European Review for Medical and Pharmacological Sciences 2015; 19: 328-333

Association of the new index of sarcopenic obesity with physical fitness in healthy Saudi men and women

L. AL-DOKHI

Department of Physiology, College of Medicine, King Saud University, Riyadh, Kingdom of Saudi Arabia

Abstract. – OBJECTIVE: Adults tend to gain weight as they get older. This gain of weight as a result of loss of muscles mass and deposition of fat, this leads to impaired insulin action and glucose uptake, which lead to the development of diabetes. Also, deposition of adipose tissue from the peripheral into the central visceral adipose depot predisposes to vascular disease. The aim of the study was to investigate the relationship and gender differences between muscle mass/fat mass ratio with physical fitness in Saudi adult population.

SUBJECTS AND METHODS: This epidemiological cross-sectional study included 461 healthy adult subjects aged 18-72 years (mean±SD, 36.78±14.17) recruited from King Khalid University Hospital, King Saud University, Riyadh, Saudi Arabia (KKUH, KSU, Riyadh). All participants underwent body composition analysis with a commercially available body analyzer measurements included body weight, body mass index (BMI), muscle mass, protein mass, fat mass, and fitness scoring based on to get values.

RESULTS: The results of the current study showed a significantly high BMI (p = 0.0001) and fat mass (p = 0.0001) in females with low muscles mass (p = 0.0001), and Fitness score (p = 0.0003) compared to males. Linear regression analysis revealed high significant correlation between fitness score and muscle mass/fat mass ratio.

CONCLUSIONS: The prevalence of obesity, increased body fat mass and poor fitness is high in Saudi adult population with significantly lower fitness scores in females compared to males. Using parameters of body fat analysis, body mass, and muscle mass/fat mass ratio would encourage people to initiate an active life early in their lives, thus, preventing the occurrence of sarcopenic obesity.

Key Words:
Body composition, Body mass index, Protein Mass, fat mass, Muscle fat ratio, Fitness score.

Introduction

Older adults tend to gain weight as they age which is primarily fat[1]. In elderly individuals there is increased risk of sarcopenic obesity and risk of cardiovascular disease and mortality. A population based cohort study of older men[2] stated that changes in body composition result in the prevalence of overweight and obesity combined with a loss of muscle mass and strength which has been defined as sarcopenic obesity that is associated with great cardiovascular mortality and all cause of mortality[2-5].

The loss of muscle mass that occurs with aging is well documented and appears to occur even in relatively weight stable healthy individuals[6]. Several mechanisms underlying age-related muscle loss have been recognized including neural[7], hormonal changes[8] such as reduction in testosterone and growth hormone levels that are associated with decline in muscle mass and may also contribute to increased fat mass accumulation[9].

Decreased responsiveness to thyroid hormone also may result in a decreased metabolic rate, which can lead to weight gain[9]. Poor nutrition[10], physical inactivity[11], and low-grade inflammation[12,13], all can lead to loss of muscle mass in elderly. With aging, significant decline in muscle strength, even after adjusting for muscle mass, has been documented[7,14]. Obesity in older adults is also associated with decline in muscle quality, characterized by a decrease in fiber size and number, preferential loss of type II fibers size decreased synthesis of muscle protein and reduced mitochondrial function[14-16].

The increased accumulation of fats in adipose tissue depots may also occur in and around organs and tissues that are lean body mass (i.e., skeletal muscle, heart, liver, pancreas, kidney,

Corresponding Author: Laila Al Dokhi, MD; e-mail: lailadokhi@yahoo.com

blood vessels). This deposition of fat in and around lean tissue can be toxic to those cells. For example, deposition in skeletal muscle leads to impaired insulin action and glucose uptake, while deposition in the pancreas leads to decreased insulin secretion and cell viability. Adipose tissue also is redistributed from peripheral adipose tissue depots into the central visceral adipose depot[17].

The aim of the present study is to investigate the relationship and association between muscle mass/fat mass ratio with physical fitness in healthy adults Saudi men and women.

