Journal of Gerontology & Geriatric Research

Pasco et al., J Gerontol Geriatr Res 2017, 7:2
DOI: 10.4172/2167-7182.1000465

Research Article Open Access

# Sarcopenic Obesity and Falls in the Elderly

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**Received:** Mar 12, 2018; **Accepted:** Mar 16, 2018; **Published:** Mar 20, 2018



## Abstract

**Background:** Sarcopenic obesity refers to age-related loss of skeletal muscle mass and function, in the face of obesity. We aimed to examine the association of falls with sarcopenic obesity and its components, among elderly individuals in the population.

**Methods:** Participants were 353 men and 245 women aged 65-98 yr of the Geelong Osteoporosis Study. Body fat and lean mass were measured using dual energy X-ray absorptiometry; body fat mass was expressed as a percentage of weight (%BF) and appendicular lean mass was adjusted for height (rALM, kg/m$^2$). Poor physical performance was assessed using the timed up-&-go (TUG) test. Sarcopenic obesity referred to low-rALM (T-score<-1), poor physical performance (TUG>10 s) and obesity (%BF >25% for men, >35% for women). Fallers were identified by self-report as having had at least one fall in the previous 12 mo. Associations between sarcopenic obesity (and its components) and falls were determined using logistic regression after adjusting for age and sex.

**Results:** In total, 219 (36.6%) had low-rALM, 205 (34.2%) had poor physical performance, 466 (77.9%) were obese and 69 (11.5%) had all three thereby meeting our criteria for sarcopenic obesity. There were 170 (28.4%) fallers; falls were more common for those with sarcopenic obesity than without (28 (40.6%) vs 142 (26.8%); p=0.017). The likelihood of a fall in association with sarcopenic obesity and its components were: sarcopenic obesity OR=1.65 (95%CI 0.96-2.85), sarcopenia OR=1.52 (0.93-2.47), poor physical performance and obesity OR=1.74 (1.16-2.61), low-rALM OR=1.41 (0.96-2.06), poor physical performance OR=1.88 (1.26-2.80), obesity OR=0.88 (0.57-1.35).

**Conclusion:** While obesity per se was not associated with falls, there was an increased risk of falls individuals with sarcopenic obesity that was of borderline statistical significance and this appears to be largely a consequence of poor physical performance.

**Keywords:** Ageing; Falls; Lean mass; Skeletal muscle mass; Muscle function; Physical performance; Sarcopenia; Sarcopenia obesity

**Abbreviations:** CI: Confidence Interval; DXA: Dual Energy X-ray Absorptiometry; EWGSOP: European Working Group on Sarcopenia in Older People; GOS: Geelong Osteoporosis Study; IQR: Interquartile Range; NHMRC: National Health and Medical Research Council; OR: Odds Ratio; rALM: Relative Appendicular Lean Mass; SD: Standard Deviation; TUG: "Timed up-and-Go" Test; %BF: Body Fat Expressed as a Percentage of Body Weight

## Introduction

Falls among older adults can lead to physical injury, loss of confidence, hospitalization and sometimes death [1]. Falls are common in this demographic yet there are environmental factors, clinical disorders and physiological anomalies that can be addressed to minimize falls risk. Environmental hazards, poor eyesight and use of psychotropic medications, antihypertensives, sedatives and diuretics are examples of risk factors that can be targeted to prevent falls. Slowing or reversing loss of skeletal muscle mass and function might also reduce falls vulnerability by mitigating problems with gait and balance.

Until recently, age-related loss of skeletal muscle mass alone was known as sarcopenia, but current definitions also include loss of muscle function [2]. Sarcopenia is characterized by diminished type II (fast) muscle fibres, a loss of lean mass that compromises protein synthesis and reduces muscle strength [3,4], and decreased motor neurons which affects balance [5]. Ageing can also be accompanied by increased adiposity [6] and, if sarcopenia occurs in the face of obesity, the condition is known as sarcopenic obesity [7]. Indeed, accumulation of body fat might aggravate skeletal muscle deterioration by favouring a pro-inflammatory state, which has a detrimental effect on muscle metabolism [8]; moreover, fat infiltration into muscle fibers is associated with a marked reduction in muscle strength [9].

