was 44 ± 13y. The average BMI was 43 ± 6kg/m², with a minimum BMI of 31kg/m² and a maximum of 72kg/m². For most of them, obesity started in adulthood and 21% of the patients had type 2 diabetes. The average waist circumference was 125 ± 16 cm. The average mean blood pressure/systolic blood pressure was 130 ± 16 /74 ± 13 mmHg, 64% of the patients had insulin resistance on the basis of the HOMA score and low grade inflammatory syndrome was present, the median CRP was 7.1 mg/l [3.3 - 12.3].

The prevalence of the metabolic syndrome was 62% with 221 patients (59%) having hypertension, 137 (37%) hyperglycemia or diabetes, 198 (53%) a decrease in HDL-cholesterol, 175 (47%) an increase in triglycerides, and all the patients had an increased waist circumference. All these data are summarized in Table 1.

Depression score

The prevalence of depression was 53%; 67 patients (18%) had mild depression, 69 patients (18%) had moderate depression and 61 patients (16%) severe depression. The mean BDI-II score was 17 ± 11.

Eating behavior

Hyperphagia was present in 67% of the patients; tachyphagia in 80%; restriction in 33%. Sixty six percent of the patients snacked and 53% had compulsions. Eating disorders such as Binge Eating Disorder (BED) and bulimia nervosa were present respectively in 17% and 6.4% of the patients.

In the Dutch Eating Behavior Questionnaire (DEBQ), 38% of the patients were scaled for restrained, 66% emotional and 39% external eating.

Table 1
Anthropometric, clinical and biological characteristics of the population

	Total (n=373)	Women (n=264)	Men (n=109)
Age, years	44 ± 13	43±14	46±12
BMI, kg/m²	43 ± 6	43 ± 6	43 ± 7
Smoking habits	103 (28%)	72 (28%)	31 (29%)
Ischemic heart disease	12 (3%)	5 (2%)	7 (7%)
Arteriopathy	3 (<1%)	2 (<1%)	1 (<1%)
Supra-aortic trunks pathology	3 (<1%)	3 (1%)	0
Treated dyslipidemia	58 (16%)	26 (10%)	32 (30%)
Apnea syndrome	62 (23%)	24 (12%)	38 (50%)
Diabetes	75 (21%)	38 (15%)	37 (34%)
Obesity beginning in			
Adulthood	177 (50%)	117 (47%)	60 (58%)
Adolescence	68 (19%)	56 (22%)	12 (12%)
Childhood	110 (31%)	79 (31%)	31 (30%)
Waist circumference, cm	125 ± 16	121 ± 14	134 ± 15
SBP, mmHg	130 ± 16	128 ± 14	134 ± 17
DBP, mmHg	74 ± 13	73 ± 13	79 ± 14
Fasting blood glucose, g/l	1.00 ± 0,3	0.97 ± 0.28	1.06 ± 0.38
HOMA-IR (>2.5)	133 (64%)	86 (59%)	47 (76%)
Total cholesterol, mmol/L	4.89 ± 1.12	4.91 ± 1.15	4.85 ± 1.04
HDL, mmol/L	1.21 ± 0.39	1.25 ± 0.41	1.11 ± 0.32
TG, mmol/L	1.77 ± 1.05	1.62 ± 0.82	2.11 ± 1.40
LDL, mmol/L	3.01 ± 1.29	3.06 ± 1.41	2.88 ± 0.91
CRP, mg/l	7.1 [3.3-12.3]	7.9 [3.8-12.7]	5.0 [2.9-9.5]

Data are presented as frequencies (associated percentages), as mean ± standard deviation or as median [interquartile range]. Missing data explains the differences in sample size (total n) for studied parameters; BMI: Body mass index; CRP: C-reactive protein; DBP: Diastolic blood Pressure; HOMA-IR : homeostasis model assessment for insulin resistance; SAS: Sleep Apnea syndrome; SBP: Systolic Blood Pressure

Assessment of muscle functions

The physical performance using the Short Physical Performance Battery (SPPB) <8 existed in 9% of the patients, the mean grip strength was 31 ± 11 kg with a minimum of 11 and a maximum of 70. In women, the grip strength was 27 ± 7 kg and 42 ± 11 in the men.

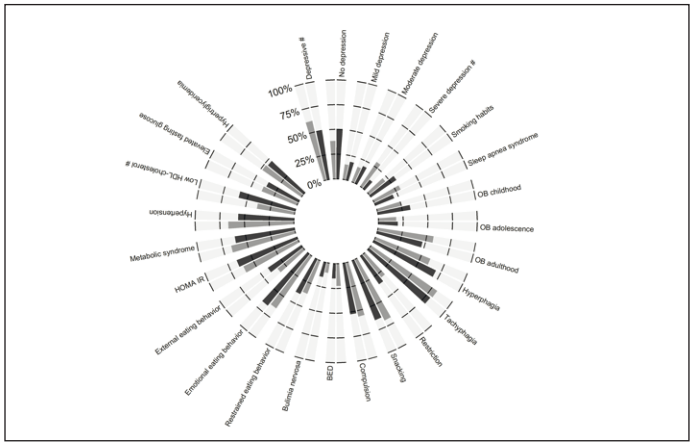
The Fat Free Mass Index (FFMI) was 23.4 ± 4.0 kg/m² with a minimum of 17.5 kg/m² and a maximum of 68.4 kg/m². The FFM/ FM ratio was 0.88 ± 0.23 with a range between 0.27 and 1.74. These data can be found in Table 2.