Subjects and Methods

This cross-sectional study was conducted in the Physiology Department, College of Medicine, King Saud University, Riyadh, Saudi Arabia. A total of 461 healthy adult Saudi subjects recruited from King Khalid University Hospital (290 males, and 171 Females), with age range between 18-72 years (36.78±14.17) were studied. They were recruited in specific clinic established at the department of physiology. Our inclusion criteria was healthy adult Saudi subjects of any sex. The exclusion criteria were chronic diseases like diabetes mellitus, cardiac diseases, endocrine, renal problems, neurological, joint and vascular diseases as all these conditions contribute to dysmobility and reduced body fitness, also all these conditions affect body composition significantly. The study was approved by College of Medicine Ethics Review Board. Only those individuals who agreed to participate in the study and signed the consent form were selected according to Helsinki declaration.

After overnight fasting and wearing light indoor clothes, each subject's body height and weight were measured by a scale. Subjects were not allowed to drink during fasting (and were asked to empty their bladders) before measurements of body composition.

BMI was calculated as the weight in kilograms divided by the square of the height in meters. All participants underwent body composition analysis by bioelectrical impendence analysis (BIA), with a commercially available body analyzer (InBody3.0, Biospace, Korea). The subject was asked to first wipe the sole of the feet by a wet tissue and then stand over the electrodes of the machine and results were ready in 3-5 minutes. Parameters recorded included height, body weight, body surface area, BMI, obesity degree, protein mass, muscle mass, fat mass, percent body fat, fat control, muscle control and fitness scoring based on the target values for ideal body fitness.

Segmental analysis can calculate slight differences by sex, age and race without using empirical estimation. The body composition analyzer works by the principal of bioelectrical impedance. Different tissues of the body have varying degrees of electrical resistance and the devise also calculates amount of each tissue with the difference in electrical impedance[18-20]. The in Body Composition Analyzer (BioSpace, Seoul, Korea) is a segmental impedance device measuring the voltage drop in the upper and lower body.

The participant stood on the device while it measured body weight, and age, height and sex were entered on the touch screen. The body uses eight points of tactile electrodes (contact at the hands and feet). This detects the amount of segmental body water. The technique uses multiple frequencies to measure intracellular and extracellular water separately. The frequency of 50 kHz measures extracellular water while frequencies above 200 kHz measure intracellular water. Biospace In Body has specific standardized criteria for fitness scoring which is automatically calculated by the machine.

Statistical Analysis

The data was analyzed by computer software program Statistical Package for Social Sciences, Version 19 (SPSS Inc., Chicago, IL, USA). Descriptive characteristics of the study patients were calculated as Mean ± SD (Standard Deviation) for continuous variables and as percentages for categorical variables. The tests applied for statistical analysis were Student's *t* test and linear regression analysis with an alpha error of 5%. A *p* value of ≤0.05 was taken as statistically significant.

Results

The present study shows relationship of body composition with physical fitness in healthy Saudi adults. Table I shows the demographic data for all subjects in the body composition parameters showing mean±SD and ranges. The mean BMI of the whole study population was 28.97±7.74, and Fitness score 67.16±11.33. There is significant gender differences were observed in different body indices and composition (Table II). Females

Table I. Demographic data of all study subjects showing mean, median, minimum and maximum values.

Variables	All (N = 461) Mean ± SD	Min	Max
Age years	36.78 ± 14.17	18	72
Height	166.39 ± 10.54	141.5	187.0
Weight kg	79.82 ± 20.21	18.3	173.2
BMI	28.97 ± 7.74	15.6	67.7
Protein mass kg	46.07 ±17.55	28.9	74.7
Fat mass kg	26.78 ± 15.56	2.2	102.5
M/F ratio	2.29 ± 2.06	0.07	22.1
Fitness score	67.16 ± 11.33	18	95

Data is expressed as mean ± SD.

