

Dynapenic obesity: A disregarded disease that affects functionality and nutrition of the older patients

Berna Evranos *, [MD]

ORCID:0000-0002-1848-888X

Volkan Atmis ¹, [MD]

ORCID: 0000-0002-0080-6448

¹Ankara University Faculty of Medicine,
Department of Geriatric Medicine, Ankara, Turkey

*Corresponding Author: Berna Evranos

Address: Yildirim Beyazit University, Faculty of
Medicine, Department of Endocrinology and
Metabolism, Ankara, Turkey, 06800

Phone: 00903122912525

ABSTRACT

Objective: Dynapenia is the age-associated loss of muscle strength without neurological or muscular disease. It is associated with physical dependence, low physical performance, falls, cognitive impairment and increased mortality in older adults. Obesity incidence increases rapidly in older adults, but in the literature, there are limited studies on dynapenic obesity and its complications. We aimed to determine the frequency of dynapenia in geriatric obese patients, examine the effect of dynapenic obesity on the functionality and the nutritional state and increase awareness of dynapenic obesity.

Materials and Methods: 177 obese geriatric patients admitted to geriatrics and endocrinology clinics divided into two groups as dynapenic or non-dynapenic according to last diagnostic criteria, depending on handgrip strength. Demographic and laboratory data, Activities of daily living, Instrumental Activities of Daily-Living, Mini-Nutritional Assessment, body mass index, and handgrip strength were investigated. Differences between the two groups were analysed by the SPSS 20.0 program.

Results: 17.5% of the subjects had dynapenia. Dynapenic geriatric patients were older ($p=0.028$), had lower mini-nutritional test scores ($p=0.009$), activities of daily living ($p=0.007$), instrumental activities of daily living ($p<0.001$), creatinine levels ($p=0.023$), and albumin levels ($p=0.049$).

Conclusion: Dynapenic obesity is associated with worse functionality and malnutrition. Realising the natural history of patients with dynapenia and obesity is critically needed.

Keywords: Dynapenic obesity, elderly patients, functionality, nutrition

Received: 16 June 2019, Accepted: 13 September 2019,
Published online: 30 September 2019

INTRODUCTION

Ageing is characterised by progressive and broadly predictable changes that are associated with increased susceptibility to many diseases. The global prevalence of obesity in the older adult population is growing, and increasing concern in both the developed and developing countries of the world. One third or more of U.S. adults aged 60 years and older

have body weights in the obese range; moreover, obesity is increasingly becoming a global health challenge [1]. Global Burden of Disease Study 2013 revealed a global rise of 27.5% in the prevalence of overweight and obesity between 1980 and 2013. The findings showed that body mass peaked at age 55 years for men (25% obese) and at age 60 years

for women (31.3% obese) in developed countries [2]. Age patterns of obesity were similar in developing countries, but with considerably lower prevalence rates; however, in both developed and developing countries, successive cohorts seemed to be gaining more weight at all ages. Diseases and disabilities that are age- and obesity-linked continues to increase.

Although there is variability, by ageing, muscle mass decreases about 30 to 50 percent in both men and women. The loss is not linear, but it rises with increasing age. The exact mechanism that explains this decline and how it affects muscle function is not fully understood [3]. There is strong evidence linking low muscle strength with incident mobility limitation, disability in instrumental and basic activities of daily living [4-6]. Dynapenia, defined by muscle weakness or low muscle strength, is a component of sarcopenia [7]. Sarcopenia is identified when there is low quantity or quality in addition to low muscle strength [8]. The age-related loss of muscle strength (dynapenia) is only partially explained by sarcopenia, and that these two conditions need to be defined independently of one another [9]. From age 30 to age 80, a typical person's grip strength decreases 60 percent. The net result is that strength loss is more significant than muscle mass loss, with strength loss being a better predictor of disability and mortality [10]. Measures of sarcopenia and dynapenia are increasingly being investigated as predictors of functional decline and health outcomes in studies of older adults [9]. However, as with the measurement of fat mass, it is difficult to directly measure sarcopenia in large samples or routine clinical settings. Conversely, dynapenia can be readily measured using grip dynamometry, which is low in cost, and commonly available in clinical settings. This age-related decline in muscle strength and muscle mass has been accompanied by increasing obesity in older adults globally [11]. The increase in adiposity as a risk factor to low muscle strength and functionality and the relationship between adipose tissue and muscle function has attracted interest in recent years [12].