Sarcopenia and its components, including low muscle mass, muscle weakness and/or poor physical performance, have been implicated in increased falls risk [10-12] but whether obesity heightens this risk is not clear. The aim of this study was to examine the association between falls and sarcopenic obesity, and its components, among elderly individuals in the population.

**Citation:** Pasco JA, Sui SX, Tembo MC, Holloway-Kew KL, Rufus PG, et al. (2018) Sarcopenic Obesity and Falls in the Elderly. J Gerontol Geriatr Res 7: 465. doi:10.4172/2167-7182.1000465



## Materials and Methods

### Participants

This cross-sectional study involves 598 elderly men (n=353) and women (n=245) aged 65-98 years who were assessed as part of the Geelong Osteoporosis Study (GOS). Details of study design, participation and non-participation have been described elsewhere [13]. In brief, the GOS is a population-based cohort study of adults randomly-selected from the Commonwealth electoral rolls for the Barwon Statistical Division in south-eastern Australia. At baseline, 1540 men and 1494 women were recruited 2001-2006 (with 67% participation) and 1994-1997 (with 77% participation), respectively. For this analysis, we focused on data collected at recent follow-up phases for elderly men (2007-2010) and women (2011-2014). At follow-up, 598 participants aged 65 years and older provided complete data required for this analysis. All participants gave written, informed consent. The Barwon Health Human Research Ethics Committee approved the study.

### Data

Body composition measures were provided by whole body densitometry using dual energy x-ray absorptiometry (DXA, Lunar Prodigy-Pro, Madison, WI, USA). The percentage body fat mass (%BF) was calculated as body fat mass expressed as a percentage of body weight. Obesity was identified as %BF >25% for men and >35% for women. Appendicular lean mass, a proxy measure of muscle mass, was expressed relative to height (rALM, kg/m2) and low rALM was defined as T-score<-1 [14]. We assessed poor physical performance as an indicator for low-muscle function, by using the "Timed Up-&-Go" (TUG) test that measures the time taken to stand from a chair, walk a measured distance of 3 m, turn around, walk back and sit down again [15]; TUG>10 s indicated poor physical performance. Body weight and height were measured to the nearest 0.1 kg and 0.001 m, respectively, and body mass index (BMI) calculated as weight/height. In this analysis we have designated individuals with sarcopenic obesity as those with low-rALM (T-score < -1) and poor physical performance (TUG>10 s) in combination with high %BF (%BF >25% for men and >35% for women). Sarcopenia referred to the combination of low-rALM (T-score < -1) and poor physical performance (TUG>10 s), while 'poor physical performance and obesity' referred to the combination of poor physical performance (TUG>10 s) and obesity (%BF >25% for men and >35% for women). Falls during the past 12-months were self-reported and individuals who reported one or more falls were classified as fallers.

### Statistical analysis

Descriptive statistics are reported as mean (± standard deviation, SD) for continuous variables that were normally-distributed, median (interquartile range, IQR) for continuous various with a skewed distribution and count (percentage, %) for categorical variables. Differences between the two groups with and without sarcopenic obesity were assessed by Students t-test or chi-square test (Fisher's exact for small counts). Associations between sarcopenic obesity (and its components) and falls were determined using logistic regression after adjusting for age and sex. Models were checked for interaction terms. All statistical analyses were performed using Minitab (version 16; Minitab, State College, PA).

## Results

Participant characteristics are shown in Table 1, for the whole group and according to the presence or absence of sarcopenic obesity. Compared to individuals without sarcopenic obesity, those with sarcopenic obesity were on average older, weighed less and had lower BMI, in addition to having higher %BF, lower rALM and higher TUG scores. Among the 598 participants, 219 (36.6%) had low-rALM, 205 (34.2%) had poor physical performance, 466 (77.9%) were obese and 69 (11.5%) had all three thereby meeting criteria for sarcopenic obesity (Figure 1). Five hundred and forty (90.3%) participants had at least one component that contributed to sarcopenic obesity and only 58 (9.7%) were healthy.