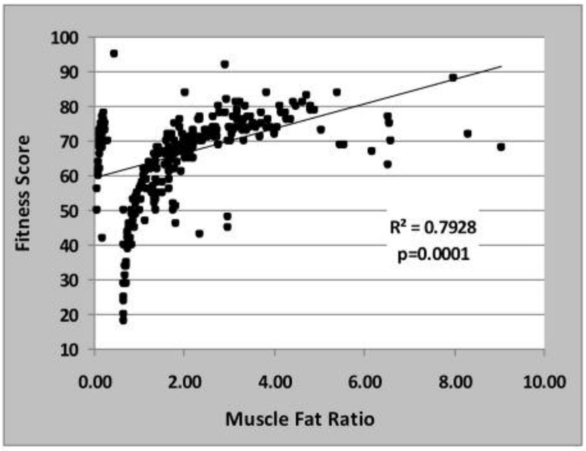

Figure 1. Linear regression analysis between muscle fat ratio and fitness score in all subjects.

had significantly higher BMI (p = 0.0001) and Fat mass (p = 0.0001) compared to males. The mean height (p = 0.0001), muscles mass (p = 0.0001), muscle mass/fat mass ratio (p = 0.00001) was significantly higher in males compared to Females. Also the mean fitness score (p = 0.0003) were significantly higher in males compared to females.

We did linear regression analysis between muscle mass/ fat mass ratio as independent variable and fitness scoring as dependent variable. The relationship was highly significant (R^2 = 0.7928, p = 0.0001) (Figure 1). Linear regression showed high significance between muscle fat ratio and fitness score in male (R^2 = 0.8373, p = 0.0001) (Figure 2).

We also, determined gender differences in this relationship. The relationship was more significant in males (R^2 = 0.8373, p = 0.0001) compared to females (R^2 = 0.6558, p = 0.0001) (Figure 3).

Discussion

This study reports a very high prevalence of obesity and poor fitness scoring in Saudi adult population. Moreover, significant gender differences were observed in BMI, Fitness score, %body fat and other parameters of body compo-

Table II. Gender differences in demographic data and fitness score.

Variables	Males N = 290	Females N = 171	*p* value
Age years	38.39 ± 15.80	34.02 ± 10.34	0.0013*
Height	171.03 ± 7.30	158.51 ± 10.51	0.0001*
Weight kg	79.90 ± 15.76	79.68 ± 26.13	0.9086
BMI	27.42 ± 4.97	31.61 ± 10.43	0.0001*
Protein Mass kg	54.09 ± 8.53	32.46 ± 20.33	0.0001*
Fat Mass kg	22.21 ± 9.66	34.54 ± 20.01	0.0001*
M/F ratio	2.92 ± 1.44	1.24 ± 2.48	0.0001*
Fitness Score	70.42 ± 7.74	61.64 ± 14.02	0.0003*

Data is expressed as mean ± SD; Differences were studied by Student's *t* test; *Significant between group males and females.

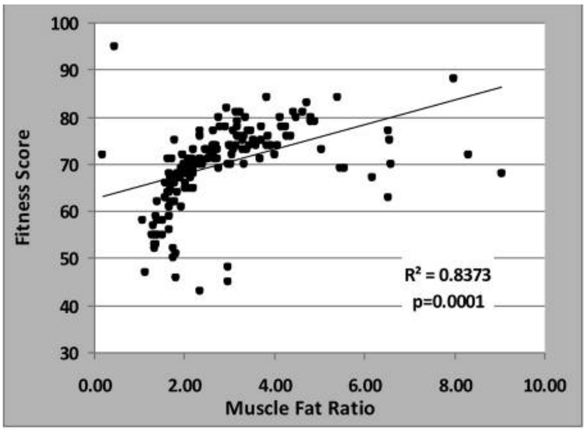

Figure 2. Linear regression analysis between muscle fat ratio and fitness score in male subjects.

sition. Our findings of the association of high fitness score with significantly high muscle mass/fat mass ratio are in accordance with the reports of Ryu et al[21] who indicated that physical activity is associated with a reduced risk of sarcopenic obesity in men than in women. Kyle et al[22] have looked into body composition and physical fitness from different aspects. And proved that body anthropometric data were frequently collected in clinics, sports medicine, nutrition and other health-related fields but the routine parameters of body fitness like BMI and waist hip ratio (WHR) did not give a true picture of physical fitness. A recent study[23] revealed that BMI is a simple and conventional index for assessing total muscularity but it doesn't give true picture of physical fitness.

