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BODY COMPOSITION AND PHYSICAL ACTIVITY IN END STAGE RENAL DISEASE

Karen M. Majchrzak¹, Lara B. Pupim^{1,2}, Mary Sundell¹, and T. Alp Ikizler¹

¹ Department of Medicine, Division of Nephrology, Vanderbilt University Medical Center, Nashville, Tennessee

² General Medicine Therapeutic Area, Nephrology, Amgen Inc., Thousand Oaks, California

Abstract

Objective—To examine the relationship between visceral and somatic protein stores and physical activity in ESRD.

Design—A cross-sectional single center study.

Setting—Vanderbilt University Outpatient Dialysis Unit.

Patients—Fifty-five prevalent chronic hemodialysis patients (CHD): 33 males, 22 females, 45 African Americans, 9 Caucasians, 1 Asian. Mean age – 47.0 ± 1.6 years, height – 166.4 ± 13.9 cm, and weight – 83.1 ± 2.6 kgs.

Methods—Body composition (body weight, body fat mass, lean body mass (LBM), percentage of fat (%FM), and body mass index (BMI)) was measured by dual energy x-ray absorptiometry. Minute-by-minute physical activity was assessed over a seven-day period utilizing a tri-axial accelerometer. Participants were interviewed by a trained registered dietitian for two 24-hour diet recalls (one from a hemodialysis day; one from a non-hemodialysis day). Laboratory values for serum concentrations of albumin, prealbumin, C-reactive protein (CRP), and creatinine were also collected.

Main Outcome Measure—Predictors of somatic protein stores.

Results—Serum albumin was negatively and significantly correlated with %FM ($p = 0.016$) and fat mass ($p = 0.044$). CRP was positively and significantly correlated with body weight ($p = 0.006$), % FM ($p = 0.017$), fat mass ($p = 0.006$), and BMI ($p = 0.004$). Physical activity and total daily protein intake were the strongest independent predictors of amount of LBM.

Conclusion—The association between somatic protein and visceral protein stores are weak in CHD patients. Whereas increased levels of physical activity and total daily protein intake are associated with higher LBM in CHD patients, higher adiposity is associated with higher CRP and lower albumin values.

Keywords

Body composition; chronic dialysis patients; dietary intake; physical activity

Address correspondence to: T. Alp Ikizler, MD, Vanderbilt University Medical Center, 1161 21st Ave. South & Garland, Division of Nephrology, S-3223 MCN, Nashville, TN 37232-2372, Telephone: (615) 343-6104, Fax: (615) 343-7156, alp.ikizler@vanderbilt.edu.

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INTRODUCTION

Kidney disease wasting (KDW)¹, a unique type of nutritional and metabolic derangement attributable to advanced kidney disease, affects 20–50% of the end stage renal disease (ESRD) patients, especially those on chronic hemodialysis (CHD). KDW is a complex syndrome that includes low concentrations of visceral proteins (e.g. serum albumin and prealbumin) and loss of somatic protein stores (e.g. lean body mass-LBM). While the nutritional status of CHD patients is considered to be an important component in predicting morbidity and mortality, there is considerable controversy regarding the best tools for diagnosis and monitoring of KDW, with no single method considered to be the gold standard. Serum albumin has been extensively studied and virtually all studies examining its association with hospitalization and death risk in CHD patients have shown the importance of low serum albumin as a predictor of poor clinical outcome [1–4]. Other measures not as extensively studied as serum albumin, such as amount of LBM, have also been associated with increased hospitalization and mortality [2,5]. Similarly, muscle atrophy in the CHD population has been associated with poor physical performance [6], which in turn is associated with impaired quality of life [7].

Despite the independent predictive abilities of measures of visceral and somatic protein stores, there are only limited studies that have examined the correlation between these two variables in CHD patients. If therapeutic strategies are to be targeted for the treatment of KDW, determining relationships between visceral and somatic protein stores are essential to identify the best possible combination of diagnostic and monitoring tools.

In this study we performed a comprehensive examination of somatic protein stores by using dual energy x-ray absorptiometry (DEXA), and correlated our findings with measures of visceral protein stores, physical activity, physical functioning, and dietary intake in 55 CHD patients.

METHODS

Study Participants

Patients undergoing CHD at the outpatient facility at Vanderbilt University Medical Center (VUMC) were recruited to participate in the study. Inclusion criteria for the study included patients who were on CHD therapy for more than 3 months and were delivered an adequate dose of dialysis (single pool Kt/V ≥ 1.2) on a thrice-weekly dialysis program using a biocompatible hemodialysis membrane (Fresenius F80, Fresenius USA, Lexington, MA). Exclusion criteria included patients with severe unstable underlying disease (stable cardiac patients were included), patients with active inflammatory or infectious diseases, and patients hospitalized within one month prior to the study. The Institutional Review Board of VUMC approved the study protocol and written informed consent was obtained from all study patients. Patient characteristics are shown in Table 1.