The co-occurrence of obesity and dynapenia is termed 'dynapenic obesity' (DO) [13]. The study of dynapenic obesity and its management is a relatively new area of research, especially about those with elevated health risks.

We aimed to determine the frequency of dynapenia in geriatric obese patients, examine the effect of DO

on the functionality and the nutritional state and increase awareness of DO.

MATERIALS AND METHODS

This study consisted of 177 obese patients aged over 65 years who applied to the geriatrics clinic of Ankara University and endocrinology and metabolism clinic of Yildirim Beyazit University.

Patients who were compatible with study protocols and volunteered were included in the present study. Individuals with severe dementia, which can cause difficulties in carrying out study tasks; communication problems; amputated limbs; immobility; and walkers were excluded from the study. Informed consent was obtained from all study participants. This study was approved by the ethical committee of Ankara University and Yildirim Beyazit University School of Medicine.

In all subjects, age and anthropometric measures (height, weight, and BMI) were recorded. Fasting blood glucose (FBG), glycosylated haemoglobin (HbA1c), serum creatinine, total protein, C-reactive protein (CRP) and albumin levels were measured.

As a measure of functionality, modified Katz activities of daily living (ADL) and Lawton instrumental ADL were assessed. The components of ADL were; feeding, continence, transferring, toileting, dressing, bathing [14] and Instrumental Activities of Daily-Living (IADL) were; using the telephone, shopping, preparing food, housekeeping, doing laundry, using transportation, handling medications, handling finances [15]. All of the measurements were carried out by the psychologist of the geriatrics clinic, who was experienced with these tests. Mini-Nutritional Assessment (MNA) was used to assess the nutritional state of the patients [16]. The dietician, who is an employee of the geriatrics clinic, applied the MNA. Height and weight were measured. Participants were barefoot and wearing light clothes while being measured. Weight was measured using a digital weighing machine. Height was measured with a height gauge. Body mass index (BMI), calculated as weight (kilograms) divided by height (meters)². Participants were included in the study if they were obese (BMI \geq 30 kg/m²).

Dynapenia was diagnosed according to the Handgrip testing [17]. A digital handheld dynamometer (Takei Scientific Instruments, Niigata, Japan) was used for handgrip testing. The participant held the dynamometer in their dominant hand

with their arm fully extended at an angle of 30° concerning the trunk and the palm perpendicular to the shoulder line [18]. The participant squeezed the dynamometer with maximum effort, which was maintained for 5 seconds. Handgrip strength (HGS) was measured twice, and the mean of two measurements was taken. HGS less than 30 kg or 20 kg was defined as low muscle strength in men and women, respectively [19]. Patients classified into two groups as the dynapenic obese (DO) group and the non-dynapenic obese (NDO) group according to handgrip testing. Demographic and laboratory data, the nutritional state and the functionality of the groups compared in this study.

Statistical analysis

The SPSS version 20.0 (IBM, Armonk, New York, USA) program was used for statistical analysis. Numeric variables were given as mean \pm standard deviation if the distributions of numeric variables were normal. Median, minimum and maximum values were used if numeric variables were not distributed normally. Differences between independent numeric variables with normal distribution were tested by independent samples t-test. The Mann–Whitney U-test was used for testing differences between independent numeric variables without normal distribution. Regression analyses was performed to determine the independent associates of dynapenic obesity. P-values less than 0.05 were accepted as statistically significant.

RESULTS

Thirty-one (17.5%) of the obese patients had dynapenia. The mean age of the patients in the DO group was 74.16 ± 3.52 while it was 72.46 ± 5.00 in the NDO group. Patients with DO were older than patients with NDO ($p=0.028$). The gender distribution and BMI were similar in groups ($p=0.5$) (Table 1). The median MNA score was 12 (5-14) in the DO group while it was 13, (8-14) in the NDO group. MNA was significantly low in the DO group ($p=0.009$). ADL and IADL were lower in the DO group than the NDO group (table 1) ($p=0.007$, $p<0.001$, respectively). Fasting blood glucose and haemoglobin A1c levels were similar in both groups ($p=0.95$, $p=0.27$, respectively). The median creatinine level was 0.69 (0.5-1.8) in DO group while it was 0.81 (0.47-1.84) in the NDO group. It was lower in the DO group ($p=0.023$). The mean albumin level was 4.37 ± 0.356 in DO group while it was 4.49 ± 0.26 in NDO group. It was lower in the DO group. The median CRP and mean total protein levels were similar in groups ($p=0.98$, $p=0.64$, respectively) (Table 1). Using multiple linear regression analyses, it was determined that, age, serum glucose, haemoglobin A1c, creatinine, total protein, albumine and CRP levels had no statistically significant associations with HGS in dynapenic obese patients ($p<0.05$ for all parameters).