The reason for very high prevalence of obesity and poor fitness scoring in Saudi adult population in the current study may be physical inactivity and high caloric intake. A clear association has been reported between low physical activity or age and height-normalized body composition parameters Body Fat Mass Index and Fat Free Mass Index (BFMI and FFMI)[22] as shown in our study.

In Korean adult population Lim et al[24] reported the association between the ratio of visceral fat to thigh muscle area and metabolic syndrome. They observed that ratio of visceral fat to thigh muscle area is significantly increased in subjects with metabolic syndrome and arterial stiffens and independently negatively associated with metabolic syndrome. They concluded that muscle mass/fat mass ratio is a new index of sarcopenic obesity, which is associated with increased cardiovascular diseases (CVD) risk. They implied that muscle strength could be more important than muscle mass for CVD protection in old age.

A recent study[25] mentioned that sarcopenic obesity is associated with hypertension, while low muscle mass is also correlated with hypertension, independent of abdominal obesity. They concluded that abdominal and sarcopenic obesity may potentiate each other to induce hypertension.

Andreasi et al[26] analyzed associations between health-related physical fitness and the anthropometric and demographic indicators of children at elementary schools. They reported that unhealthy physical fitness levels were related to female sex, obesity and excessive abdominal adiposity and this is in accordance to our finding but in different age groups.

Similar to our findings Ryu et al[21] stated that physical activity is associated with risk of sarcopenic obesity in older Korean adults. There were gender differences in the relationship, with stronger associations observed on men than in women.

The low muscle mass and its association to poor physical fitness observed in the present study is also proved by Binkley et al[27] who stated that the age-related decline in muscle mass and function is associated with increased risk of disability and reduce quantity/quality of life. Also, Marcus et al[28] considered that a high ratio of fat to lean mass places additional demand on the inadequate locomotor system and reduce mobility performance. The causative factor for the low muscle mass in Saudi women observed in the present study may be multi factorial as stated by

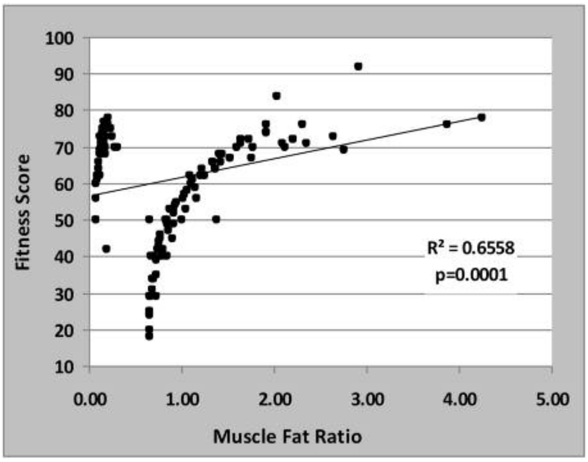

Figure 3. Linear regression analysis between muscle fat ratio and fitness score in female subjects.

previous report who suggested that the decline in muscle mass and high intramuscular fat are multi factorial in origin being caused partly by inflammation, hormonal and/ or nutritional deficits, toxins and sedentariness[29].

In accordance to the findings of our study Kim et al[30] found that muscle mass/fat mass ratio was significantly associated with waist circumference, blood pressure, lipid profiles, glucose and brachial-ankle pulse wave velocity (baPWV) and they considered muscle mass/fat mass ratio as new index of sarcopenic obesity.

Conclusions

Adults Saudi women have poor muscle mass/fat mass ratio with poor physical fitness scores compared to Saudi males and this mean that sarcopenic obesity is associated with poor fitness score.

Using data from this study, helps us to calculate that implementation of effective programs to change lifestyle for achieving physical fitness and healthy nutrition in schools are needed. Weight reduction can be achieved through structured and community tailored training programs that would optimize body composition and fitness level both in young and elderly people speciality in women to initiate an active life style early in their lives thus preventing diseases related to obesity and physical inactivity.