Study Design

This was a cross-sectional analysis of 55 prevalent CHD patients. Study participants were asked to come to the General Clinical Research Center (GCRC) at VUMC on a non-dialysis day to perform study-related tests. Within 7 days of the body composition test, dietary nutrient intake was assessed and blood was drawn for laboratory values. Physical functioning tests were performed on 29 participants after the body composition test at the GCRC. Twenty-five

¹The term “Kidney Disease Wasting” (KDW) is proposed as the unifying term to replace all diverse terms related to malnutrition and wasting in uremia based on a consensus committee meeting that was held as a part of the International Society of Renal Nutrition and Metabolism (ISRNM) meeting in Merida, Mexico in March 2006.

participants were given a non-invasive, portable accelerometer to wear for seven days in the free-living for assessment of physical activity.

Study Measurements

Body Composition—Body composition variables included in this study were body weight, body fat mass, LBM, percentage of fat (%FM), and body mass index (BMI). DEXA utilizes a three compartment model to measure fat mass, LBM, and bone mineral content. Additionally %FM was calculated for all study participants on a non-dialysis day. A Lunar Prodigy DEXA machine (Version 9.15.010, General Electric, Madison, WI) was utilized for all measurements. Subjects were required to remain still on the DEXA bed in the supine position for approximately six to ten minutes to complete a total body scan.

Physical Activity—Physical activity was examined over a 7-day period. In order to be included in the analyses, participants had to have at least 5 days of recorded physical activity during the 7-day measurement period and at least 2 dialysis days and 2 non-dialysis days. The RT-3 Tri-axial Research Tracker activity monitor (Stayhealthy®, Monrovia, CA) was used to measure minute-by-minute body movements in three dimensions (X, antero-posterior; Y, medial-lateral; and Z, vertical axis). The monitor is the size of a small pager and was clipped over the right hip. Readings were recorded throughout waking hours, except for instances when this was not feasible (e.g., during showering and swimming). The RT-3 monitor reports physical activity in three categories: total energy expenditure (TEE – kcals/day), energy expenditure of activity (EEact – kcals/day), and vector magnitude. EEact is the estimated energy expenditure of activity, which is calculated by using the vector magnitude and subject demographic information (such as age, weight, height, and gender). Vector magnitude consists of raw numbers or counts calculated by the three axes of the accelerometer (PA counts). TEE was calculated by summing the EEact and estimated resting energy expenditure. TEE, EEact, and PA counts were calculated per day by averaging each minute-by-minute variable for each day over the 7-day period.

Physical Functioning Tests—Physical functioning tests can be utilized to assess specific physiological functions in a relatively short period of time. In the present study, physical functioning tests consisted of activities of daily living (sit-to-stand), cardiopulmonary capacity (six-minute walk), and lower body strength (one-repetition maximal leg-press exercise).

Sit-to-stand: Each participant sat in a designated chair with arms folded across their chest. Participants had one minute to complete as many sit-to-stands as possible without the use of their arms [8].

Six-minute walk: Participants were instructed to walk as fast as tolerated on a flat surface for six minutes while the walking distance was measured by a device called Hi-Viz Lufkin (Raleigh, NC). Hi-Viz Lufkin is a rolatape, which consists of a wheel with one foot circumference and a 38-inch tubular handle [9].

One-repetition maximal double leg-press exercise: A pneumatic leg press machine (Keiser®, Fresno, CA), located in the Vanderbilt's GCRC, was utilized for the one-repetition maximal test. The objective of the test was to determine the maximum amount of weight a participant could push at one time. Initial weight was determined to be approximately equal to the participant's body weight. Weight (approximately 11 kg – 25 kg) was added at each repetition until the participant could no longer push the platform. A one-minute rest period was allowed between repetitions [10].

Dietary Intake—Participants were interviewed by a trained registered dietitian for two 24-hour diet recalls (one from a hemodialysis day; one from a non-hemodialysis day). All dietary intake data were collected and analyzed using the Nutrition Data System for Research software version 5.0, developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN. To ensure accuracy, a multiple-pass system was used when obtaining the 24-hour diet recalls. This system consists of three different passes intended to provide the participant with signals and opportunities to report their intake. The three passes include a quick list, a detailed description, and a final review of intake to allow participants the opportunity to report their diet recalls as accurately as possible.

Laboratory Values

Blood draw: Upon venipuncture, 20 ml of blood was collected for the baseline assessment of serum concentrations of albumin, prealbumin, C-reactive protein (CRP), and creatinine. Nutritional biochemical parameters were done at a specialized ESRD clinical and special chemistry laboratory (RenaLab, Richland, MS). Serum albumin was analyzed using bromocresol green technique. Serum prealbumin was analyzed by an antigen-antibody complex assay. CRP was measured using nephelometric analysis at the Vanderbilt University Medical Center clinical chemistry laboratory.

