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Original Article

# The Association of Food Intake and Physical Activity with Body Composition, Muscle Strength and Muscle Function in Postmenopausal Women

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## ABSTRACT

**Background and Objectives:** Sarcopenia is explained as age-related reduction in muscle mass and performance. Some of the most important risk factors for sarcopenia include age, malnutrition, and sedentary life style. The aim of this study was to investigate the association of food intake and physical activity with body composition, muscle strength and muscle function in post-menopausal women.

**Materials and Methods:** In this cross-sectional study, a total of 190 women aged 40-60 years were recruited from the staff working in Iran University of Medical Sciences. Variables consisting of muscle strength and muscle function, anthropometric indices, dietary intakes, and physical activity were evaluated. Statistical analysis was performed using SPSS version 21.

**Results:** There was a positive association between physical activity and handgrip strength ($P$=0.01), calorie intake and muscle function, protein intake and fat free mass percentage, total fat intake and fat mass percentage (in all associations, $P$<0.001). In addition, a negative association was observed between carbohydrate intake and muscle function, as well as total fat intake and fat free mass percentage (in both associations, $P$<0.001). There was not a significant relationship between the other variables ($P$>0.05).

**Conclusions:** It seems in this middle-aged women group, mild fat and carbohydrate restriction combined with mild or moderate physical activity may lead to reduction in fat mass, increased fat free mass, and improvement in muscle strength and muscle function.

**Keywords:** Food intake, Physical activity, Body composition, Muscle strength, Muscle function, Post-menopausal women

## Introduction

Advancing age, even in healthy old people, is accompanied by a decrease in muscle mass and muscle strength (1,2). Sarcopenia is a multidimensional age-related disease correlated with age (3), sedentary lifestyle (4), malnutrition (5), and lack of anabolic and anti-catabolic responsiveness to changes in the concentration of extracellular amino acids (6), as well as a rise in abnormal reactive oxygen species (ROS) (7). Hormonal changes in women occur with physiological and behavioral changes (8). Alterations in the size and body composition of postmenopausal women are notable, especially the reduction in lean mass and promotion in fat mass. These alterations also take place in aging, but promote upon the entrance of menopause (8). Recent studies have shown that sarcopenia is an important risk factor for metabolic diseases (9,10). The slow loss of muscle strength leads to functional disability (11,12), the requirement for help in the performance of daily activities (13,14), and elevated

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risk of falling and fractures (15). In brief, the functional restrictions and disorders due to sarcopenia decrease the quality of life and functional independence during senescence (4). Therefore, the preservation of the muscle strength in aging is important.

Diet and physical activity are among the steadiest risk factors for sarcopenia and are commonly examined in intervention trials to decrease sarcopenia incidence and/or severity (3). Hence, the present study aimed to investigate the association of food intake and physical activity with body composition, muscle strength and muscle function in middle-aged women.

## Materials and Methods

This cross-sectional study was conducted on middle-aged women staff working in Iran University of Medical Sciences (IUMS), Tehran in 2014. Volunteers could participate in this study if they were menopause female, aged 40-60 years, had a Body Mass Index (BMI) 18.5-29.9, not to be ovariectomized, were not suffering from any chronic or acute diseases, and not taking multivitamins, minerals, laxatives, or hormone medications.

The sample size estimate was based on the correlation between handgrip strength and physical activity. Using the sample size formula for correlation studies and on the basis of the previous studies, the expected minimum correlation coefficient between handgrip strength and physical activity (r=0.20) was estimated (16). We determined that 190 individuals would provide a power of 80% to detect a correlation between these two variables on the basis of two-sided alpha level of 0.05. The 190 women, who met the inclusion criteria, were informed of the aims and protocol of the study, wrote informed consent, and signed participant assent. This study was approved by the Ethics Committee of Iran University of Medical Sciences (IUMS), Tehran, Iran.

**Anthropometric, dietary intake and physical activity assessments:** We evaluated body weight to the nearest 0.1 kg while the women were minimally clothed and without shoes by e-body (Beurer, Germany). Height was assessed to the nearest 0.5 cm in standing posture, without shoes. Body mass index (BMI) was calculated as body weight (kg) divided by height squared ($m^2$). Body composition consisting of Fat Mass percentage (FM%) and Fat Free Mass percentage (FFM%) was taken by e-body (Beurer, Germany).

Dietary intakes were assessed with a 24-h recall for 2 days (1 week day and 1 week-end day), and energy and macronutrient (total fat, carbohydrate, protein) intakes were evaluated using the Nutritionist 4 software. Physical activity level was measured by the Persian and short-form of the International Physical Activity Questionnaire (IPAQ) and demonstrated in Met-Min/week (17).

**Muscle performance:** The upper body strength was assessed by handgrip strength test, and muscle function was measured quantitatively by the use of Time Get Up and Go (TGUG) test.