Using parameters of body fat analysis, lean body mass and muscle fat ratio would encourage people to initiate an active life style early in their lives thus preventing the occurrence of sarcopenic obesity and low muscle/fat mass ratio.

Awareness programs should be applied for the public including exercise, diet and health education programs in the community to improve the public awareness about the growing problem of obesity.

Acknowledgements

Thankful to the College of Medicine Research Centre and Deanship of Scientific Research, King Saud University, Riyadh, Saudi Arabia. Author also thank to Prof. Faten Zakria and Prof. Syed Shahid Habib for reviewing the article and Mr Timhar Amlih and Mr Adnan Ali Khan for technical assistance.

Conflict of Interest

The Authors declare that they have no conflict of interests.

References

1) Zamboni M, Zoico E, Scartezzini T, Mazzali G, Tosoni P, Zivelonghi A, Gallagher D, De Pergola G, Di Francesco V, Bosello O. Body composition changes in stable-weight elderly subjects: the effect of sex. Aging Clin Exp Res 2003; 15: 321-327.
2) Atkins JL, Whincup PH, Morris RW, Lennon LT, Papacosta O, Wannamethee SG. Sarcopenic obesity and risk of cardiovascular disease and mortality: a population-based cohort study of older men. J Am Geriatr Soc 2014; 62: 253-260.
3) Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, Martin FC, Michel JP, Rolland Y, Schneider SM, Topinková E, Vandewoude M, Zamboni M; European Working Group on Sarcopenia in Older People. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Aging 2010; 39: 412-423.
4) Narici MV, Maffulli N. Sarcopenia: characteristics, mechanisms and functional significance. Br Med Bull 2010; 95: 139-159.
5) Zamboni M, Mazzali G, Fantin F, Rossi A, Di Francesco V. Sarcopenic obesity: a new category of obesity in the elderly. Nutr Metab Cardiovasc Dis 2008; 18: 388-395.
6) Newman AB, Lee JS, Visser M, Goodpaster BH, Kritchevsky SB, Tylavsky FA, Nevitt M, Harris TB. Weight change and the conservation of lean mass in old age: the Health, Aging and Body Composition Study. Am J Clin Nutr 2005; 82: 872-878.
7) Vandervoort AA. Aging of the human neuromuscular system. Muscle Nerve 2002; 25: 17-25.
8) Solomon AM, Bouloux PM. Modifying muscle mass--the endocrine perspective. J Endocrinol 2006; 191: 349-360.
9) Villareal DT, Apovian CM, Kushner RF, Klein S; American Society for Nutrition; NAASO, The Obesity Society. Obesity in older adults: technical review and position statement of the American Society for Nutrition and NAASO, The Obesity Society. Obes Res 2005; 13: 1849-1863.
10) Dreyer HC, Volpi E. Role of protein and amino acids in the pathophysiology and treatment of sarcopenia. J Am Coll Nutr 2005; 24: 140S-145S.
11) Szulc P, Duboeuf F, Marchand F, Delmas PD. Hormonal and lifestyle determinants of appendicular skeletal muscle mass in men: the MINOS study. Am J Clin Nutr 2004; 80: 496-503.
12) Roth SM, Metter EJ, Ling S, Ferrucci L. Inflammatory factors in age-related muscle wasting. Curr Opin Rheumatol 2006; 18: 625-630.
13) isser M, Pahor M, Taaffe DR, Goodpaster BH, Simonsick EM, Newman AB, Nevitt M, Harris TB. Relationship of interleukin-6 and tumor necrosis factor-alpha with muscle mass and muscle strength in elderly men and women: the Health ABC Study. J Gerontol A Biol Sci Med Sci. 2002; 57: M326-M332.

14) NAIR KS. Aging muscle. Am J Clin Nutr 2005; 81: 953-963.

15) NILWIK R, SNIJDERS T, LEENDERS M, GROEN BB, VAN KRANENBURG J, VERDIJK LB, VAN LOON LJ. The decline in skeletal muscle mass with aging is mainly attributed to a reduction in type II muscle fiber size. Exp Gerontol 2013; 48: 492-498.