| Variables | All | Sarcopenic Obesity | | p |
|---|---|---|---|---|
| | N = 598 | Yes (n = 69) | No (n = 529) | |
| Male | 353 (59.0%) | 47 (68.1%) | 306 (57.8%) | 0.103 |
| Age (yr) | 74.5 (69.7-80.4) | 82.2 (74.6-86.0) | 73.5 (69.1-79.2) | <0.001 |
| Weight (kg) | 78.0 (± 14.7) | 74.2 (± 11.0) | 78.5 (± 15.1) | 0.005 |
| Height (m) | 1.67 (± 0.09) | 1.67 (± 0.09) | 1.66 (± 0.09) | 0.667 |
| BMI (kg/m2) | 28.1 (± 4.7) | 26.5 (± 2.1) | 28.3 (± 4.9) | <0.001 |
| %BF | 34.3 (± 9.6) | 36.0 (± 7.0) | 34.1 (± 9.9) | 0.045 |
| rALM (kg/m2) | 7.44 (± 1.12) | 6.76 (± 0.92) | 7.53 (± 1.11) | <0.001 |
| TUG (s) | 9.4 (8.2-11.3) | 12.8 (11.4-16.2) | 9.1 (8.0-10.4) | <0.001 |
| Faller | 170 (28.4%) | 28 (40.6%) | 142 (26.8%) | 0.017 |

Data are presented as mean (± SD), median (interquartile range) or n (%).
BMI: Body Mass Index; %BF Body Fat Percentage; TUG: Timed Up-&-Go Test

**Table 1:** Subject characteristics. Data are presented for all and according to the presence or absence of sarcopenic obesity.

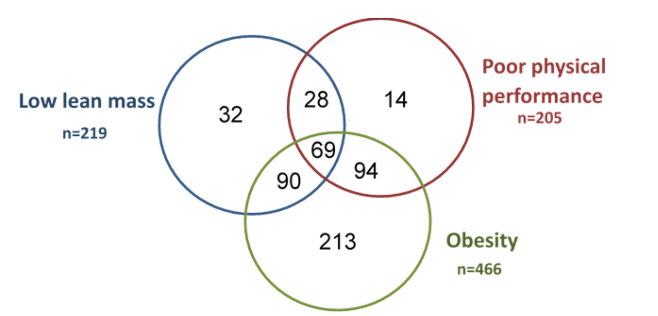


**Figure 1:** Venn diagram depicting the number of individuals with each physical attribute that contributes to sarcopenic obesity (low relative appendicular mass, poor physical performance and obesity).

There were 170 (28.4%) fallers, and these were more common among participants with sarcopenic obesity (28 (40.6%) vs 142 (26.8%; p=0.017), sarcopenia (37 (38.1%) vs 133 (26.6%; p=0.020), combined poor physical performance and obesity (65 (39.9%) vs 105 (24.1%; p<0.001) and low-rALM (73 (33.3%) vs 97 (25.6%; p=0.043), whereas there was no difference detected between those with and without obesity (130 (27.9%) vs 40 (30.3%; p=0.6).

In multivariable analyses adjusted for age and sex, sarcopenic obesity was associated with increased likelihood of a fall (OR 1.65, 95%CI 0.96-2.85, p=0.07) as was sarcopenia (OR 1.52 95%CI 0.93-2.47, p=0.09) and low-rALM (OR 1.41, 95%CI 0.96-2.06, p=0.08), but these did not achieve statistical significance. Poor physical performance was associated with a 1.88-fold increase in the likelihood for falls (OR 1.88, 95%CI 1.26-2.80, p=0.002), and the combination of poor physical performance and obesity was associated with 1.74-fold increase (OR 1.74, 95%CI 1.16-2.61, p=0.007), whereas no association was detected for obesity (OR 0.88, 95%CI 0.57-1.35, p=0.6). No effect modification was detected in the models.

## Discussion

While obesity per se was not associated with falls, individuals with sarcopenic obesity had an increased risk for falls of borderline significance and this appears to be largely a consequence of poor physical performance. Elderly individuals with sarcopenia have limited mobility and are habitually less active [16] which aggravates muscle deterioration and promotes weight gain, and this combination impacts negatively on functional status. Mobility limitations, however, may limit the exposure to falls risk, possibly explaining our inability to observe a statistically significant increase.