Table 1. Demographic, laboratory and clinical variables of DO and NDO groups

	DO group (n:31)	NDO group (n:146)	p
Age (years) (mean)	74.16 ± 3.52	72.46 ± 5.00	0.028
Female/Male (n)	16/15	80/66	0.27
BMI (mean)	34.9 ± 4.2	34.5 ± 3.9	0.5
MNA (median)	12 (5-14)	13 (8-14)	0.009
ADL (median)	5 (3-6)	6 (3-6)	0.007
IADL (median)	5 (1-8)	7 (1-8)	0.001
Glucose (mg/dL) (median)	103 (82-207)	107.5 (75-454)	0.957
HbA1c (%) (median)	6.56 (4.68-11.77)	6.09 (4.91-12.52)	0.272
Creatinine (mg/dL) (median)	0.69 (0.50-1.80)	0.81 (0.47-1.84)	0.023
Total protein (g/dL) (mean)	7.3 ± 0.488	7.23 ± 0.479	0.641
Albumin (g/dL) (mean)	4.37 ± 0.356	4.49 ± 0.266	0.049
CRP (mg/L) (median)	4.79 (3-171)	3.21 (3-78.50)	0.986

DO: dynapenic obese; NDO: non-dynapenic obese; MNA: Mini-Nutritional Assessment; ADL: activities of daily living; IADL: instrumental activities of daily living; HbA1c: glycosylated haemoglobin; CRP: C-reactive protein; BMI: Body mass index.

DISCUSSION

In this study, 17.5% of the older obese patients had dynapenia. Patients in the DO group were older. The ADL, IADL and MNA scores were higher in NDO group than the DO group. Both groups had similar fasting blood glucose and haemoglobin A1c levels. Albumin levels were lower in the DO group than the NDO group.

In this study, the frequency of dynapenia in older obese patients was 17.5%. To our knowledge, there is no data that reports the prevalence and incidence of DO. The reports of the review by Leahy et al., which is planned to be published in the future, is expected to provide this information [20]. The prevalence of sarcopenia estimated by Baumgartner et al., using such a definition in a sample of 426 men and 382 women of the New Mexico Elder Health Survey, increased from 13-24% in individuals under 70 years to >50% in those over 80 years [21].

The ageing process causes a significant loss of muscle mass and strength [22]. Muscle strength reaches its plateau in between second and third decades of life [3]. Changes marked with the ageing process occur after 50th life year. From this age, a loss of muscle strength of 1.5–5%/year was observed [3,23]. Dynapenic patients were older than the non-dynapenic patients in our study, compatible with the literature.

In our study, the median MNA score and mean albumin level were lower in DO patients. Albumin has been widely used as a nutrition marker among other serum proteins synthesised by the liver. To the best of our knowledge, no study evaluates nutritional state in DO patients. Sousa-Santos et al. showed that sarcopenia was directly associated with undernutrition or undernutrition risk [24]. Supporting the previous study, Cruz-Jentoft et al. and Norman et al. have shown that reductions in handgrip strength are common in individuals who have sarcopenia as well as in malnourished individuals [25,26].

There are also studies assessing the effects of glucose levels on functionality. Bardenheier et al. showed that adults with diabetes died 4.6 years earlier, developed disability 6-7 years earlier, and spent about 1-2 more years in a disabled state than adults without diabetes [27]. With increasing baseline age, diabetes was associated with significant ($p < 0.05$) reductions in the number of total and disability-free life-years, but the absolute difference in years between those with and without diabetes was less

than at younger baseline age. Godino et al. reported that the burden of functional disability associated with diabetes was not entirely explained by known risk factors, including comorbidities among older adults. Hyperglycemia below the threshold for the diagnosis of diabetes was not associated with disability. Research into practical strategies for the prevention of functional disability among older adults with diabetes is needed [28]. In our study, fasting blood glucose and HbA1c levels were in near normal ranges and similar in groups. We do not think these results have an impact on disability.