16) MARCELL TJ. Sarcopenia: causes, consequences and preventions. J Gerontol Med Sci 2003; 58A: M911-M916.

17) HARRIS TB. Invited commentary: body composition in studies of aging: new opportunities to better understand health risks associated with weight. Am J Epidemiol. 2002; 156: 122-124.

18) HOUTKOOPER LB, LOHMAN TG, GOING SB, HOWELL WH. Why bioelectrical impedance analysis should be used for estimating adiposity. Am J Clin Nutr l996; 64(suppl): 436S-448S.

19) CHUMLEA WC, GUO SS, KUCZMARSKI RJ, FLEGAL KM, JOHNSON CL, HEYMSFIELD SB, LUKASKI HC, FRIEDL K, HUBBARD VS. Body composition estimates from NHANES III bioelectrical impedance data. Int J Obes 2002: 26, 1596-1611.

20) BONEVA-ASIOVA Z, BOYANOV MA. Body composition analysis by leg-to-leg bioelectrical impedance and dual-energy X-ray absorptiometry in non-obese and obese individuals. Diabetes Obes Metab 2008; 10: 1012-1018.

21) RYU M, JO J, LEE Y, CHUNG YS, KIM KM, BAEK WC. Association of physical activity with sarcopenia and sarcopenic obesity in community-dwelling older adults: the Fourth Korea National Health and Nutrition Examination Survey. Age Ageing 2013; 42: 734-740.

22) KYLE UG, MORABIA A, SCHUTZ Y, PICHARD C. Sedentarism affects body fat mass index and fat-free mass index in adults aged 18 to 98 years. Nutrition 2004; 20: 255-260.

23) KANEHISA H, FUKUNAGA T. association between body mass index and muscularity in healthy older Japanese women and men. J Physiol Anthropol 2013; 32: 4.

24) LIM KI, YANG SJ, KIM TN, YOO HJ, KANG HJ, SONG W, BAIK SH, CHOI DS, CHOI KM. The association between the ratio of visceral fat to thigh muscle area and metabolic syndrome: the Korean Sarcopenic Obesity Study (KSOS). Clin Endocrinol (Oxf) 2010; 73: 588-594.

25) PARK SH, PARK JH, SONG PS, KIM DK, KIM KH, SEOL SH, KIM HK, JANG HJ, LEE JG, PARK HY, PARK J, SHIN KJ, KIM DI, MOON YS. Sarcopenic obesity as an independent risk factor of hypertension. J Am Soc Hypertens 2013; 7: 420-425.

26) ANDREASI V, MICHELIN E, RINALDI AE, BURINI RC. Physical fitness and associations with anthropometric measurements in 7 to 15-year-old school children. J Pediatr (Rio J) 2010; 86: 497-502.

27) BINKLEY N, KRUEGER D, BUEHRING B. What's in a name revisited: should osteoporosis and sarcopenia be considered components of "dysmobility syndrome?". Osteoporos Int 2013; 24: 2955-2959.

28) MARCUS RL, BRIXNER DI, GHATE S, LASTAYO P. Fat modulates the relationship between sarcopenia and physical function in nonobese older adults. Curr Gerontol Geriatr Res 2012; 2012: 216185.

29) ROLLAND Y, CZERWINSKI S, ABELLAN VAN KAN G, MORLEY JE, CESARI M, ONDER G, WOO J, BAUMGARTNER R, PILLARD F, BOIRIE Y, CHUMLEA WM, VELLAS B. Sarcopenia: its assessment, etiology, pathogenesis, consequences and future perspectives. J Nutr Health Aging 2008; 12: 433-450.

30) KIM TN, PARK MS, LIM KI, YANG SJ, YOO HJ, KANG HJ, SONG W, SEO JA, KIM SG, KIM NH, BAIK SH, CHOI DS, CHOI KM. Skeletal muscle mass to visceral fat area ratio is associated with metabolic syndrome and arterial stiffness: The Korean Sarcopenic Obesity Study (KSOS). Diabetes Res Clin Pract 2011; 93: 285-291.