Sarcopenic obesity has been linked to increased falls risk in some [9,17] but not all [17,18] studies. A prospective study of older men enrolled in the Concord Health and Ageing in Men Project in Australia used recommendations from the European Working Group on Sarcopenia in Older People (EWGSOP) [2] in combination with %BF >30 to identify sarcopenic obesity; they reported that compared with non-sarcopenic non-obese men, those with sarcopenic obesity, non-sarcopenic obesity and sarcopenic non-obesity all had elevated 2-year fall rates [17]. In this study, there were no associations detected between sarcopenic obesity and falls when sarcopenia was defined according to recommendations by the Foundation for the National Institutes of Health (FNIH) Sarcopenia Project [19]. This disparity highlights how different definitions for caseness can affect study findings and underscores the need for a consensus for defining sarcopenia and sarcopenic obesity.

Therefore, discrepancies in extant literature are likely driven by heterogeneous study designs and methodologies. In our study, we based the definition of sarcopenia on recommendations from EWGSOP, which considered low muscle mass and low muscle function [2]. Muscle mass is commonly measured by densitometry or bioelectric impedance analysis; we utilised DXA-derived rALM and thresholds from an Australian population [14]. Muscle function can be assessed via measures of muscle strength and/or physical performance; we opted to use the TUG test [15] and a threshold of 10s as a marker of poor physical performance. It should be noted that TUG assesses gait and balance, and high TUG times have previously been recognized as a marker of increased falls risk [20]. Furthermore, different definitions for obesity might involve BMI, waist circumference measures or assessment of body fat mass. In our study, we selected whole body DXA-derived %BF because anthropometric measures commonly underestimate obesity in the elderly [21]. Using these criteria, most (90.3%) of our study participants had at least one component that contributed to sarcopenic obesity.

Another study in Australia previously reported that dynapenic obesity and not sarcopenic obesity is a predictor of falls risk among middle-aged and older adults [17]. Dynapenia refers to muscle weakness [3], thus dynapenic obesity was identified for individuals with low muscle strength in combination with obesity. In this context, sarcopenia referred to low appendicular lean mass (adjusted for height and fat mass), and dynapenia referred to poor lower limb strength, so the findings suggested that concurrent obesity and muscle weakness, rather than low muscle mass, increased falls risk. As muscle weakness is an indicator of muscle function, and TUG (a measure of physical performance) is also an indicator of muscle function, our study findings broadly support the notion from the previous study, that muscle function assessment could have utility for predicting falls risk in older obese individuals.

## Conclusion

Our study has several strengths and limitations. Participants were drawn at random from the general population and were not selected on the basis of disease. The objective measures of DXA-derived rALM and body fat mass are particular strengths. We acknowledge that a test of muscle strength would arguably have been more indicative of muscle function than the TUG, and we relied on self-reported falls data to identify fallers. Furthermore, our data were derived from a follow-up phase and participation bias cannot be excluded. We adjusted our models for differences in age and sex but, as with all observational studies, we cannot exclude the possibility of unrecognized confounding. As most of our participants were elderly white residents of Australia, the findings may not be applicable to other populations. It is also difficult to directly compare our findings with those from other studies, as results are dependent on criteria for caseness.

Given these limitations, we conclude that individuals with sarcopenic obesity tended to be at greater risk for falls than their non-sarcopenic non-obese peers and that this appeared to be driven by poor physical performance.

## Conflicts of Interest

The authors have declared that no competing interests exist.

## Acknowledgement

The authors acknowledge the men and women who participated in the study.

Author Contributions: All authors contributed to the interpretation of data, the writing and critical appraisal of the manuscript and approved the final version for submission.

## Financial Support

The Geelong Osteoporosis Study was funded by the National Health and Medical Research Council (NHMRC) Australia (projects 299831, 251638, 628582). This funding organisation played no role in the design and conduct of the study, in the collection, management, analysis and interpretation of the data, or in the preparation, review and approval of the manuscript. SXS, MCT and PGR were supported by Deakin Postgraduate Scholarships and KLH-K was supported by an Alfred Deakin Postdoctoral Research Fellowship.