Comparative analysis of dynapenic and non-dynapenic patients (Figure 1)

Dynapenia and clinical data

Age was strongly and significantly associated with dynapenia. The average age of dynapenic patients (D) was 48 ±16 compared to 43±12 for non-dynapenic patients (ND) (p = 0.004). No difference was observed between D and ND concerning obesity onset and smoking habits (p=NS). Sleep Apnea syndrome (SAS) was not significantly associated with dynapenia but in women, a significant difference was observed: 22% of D patients had SAS versus 8% of ND patients (p=0.009).

Figure 1
Polar histogram plot of parameters analyzed in dynapenic (grey box) vs non-dynapenic (black box) obese patients



BED: Binge Eating Disorder. OB: Obesity beginning (childhood/adolescence/adulthood), #: p<0.05

Table 2
Assessment of muscle function in the total studied population

	Women	Men
SPPB < 8	10% (26/264)	7% (8/109)
SPPB mean (/12)	10.88 ± 1.87 [0-12]	11.05 ± 1.80 [0-12]
Grip strength (kg force)	27 ± 7 [11-58]	42 ± 11 [17-70]
FFMI	22 ± 3 [17-36]	26 ± 52 [19-68]
FFM/FM ratio	0.96 ± 0.19 [0.46-1.74]	0.68 ± 0.19 [0.27-1.32]

Data is mean ±SD [min-max] for continuous variables and % for categorical variables. Missing data explains the differences in sample size (total n) for studied parameters; FM: Fat mass; LM: Lean mass; FFMI: Fat Free Mass Index; SPPB: Short Physical Performances Battery

Dynapenia and Metabolic Syndrome

The average BMI was comparable between D and ND (44±8.5 vs 43±6 kg/m²). Respectively, the waist and hip circumference were comparable between D and ND (125±14 vs 125±16 cm; 134±13 vs 132±14 cm). Respectively, SBP and DBP were comparable between D and ND (130±15 vs 130±16; 75±12 vs 74±14 mmHg).

Respectively, the mean total cholesterol, LDL cholesterol and triglycerides for D and ND were 4.94/4.91 mmol/L, 2.95/3.05 mmol/L, 1.76/1.76 mmol/L (p=NS). The mean fasting blood glucose was comparable between D and ND (0.99±0.3 vs 1.00±0.3 g/l). The HbA1c was comparable between D and

ND (6.00±1.0 vs 5.94±0.98). The median CRP was comparable between D and ND (8.1 mg/l [3.65-12.4] vs 6.7 mg/l [3.1-12.2]) (all p = NS).

Metabolic syndrome (MS) was not significantly related with dynapenia. However, dynapenic female patients had a higher MS compared to non-dynapenic patients (68% vs 54%; p = 0.03).

The fat free mass/fat mass ratio was significantly associated with dynapenia. It was respectively 0.92 ± 0.24 and 0.86 ± 0.22 for D and ND patients (p = 0.02).

Dynapenia and depression

Depression was significantly associated with dynapenia. We observed that 62% of the patients who had dynapenia suffered from depression compared to 50% of non-dynapenic patients (p = 0.036). The BDI-II score for D and ND patients was respectively 20 ± 13 and 15 ± 10 (p = 0.001).

The intensity of the depression was significantly associated with dynapenia. Indeed, dynapenic patients had a higher prevalence of severe depression (30% versus 11%, p < 0.001).

Multivariate analysis

The multivariable model studied the influence of depression, smoking, the presence of SAS and metabolic syndrome on dynapenia.

Depression is associated with a higher risk of dynapenia (Odds ratio = 2.85 [1.55-5.25], p = 0.001). There was no influence of the presence of SAS and MS on dynapenia (Odds ratio = 1.83 [0.96-3.52] and 1.23 [0.67-2.27] respectively).

Discussion

This study demonstrates that depression and the intensity of depressive symptoms in severely obese patients are significantly associated to a decrease in muscle functional capacities (or dynapenia) for which the impact on mortality has been recently demonstrated (26). Dynapenia was assessed rather than sarcopenia since the defined criteria according to lean mass in geriatric subjects did not seem to apply to a non-elderly population: no patient had lean mass threshold values corresponding to sarcopenia, whereas the functional capacities were significantly impaired. This observation suggests the need to develop specific sarcopenia criteria for defining sarcopenic obesity by analyzing population's functional alterations of muscle, followed by pertinent measurements of body compartments for this specific population of young obese adults. Thus, amongst the determining factors of functional alterations of muscle, depression and its intensity appear to be the most closely factors linked to dynapenia in severe and morbidly obese patients.