Handgrip strength was assessed in kg in dominant hand with a hand-held dynamometer (digital hand dynamometer “DIGI-II, Korea”). The women were seated on armchair, while their shoulder adducted and neutrally rotated turned, elbow was flexed to $90^0$, and the forearm and wrist were in a neutral posture (18).

For TGUG test, the women were seated on the chair. They were asked to stand up and walk at common step 3m, then turn to the chair, and sit down again. The obtained value was reported in seconds (s) (19,20).

Statistical analysis was performed by using SPSS version 21.0 (SPSS Inc, Chicago, Illinois) software. The Kolmogorov-Smirnov’s test was used to assess the normality of data. Descriptive statistics were expressed as mean±SD. Multiple linear regression was used for determining the relationship between food intake and physical activity with body composition, muscle strength and muscle function adjusted for potential confounders. $P$ value < 0.05 was considered significant.

## Results

Descriptive statistics of the participants are shown in Table 1. Dominant hand in 181 (95.3%) women was right hand, and in 9 (4.7%) of them was left hand.



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**Table 1.** Characteristics and food intakes of the participants (n=190)

| Variable | Value [a] | Min | Max |
|---|---|---|---|
| Age, years | 47.3±4.2 | 43.00 | 51.50 |
| Height, cm | 157.37±6.17 | 141.00 | 173.00 |
| Weight, kg | 66.09±7.40 | 50.00 | 84.70 |
| BMI, kg/m$^2$ | 26.65±2.57 | 19.50 | 29.90 |
| Fat mass, (%) | 36.94±5.17 | 26.00 | 48.50 |
| Fat free mass, (%) | 63.04±5.15 | 51.50 | 74.00 |
| Energy intake, kcal/day | 2200.85±661.44 | 1082.00 | 3360.00 |
| Carbohydrate intake, g/day | 319.49±110.5 | 146.70 | 494.40 |
| Total fat intake, g/day | 71.19±49.14 | 29.44 | 200.700 |
| Protein intake, g/day | 21.24±16.94 | 22.21 | 105.40 |
| Physical Activity, Met-min/week | 854.76±775.94 | 33.00 | 6293.00 |

[a] Values are shown as mean±SD.

In linear regression models, after adjustment for physical activity and body weight, there was a positive and significant association between calorie intake and muscle function between protein intake and FFM%, and also between FM% and total fat intake (*P*<0.001). In addition, a negative and significant association between muscle function and carbohydrate intake, between total fat intake and FFM%, and also between FM% and protein intake was seen (*P*<0.001). But there was not any significant association between muscle strength, muscle function and other investigated variables of food intake (Table 2).

According to the linear regression analysis and after an adjustment for food intake and body weight, we found a positive and significant association between physical activity and handgrip strength (*P*=0.01) but not a significant relationship between physical activity and other indicators of body composition and muscle function (Table 3).

Moreover, to evaluate the relationship of body weight with muscle function and muscle strength, after an adjustment for food intake and physical activity, there was a positive and significant association between body weight with FM%, and handgrip strength (*P*<0.001); however, body weight was negatively associated with FFM% (*P*<0.001). Furthermore, body weight was not associated with muscle function (P=0.35).

## Discussion

In the present study, we found a positive and significant association between calorie intake and muscle function, protein intake and FFM%, and total fat intake and FM%. Moreover, there was a negative and significant association between muscle function and carbohydrate intake, and between protein intake and FM%. Miller *et al*. (21) evaluated the relationships between body fat, diet composition, calorie intake and exercise among male (n=107) and female (n=109) adults aged 18-71 years. They found no relationship between energy intake and adiposity, but leanness and exercise were correlated. In fact, they showed that body fat mass is more related to diet composition and physical activity than calorie intake. Valenzuela *et al*. (22), in a study on 78 men and women aged 60 years, found that low protein intake and insufficient distribution of protein could result to muscle mass reduction and elevated risk of sarcopenia. In the current study, we did not investigate the distribution of protein intake in a day. In addition to physical activity level, calorie and macronutrient intake, several factors such as sex hormone deficiency, vitamin D deficiency, and inflammation are known to be important agents in skeletal muscle structure and function (23) that we did not evaluate them. Furthermore, quality of diet can also affect the body composition and, in turn, muscle performance, which we did not assess them.