In our study, DO patients had more reduced physical functions than NDO patients. Bouchard et al. evaluating 2039 American men and women aged 55 years and over showed that dynapenic-obesity was associated with a poorer physical function than obesity alone and in most cases with dynapenia alone [13]. Rossi et al. demonstrated that dynapenic abdominal obese subjects are at higher risk of worsening disability and mortality than subjects with dynapenia or central fat distribution only [29]. Stenholm et al. found that obesity with low muscle strength increases the risk of decline in walking speed and developing mobility disability, especially among persons younger than 80 years old [30]. Batsis et al. examining 2025 subjects with knee osteoarthritis aged 60 years and over during four years of follow-up in the US, showed that dynapenic obesity might be a risk factor for functional decline suggesting the need to target subjects with low knee strength and obesity [31]. Yang et al. analysing a total of 616 patients with non-dynapenia/non-obesity, dynapenia-alone, obesity-alone, and dynapenic obesity in a cross-sectional study reported that dynapenic obesity was associated with a higher risk of slow gait speed and mobility disability compared with dynapenia-alone or obesity-alone [32]. Finally, Alexandre et al. demonstrated abdominal obesity as a significant risk factor for IADL decline, and the participants with dynapenic abdominal obesity had the highest rate of IADL decline over time among English and Brazilian older adults [12].

The present study had limitations. The cross-sectional design prevented investigating causality. The limited number of patients prevents determination of the prevalence of the dynapenia.

CONCLUSION

Patients with dynapenic obesity is associated with worse functionality and malnutrition than obese patients. To our knowledge, there is very little data demonstrating the higher, yet theoretical, cumulative risk of dynapenia with obesity than with either disorder on its own. Quantifying the prevalence and incidence of dynapenic obesity and realising the

natural history of patients with dynapenic obesity is critically needed to allow clinicians to intervene in this at-risk population.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