## References

1. Fu WW, Fu TS, Jing R, McFaull SR, Cusimano MD (2017) Predictors of falls and mortality among elderly adults with traumatic brain injury: A nationwide, population-based study. PLoS One 12: e0175868.
2. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, et al. (2010) Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing 39: 412-423.
3. Clark BC, Manini TM (2008) Sarcopenia =/= dynapenia. J Gerontol A Biol Sci Med Sci 63: 829-834.
4. Lexell J (1995) Human aging, muscle mass, and fiber type composition. J Gerontol Biol Sci Med Sci 50: 11-16.
5. Cederholm T, Cruz-Jentoft AJ, Maggi S (2013) Sarcopenia and fragility fractures. Eur J Phys Rehabil Med 49: 111-117.
6. Pasco JA, Nicholson GC, Brennan SL, Kotowicz MA (2012) Prevalence of obesity and the relationship between the body mass index and body fat: cross-sectional, population-based data. PLoS One 7: e29580.
7. Zamboni M, Mazzali G, Fantin F, Rossi A, Di Francesco V (2008) Sarcopenic obesity: a new category of obesity in the elderly. Nutr Metab Cardiovasc Dis 18: 388-395.
8. Stenholm S, Harris TB, Rantanen T, Visser M, Kritchevsky SB, et al. (2008) Sarcopenic obesity: definition, cause and consequences. Curr Opin Clin Nutr Metab Care 11: 693-700.
9. Baumgartner RN (2000) Body composition in healthy aging. Ann NY Acad Sci 904: 437-448.
10. Scott D, Seibel M, Cumming R, Naganathan V, Blyth F, et al. (2017) Sarcopenic obesity and its temporal associations with changes in bone mineral density, incident falls, and fractures in older men: The Concord Health and Ageing in Men Project. J Bone Miner Res 32: 575-583.
11. Hita-Contreras F, Martínez-Amat A, Cruz-Díaz D, Pérez-López FR (2015) Osteosarcopenic obesity and fall prevention strategies. Maturitas 80: 126-132.
12. Landi F, Liperoti R, Russo A, Giovannini S, Tosato M, et al. (2012) Sarcopenia as a risk factor for falls in elderly individuals: results from the ilSIRENTE study. Clin Nutr 31: 652-658.
13. Pasco JA, Nicholson GC, Kotowicz MA (2012) Cohort profile: Geelong Osteoporosis Study. Int J Epidemiol 41: 1565-1575.
14. Gould H, Brennan SL, Kotowicz MA, Nicholson GC, Pasco JA (2014) Total and appendicular lean mass reference ranges for Australian men and women: the Geelong Osteoporosis Study. Calcif Tissue Int 94: 363-372.
15. Podsiadlo D, Richardson S (1991) The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc 39: 142-148.
16. Pasco JA, Brennan-Olsen SL, Holloway KL, Hyde NK, Kotowicz MA (2016) Low lean tissue mass and physical performance as markers of sarcopenia in older men and women. J Gerontol Geriatr Res 5: 306.
17. Scott D, Sanders KM, Aitken D, Hayes A, Ebeling PR, et al. (2014) Sarcopenic obesity and dynapenic obesity: 5-year associations with falls risk in middle-aged and older adults. Obesity (Silver Spring) 22: 1568-1574.
18. Lloyd BD, Williamson DA, Singh NA, Hansen RD, Diamond TH, et al. (2009) Recurrent and injurious falls in the year following hip fracture: a prospective study of incidence and risk factors from the Sarcopenia and Hip Fracture study. J Gerontol A Biol Sci Med Sci 64: 599-609.
19. Studenski SA, Peters KW, Alley DE, Cawthon PM, McLean RR, et al (2014) The FNIH sarcopenia project: rationale, study description, conference recommendations, and final estimates. J Gerontol A Biol Sci Med Sci 69: 547-558.
20. Kang L, Han P, Wang J, Ma Y, Jia L, et al. (2016) Timed up and go test can predict recurrent falls: a longitudinal study of the community-dwelling elderly in China. Clin Interv Aging 12: 2009-2016.
21. Pasco JA, Holloway KL, Dobbins AG, Kotowicz MA, Williams LJ, et al. (2014) Body mass index and measures of body fat for defining obesity and underweight: a cross-sectional, population-based study. BMC Obesity 1: 9.