With regard to the frequency of depression, the prevalence of depression in adult obese patients was close to another cross-sectional study carried out in 56 primary care patients, with an average age of 48y, including 24 overweight and 32 obese women. The Patient Health Questionnaire (PHQ-9) was used to assess depression and a score higher or equal to 10 on a scale of 27 points was used to define pertinent clinically depressive symptoms. The prevalence of depression in this study was similar in overweight and obese people (48.4% and 51.6% respectively) and significantly higher compared to the prevalence of depression in the general population (between 16% and 34%). Our results therefore are in line with data in the litterature, as in our study, the prevalence of depression (53%) was significantly higher than in the general population, confirming that depression is a frequent comorbidity of obesity (27).

Presently, no study has analysed the link between dynapenia and depression in a population of adult subjects with severe obesity. However, some studies have looked at the association of sarcopenia and depression, with regard to older individuals mostly of a normal weight. A korean study focusing on elderly subjects with normal weight highlighted a significant association between depression and sarcopenia amongst elderly men (28). In a study by Remigio-Baker et al, 2015, the severity of depressive symptoms was correlated inversely with muscle mass (16). Depression was associated with a reduction of muscle mass adjusted according to age and BMI irrespective of gender, and a reduction of locomotion muscle mass in men only (16). In elderly Japanese adults (65 years or older), after adjustment for potential confounders, SO was positively associated with depressive symptoms compared to non-sarcopenic/non-obese subjects, whereas subjects who were either only sarcopenic or only obese were not associated with depressive symptoms (29). Cho et al, assessed the association between SO and several psychological health and quality of life indexes amongst Korean adults (30). This cross-sectional study was carried out on 11,521 participants aged 20 and above. Psychological health, including depressive symptoms, perceived stress, suicidal thoughts, as well as quality of life were assessed by an EQ-5D self-report questionnaire. The assessment of depressive symptoms corresponded to the presence of these symptoms for more than 2 consecutive weeks during a year. SO was associated with unfavorable psychological health and an inferior quality of life compared to general obesity. These results seem consistent with those of our study, as people with muscle dysfunctions have more depressive symptoms than people without muscle dysfunctions (30). More recently, Byeon et al. assessed the association between sarcopenia and depression. The study focused on a population of 7,364 people and ≥20 years of age. Depression was classified into three groups (not depressed, depressed and depression). The depression group included people who have received a clinical diagnosis of depression. Amongst those who were not diagnosed clinically, those who replied "yes" to the question: "During the past year, have you felt sadness or despair for two weeks or more and was this serious enough to interfere with your daily life?" were assigned to the group with depressive symptoms. Furthermore, those who

were not diagnosed clinically and who did not state that they had depressive symptoms for 2 weeks or more were classified as non-depressed. Surprisingly, obesity was classified as a BMI ≥ 25 kg/m². Sarcopenia was defined as appendicular skeletal muscle mass divided by body weight, minus 2 standard deviations in comparison to young adults. Depending on their sarcopenia and obesity condition, the participants were divided into sarcopenic obese, non-sarcopenic obese, sarcopenic non-obese and non-obese sarcopenic groups. No association between sarcopenia and depression or depressive symptoms were found in the Korean adults. Nevertheless, the authors suggested that the cross-sectional nature of this study limited the capacity to prove an association between sarcopenia and depression. Furthermore, the use of a subjective questionnaire rather than a depression assessment tool to define depressive states in this study may have led to underestimation and classification errors (31). Finally, this study once again confirms that muscle function is a parameter which is as important or even more important than muscle mass.

In another study by Hamer et al. in 2015 a decrease in grip strength was associated with a higher risk of depressive symptoms in obese participants only. Participants who were obese at baseline and had a decrease of more than one standard deviation in grip strength over a 4-year follow-up period were at greatest risk of depressive symptoms (OR=1.97, 95% CI, 1.22, 3.17) compared to non-obese participants with stable grip strength. Sarcopenic obesity was defined as obese individuals (Body mass index ≥30 kg/m²) in the lowest tertile of sex-specific grip strength (<35.3 kg men; <19.6 kg women) (32).

To date, there is no consensus on the definition of sarcopenic obesity (6). It is therefore important to better define this syndrome in order to improve the detection of sarcopenia in a context of obesity (6). In our study, the measurement of lean mass and fat mass was assessed by impedance measurement, the lean mass/fat mass ratio was significantly correlated with dynapenia (p=0.01). Taking this ratio into account when assessing sarcopenia may be a good indicator, all the more so as new population references on the basis of the National Health and Nutrition Examination Survey (NHANES) make it possible to set accurate criteria of sarcopenia in obese subjects even young ones (33).

Conclusion

Depression and the intensity of depressive symptoms in the obese was significantly associated with a decrease in muscle functional abilities. The severely obese patients with dynapenia have significantly higher depression scores than the obese without dynapenia. The intensity of the depression was significantly more severe in the obese patients with dynapenia compared to the obese patients without dynapenia. These data suggest that mobility disorders in obesity may be linked to mood disorders which should be systematically searched in obese patients in order to prevent or limit disability and further loss of quality of life. From this study, it is also proposed that severe depression appears to be an important factor of sarcopenic obesity.

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Ethical Standards: We declare that the work is in complete adequacy with the current french ethical laws including the required authorizations.

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