REFERENCES

- [1] Mathus-Vliegen EM. Obesity and the elderly. *J Clin Gastroenterol* 2012; 46: 533-44.
- [2] Ng M, Fleming T, Robinson M, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2014; 384: 766-81.
- [3] Goodpaster BH, Park SW, Harris TB, et al. The loss of skeletal muscle strength, mass, and quality in older adults: the health, aging and body composition study. *J Gerontol A Biol Sci Med Sci* 2006; 61: 1059-64.
- [4] Al Snih S, Markides KS, Ottenbacher KJ, Raji MA. Hand grip strength and incident ADL disability in elderly Mexican Americans over a seven-year period. *Aging Clin Exp Res* 2004; 16: 481-86.
- [5] Hairi NN, Cumming RG, Naganathan V, et al. Loss of muscle strength, mass (sarcopenia), and quality (specific force) and its relationship with functional limitation and physical disability: the Concord Health and Ageing in Men Project. *J Am Geriatr Soc* 2010; 58: 2055-62.
- [6] Rantanen T, Guralnik JM, Foley D, et al. Midlife hand grip strength as a predictor of old age disability. *JAMA* 1999; 281: 558-60.
- [7] Studenski SA, Peters KW, Alley DE, et al. The FNIH sarcopenia project: rationale, study description, conference recommendations, and final estimates. *J Gerontol A Biol Sci Med Sci* 2014; 69: 547-58.
- [8] Cruz-Jentoft AJ, Bahat G, Bauer J, et al, Writing Group for the European Working Group on Sarcopenia in Older P, the Extended Group for E. Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing* 2019; 48: 16-31.
- [9] Manini TM, Clark BC. Dynapenia and aging: an update. *J Gerontol A Biol Sci Med Sci* 2012; 67: 28-40.
- [10] Newman AB, Kupelian V, Visser M, et al. Strength, but not muscle mass, is associated with mortality in the health, aging and body composition study cohort. *J Gerontol A Biol Sci Med Sci* 2006; 61: 72-77.
- [11] Finucane MM, Stevens GA, Cowan MJ, et al, Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating G. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet* 2011; 377: 557-67.
- [12] Alexandre TDS, Scholes S, Ferreira Santos JL, et al. The combination of dynapenia and abdominal obesity as a risk factor for worse trajectories of IADL disability among older adults. *Clin Nutr* 2018; 37: 2045-53.
- [13] Bouchard DR, Janssen I. Dynapenic-obesity and physical function in older adults. *J Gerontol A Biol Sci Med Sci* 2010; 65: 71-77.
- [14] Katz S, Ford AB, Moskowitz RW, et al. Studies of Illness in the Aged. The Index of Adl: A Standardized Measure of Biological and Psychosocial Function. *JAMA* 1963; 185: 914-19.
- [15] [Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist* 1969; 9: 179-86.
- [16] [16] Sarikaya D, Halil M, Kuyumcu Meet al. Mini nutritional assessment test long and short form are valid screening tools in Turkish older adults. *Arch Gerontol Geriatr* 2015; 61: 56-60.
- [17] Yalcin A, Aras S, Atmis V, et al. Sarcopenia prevalence and factors associated with sarcopenia in older people living in a nursing home in Ankara Turkey. *Geriatr Gerontol Int* 2016; 16: 903-10.
- [18] Aparicio VA, Ortega FB, Heredia JM, et al. Handgrip strength test as a complementary tool in the assessment of fibromyalgia severity in women. *Arch Phys Med Rehabil* 2011; 92: 83-88.
- [19] Landi F, Liperoti R, Fusco D, et al. Prevalence and risk factors of sarcopenia among nursing home older residents. *J Gerontol A Biol Sci Med Sci* 2012; 67: 48- 55.
- [20] [20] Leahy S, Cassarino M, MD OC, et al. Dynapenic obesity and its association with health outcomes in older adult populations: protocol for a systematic review. *BMJ Open* 2019; 9: e027728.
- [21] Baumgartner RN, Koehler KM, Gallagher D, et al. Epidemiology of sarcopenia among the elderly in New Mexico. *Am J Epidemiol* 1998; 147: 755-63.
- [22] Keller K, Engelhardt M. Strength and muscle mass loss with aging process. Age and strength loss. *Muscles Ligaments Tendons J* 2013; 3: 346-50.
- [23] Frontera WR, Hughes VA, Lutz KJ, Evans WJ. A cross-sectional study of muscle strength and mass in 45- to 78-year-old men and women. *J Appl Physiol* (1985) 1991; 71: 644-50.
- [24] Sousa-Santos AR, Afonso C, Borges N, et al. Factors associated with sarcopenia and undernutrition in older adults. *Nutr Diet*. 2019.

- [25] Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al, European Working Group on Sarcopenia in Older P. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age Ageing* 2010; 39: 412-23.
- [26] Norman K, Stobaus N, Gonzalez MC, et al. Hand grip strength: outcome predictor and marker of nutritional status. *Clin Nutr* 2011; 30: 135-42.
- [27] Bardenheier BH, Lin J, Zhuo X, et al. Disability-Free Life-Years Lost Among Adults Aged \geq 50 Years With and Without Diabetes. *Diabetes Care* 2016; 39: 1222-29.
- [28] [28] Godino JG, Appel LJ, Gross AL, et al. Diabetes, hyperglycemia, and the burden of functional disability among older adults in a community-based study. *J Diabetes* 2017; 9: 76-84.
- [29] Rossi AP, Fantin F, Caliarì C, et al. Dynapenic abdominal obesity as predictor of mortality and disability worsening in older adults: A 10-year prospective study. *Clin Nutr* 2016; 35: 199-04.
- [30] Stenholm S, Alley D, Bandinelli S, et al. The effect of obesity combined with low muscle strength on decline in mobility in older persons: results from the InCHIANTI study. *Int J Obes (Lond)* 2009; 33: 635-44.
- [31] Batsis JA, Zbehlik AJ, Pidgeon D, Bartels SJ. Dynapenic obesity and the effect on long-term physical function and quality of life: data from the osteoarthritis initiative. *BMC Geriatr* 2015; 15: 118.
- [32] [Yang M, Jiang J, Hao Q, Luo L, Dong B. Dynapenic obesity and lower extremity function in elderly adults. *J Am Med Dir Assoc* 2015; 16: 31-36.