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**Table2.** Association between food intake and body composition, muscle strength and muscle function in the participants (n=190)

| | Fat free mass (%) | | | | Fat mass (%) | | | | Handgrip strength (kg) | | | | Muscle function (s)[a] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1* | | Model 2 ** | | Model 1 | | Model 2 | | Model 1 | | Model 2 | | Model 1 | | Model 2 | |
| | β | P | β | P | β | P | β | P | β | P | β | P | β | P | β | P |
| Calorie intake, kcal/day | -0.51 | <0.001 | -0.45 | <0.001 | 0.06 | 0.51 | 0.45 | 0.06 | -0.34 | <0.001 | 0.05 | 0.77 | 0.31 | <0.001 | 1.16 | <0.001 |
| CI (95%) | (-0.005- -0.003) | | (-0.007-0.00) | | (0.003-0.005) | | (0.00-0.007) | | (-0.006- -0.002) | | (-0.004- 0.005) | | (0.001-0.002) | | (0.002-0.008) | |
| Carbohydrate intake,g/day | -0.26 | <0.001 | -0.11 | 0.45 | 0.26 | <0.001 | 0.10 | 0.47 | -0.11 | 0.13 | -0.08 | 0.46 | 0.08 | 0.22 | -3.33 | <0.001 |
| CI (95%) | (-0.019- -0.006) | | (-0.019-0.009) | | (0.006-0.019) | | (-0.009-0.019) | | (-0.018- 0.002) | | (-0.21-0.1) | | (-0.001-0.006) | | (-0.025- -0.006) | |
| Total fat intake, g/day | -0.50 | <0.001 | -3.57 | <0.001 | 0.50 | <0.001 | 3.57 | <0.001 | -0.45 | <0.001 | -0.52 | 0.56 | 0.27 | <0.001 | -2.60 | 0.08 |
| CI (95%) | (-0.067- -0.041) | | (-0.617- -0.133) | | (0.041-0.067) | | (0.132-0.616) | | (-0.093- -0.052) | | (-0.364-0.199) | | (0.008- 0.024) | | (-0.322- 0.020) | |
| Protein intake, g/day | -0.22 | <0.001 | 0.27 | <0.001 | 0.22 | <0.001 | -0.27 | <0.001 | -0.05 | 0.42 | 0.05 | 0.43 | 0.14 | 0.04 | 0.05 | 0.65 |
| CI (95%) | (-0.112- -0.027) | | (0.027-0.141) | | (0.026-0.112) | | (-0.141- -0.26) | | (-0.093- 0.039) | | (-0.04-0.093) | | (0.001-0.049) | | (-0.031- 0.050) | |

*Unadjusted
**Adjusted for physical activity and weight
[a] Muscle function was measured by use of Time Get Up and Go (TGUG) test

**Table3.** Association between physical activity and body composition, muscle strength and muscle function in the participants (n=190)

| | Fat free mass (%) | | | | Fat mass (%) | | | | Handgrip strength (kg) | | | | Muscle function (s) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1* | | Model 2 ** | | Model 1 | | Model 2 | | Model 1 | | Model 2 | | Model 1 | | Model 2 | |
| | β | P | β | P | β | P | β | P | β | P | β | P | β | P | β | P |
| Physical activity, (Met-min/week) | 0.38 | <0.001 | -0.19 | 0.39 | -0.38 | <0.001 | 0.20 | 0.38 | 0.41 | <0.001 | 0.43 | 0.01 | -0.22 | <0.001 | 0.55 | 0.057 |
| CI (95%) | (0.002-0.003) | | (-0.004- 0.002) | | (-0.003- -0.002) | | (-0.002-0.004) | | (0.003-0.005) | | (0.001-0.008) | | (-0.001- 0.00) | | (0.00-0.004) | |

* Unadjusted
**Adjusted for food intake and body weight

Our findings demonstrated no significant association between physical activity level, and FM% and FFM%. Westerterp *et al*. (24) investigated the relationship between physical activity level and parameters of aging among the 136 women and 180 men over 20 years. They found that advancing age was correlated with lower activity levels and lower fat free mass. After controlling for age, they found no association between physical activity level and fat free mass. In old subjects with relatively high physical activity level compared with those with low levels of physical activity, there was no difference in fat mass and fat free mass (24). This study found that the effect of exercise on body composition depends on the kind of exercise (24). Resistance exercise elevates fat free mass by 1.1 to 2.1 kg, while aerobic exercise had no impact on fat free mass. In addition, in older adults, exercise training did not lead to a promotion in TEE (Total Energy Expenditure), and exercise activity was compensated by reduction in spontaneous activity (24).

In the current study, there was a significant relationship between physical activity level and handgrip strength. Kuh *et al*. (25) revealed that middle-aged women had much poorer handgrip strength, weaker balance time, and poorer chair rise time, were less active and suffered from health problems. We found no significant association between physical activity level and muscle function, which is probably resulted from lack of association between physical activity level, and FM% and FFM%.

In spite of these findings, it should be noted that, because of the cross-sectional nature of this study, causality could not be determined, and could not find the temporality of the observed results. In this regard, life-span (longitudinal and prospective) studies are needed.

There were some limitations in the present study; including the cross-sectional design of this study, and lack of assessment of oxidative stress and inflammatory biomarkers in the participants. To evaluate the muscle strength, we measured the upper body muscle strength, only.

In conclusion, it seems in this middle aged women group, mild fat and carbohydrate restriction combined with mild or moderate physical activity may lead to reduction in fat mass, and increased fat free mass and also improvement in muscle performance.


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None conflict of interest has been declared.

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