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Editorial

Sarcopenic obesity: an undefined dilemma

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Weight gain in healthy young and old people is generally accompanied by increase in fat and muscle mass. But in some older adults, there is disproportionate increase in adiposity (obesity) without concomitant increase or rather relative decrease in muscle mass/strength, known as sarcopenic obesity[1]. One of the critical factors for sarcopenic obesity is decline in physical activity with advancing age that promotes positive energy balance and adipose tissue accumulation but disuse loss of muscle. Adiposity can potentiate further catabolic loss of muscle mass through production of adipose-tissue derived inflammatory cytokines[2]. Adiposity also impairs muscle "quality" through intramuscular fat deposition resulting in decrease in muscle mass, strength and disability[3]. Obesity is a known risk factor for poor physical function and disability[4], sarcopenic obesity is expected to impose even greater risk for these adverse consequences. Knee osteoarthritis (OA) is a leading cause of poor physical function and disability world-wide. Obesity as a risk factor and contributor to adverse consequences in knee OA is extensively studied[5] but sarcopenic obesity is understudied in relation to knee OA.

In this issue of *Osteoarthritis and Cartilage*, Godziuk *et al.* report on a study comparing the prevalence of sarcopenic obesity using different definitions in a cohort of community-dwelling end-stage knee OA patients referred for knee replacement (KR) surgery. Inclusion criteria required all participants to be obese, defined as body mass index (BMI) >30 kg/m2 (WHO criteria) but authors state that all participants met criteria for obesity by other definitions also i.e., waist circumference (>88 cm for females; >102 cm for males) and % body fat (>35% female; >25% in males). Conditioning the inclusion on obesity poses a challenge, as not all knee OA patients referred for KR are obese. What this study has ended up presenting is the prevalence of sarcopenia among obese subjects with end-stage knee OA. Some degree of muscle loss is expected in all end-stage knee OA patients due to disuse, although individual variation in the severity of muscle loss may be present based on age, gender, physical activity level, etc. Thus, generalizability is limited, as only end-stage knee OA subjects were included in this study and may not apply to early stage knee OA. Further, the cross-sectional design lends itself to reverse causation issue, i.e., unclear whether sarcopenic obesity preceded or followed development of knee OA.

To define sarcopenia in this study, Godziuk *et al.* used three previously described definitions based on muscle mass alone and one definition combining muscle mass with strength or function. Muscle mass was assessed using whole body Dual Energy X-ray (DXA) and appendicular skeletal muscle mass (ASM = sum of upper and lower extremity muscle mass) was calculated for all subjects. ASM was standardized by three different body size parameters: 1) by height squared (ASM)/ht^2); 2) by body weight (ASM/weight); and 3) by body mass index (ASM/BMI). ASM/ht^2 definition and the cut offs for men and women applied in this study were initially described by Baumgartner *et al.*[6] Analogous to osteoporosis definition, Baumgartner *et al.* defined sarcopenia as 2 standard deviation below that of the mean sex-specific ASM)/ht^2 of a young healthy adults[6]. Baumgartner *et al.*'s reference data set comprised non-hispanic white healthy adults in New Mexico between ages 18–40 years[6]. The generalizability of this cut off to the study population that Godziuk *et al.* examined is uncertain, as the prevalence using this definition is lower than reported by Baumgartner *et al.* Godziuk and colleagues adopted ASM/weight definition and its cut offs previously used by other studies[7] but initially described by Janssen *et al.*[8] However, unlike this study, Janssen *et al.*[8] assessed age- and gender-adjusted skeletal muscle mass using bioimpedance (not DXA) and defined sarcopenia by skeletal muscle mass index (SMI = skeletal muscle mass adjusted for age and gender/body mass × 100) below 1- or 2-SD of that of young healthy adults. Again, the generalizability of the cut points to this study by Godziuk *et al.*, is not known. The third mass based definition adopted by Godziuk *et al.* was ASM/BMI which was proposed by Foundation for the National Institutes of Health (FNIH) Sarcopenia Project[9] and has been associated with incident disability, institutionalization and mortality[10].

Godziuk *et al.* of demonstrated variation in prevalence of sarcopenia among obese end-stage knee OA patients using different definitions, ranging from 1.3% to 27.2%, which is consistent with other studies that report similar differential definition-based prevalence in other populations[11–13]. Pertaining to the association between sarcopenic obesity and muscle strength/function, both ASM/weight and ASM/BMI were associated inversely with strength and function, but ASM/ht^2 could not be assessed due to very low prevalence.

In addition, the Godziuk *et al.* used the European Working Group on Sarcopenia in Older People (EWGSOP) based definition, combining muscle mass and strength (grip strength) or function (gait speed) to assess the prevalence of sarcopenic obesity in the study population[14]. As the association between muscle mass and strength is not linear, this definition encompasses the broader concept of muscle loss as loss in other parameters than mass alone.

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In the updated manuscript from 2019, the EWGSOP emphasize use of muscle strength as a key descriptor for sarcopenia and provide clear cut off points[15]. Applying this definition to examine prevalence of sarcopenic obesity in end-stage knee OA patients in this study by Godziuk adds value to this paper. As strength and function are incorporated into the definition of sarcopenic obesity, using this definition to study the association between sarcopenic obesity and outcomes of muscle strength and function is difficult to interpret. It is noteworthy that in general applying EWGSOP definition of sarcopenia/sarcopenic obesity to study prevalence or other outcomes works well but is highly problematic when used to study the association with muscle strength or function. Thus, understandably, despite the stellar effort and interesting findings, Godziuk *et al.* shied away from recommending their preference of sarcopenic obesity definition as it remains unclear.

An important contribution of this paper by Godziuk and colleagues is highlighting the difference by age and sex. The increase in prevalence of sarcopenic obesity, irrespective of the definition used, among older adults compared to younger adults aligns with the expected age-related decline in muscle mass/strength. Perhaps this age-related increase in prevalence provides best attestation for the existence of sarcopenic obesity. But contrary to the existing literature, why Godziuk *et al.* found greater prevalence of sarcopenic obesity in men than women is not clear. Having a non-obese and/or comparator group in this study would have solidified these findings.

Presence of obesity likely contributes to poor physical function and disability in knee OA. Understanding the role and impact of sarcopenic obesity in knee OA is of pivotal interest. Few studies have examined sarcopenic obesity in relation to knee OA, and even fewer have focused on its functional consequences in knee OA. Most prior studies are cross-sectional, limiting the interpretability of the results. Further, sarcopenic obesity has been defined by several definitions, hence comparing the findings of prior studies is challenging. Until a consensus definition is reached, sarcopenic obesity will remain elusive.

In summary, recognizing sarcopenic obesity as a public health concern and emphasizing the need to expand research on it is the first step. The next step is not to perform another study to demonstrate differences between existing definitions but rather to collaborate in developing a consensus definition that will facilitate our understanding of the true prevalence and impact of sarcopenia or sarcopenic obesity.

Author contributions

Dr. Misra developed the concept and drafted the manuscript.

Conflict of interest

None.

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