Statistical Analysis

Data are presented as mean $\pm$ SEM, unless otherwise noted. When examining differences within the study population, a student's t-test and one-way ANOVA for parametric distribution or Mann-Whitney U test and Kruskal-Wallis test for nonparametric distribution were used to determine differences between the means. A Spearman correlation coefficient was used to assess the relationship between body composition variables and study variables. In order to determine predictors of LBM, a multivariate linear regression analysis was performed. The covariates chosen for this model included gender, PA counts, six-minute walk, total protein, carbohydrate and lipid intake, serum albumin, and CRP. The covariates were chosen due to their clinical relevance in regards to LBM or to adjust for subject demographic differences in relation to LBM. All of the above-mentioned covariates were used in a multivariate linear regression analysis with the dependent variable fat mass, with the addition of diabetes status since there was a difference in fat mass between diabetics and non-diabetics. Statistical significance was established when a two-tailed p value was less than 0.05. The software SPSS (SPSS Inc, Chicago, IL) version 14 was used for all analyses.

RESULTS

Patient characteristics

Table 1 depicts subject characteristics, body composition, physical activity, physical functioning, dietary nutrient intake, and laboratory variables for the study participants. The influence of age, gender, race, and presence of diabetes mellitus (DM) on body composition was examined. There was a significant difference between men and women when examining %FM, fat mass, LBM, and BMI (Table 2). Percent FM, fat mass and BMI were significantly higher in patients with a diagnosis of DM compared to patients without DM (Table 3). There was no significant difference in any of the body composition variables in regards to race or age. When comparing patients who had completed physical activity and physical functioning tests to those that had not, there was no significant difference in any body composition variables between the two group except in regards to %FM in the physical functioning data (29.7 ± 2.2 vs 36.8 ± 2.3 , respectively, $p = 0.02$).

Associations among body composition measures and other study variables

Table 4 shows the univariate associations between body composition measures and other study variables. Body weight, %FM, fat mass, and BMI were correlated to one another (all $p < 0.001$). LBM was only significantly associated to body weight ($p < 0.001$). In terms of correlations between body composition and other variables, several statistically significant associations were found, albeit the correlation coefficients were low. Of specific interest, serum albumin was negatively and significantly correlated with %FM ($p = 0.016$) and fat mass ($p = 0.044$). CRP was positively and significantly correlated with body weight ($p = 0.006$), %FM ($p = 0.017$), fat mass ($p = 0.006$), and BMI ($p = 0.004$). As expected, CRP was inversely correlated with serum albumin ($r = -0.375$, $p = 0.007$). TEE was significantly correlated with body weight ($p < 0.001$), %FM ($p = 0.042$), fat mass ($p = 0.002$), LBM ($p < 0.001$), and BMI ($p = 0.002$), whereas EEact was significantly associated with body weight ($p = 0.025$) and LBM ($p = 0.043$). Total daily protein intake (TPI) was positively correlated to LBM ($p = 0.006$). Daily energy intake per kg of body weight (DEI) was negatively correlated to body weight, %FM, fat mass, and BMI (all $p < 0.001$). Daily protein intake per kg of body weight (DPI) was negatively correlated to body weight ($p = 0.012$), %FM ($p = 0.004$), fat mass ($p = 0.003$), and BMI ($p = 0.018$).

Independent predictors of lean and fat body masses

As seen in Table 5, physical activity (PA counts) and TPI were the strongest independent predictors of LBM, and CRP was an important, although not statistically significant predictor. None of the study variables significantly predicted fat mass (Table 6).

DISCUSSION

The primary purpose of this study was to examine the relationship between visceral and somatic protein stores, components of KDW, and to determine what study variables, if any, could predict LBM in this CHD population. Our results showed that components of body composition, as assessed by DEXA, have limited associations with commonly utilized nutritional biomarkers (i.e. measures of visceral protein stores), physical activity, physical functioning and dietary protein and energy intake in the CHD population. Likewise, there was no association between LBM and visceral protein stores.

The lack of any significant correlation between the commonly utilized nutritional biomarkers and components of body composition demonstrates the complex nature of KDW. It is very likely that visceral and somatic protein stores are altered by different mechanisms in ESRD, which may or may not be affected simultaneously. A plethora of studies have shown that there is increased activation of molecular pathways leading to muscle protein breakdown in advanced chronic kidney disease [11–13]. However, the exact mechanism(s) by which these pathways are activated have not been fully elucidated. A possible culprit for such an adverse effect is inflammation, primarily mediated through the actions of pro-inflammatory cytokines. The adverse nutritional and metabolic effects of pro-inflammatory cytokine activation and inflammation are well-known and include lean body mass wasting [14,15] and reduced levels of negative acute-phase reactants such as serum albumin and serum prealbumin [16–18]. Our study did not show any significant association between CRP, a well-established biomarker of the inflammatory response, with LBM. The lack of any correlation between these markers could be due to the fact that our study population was relatively stable with low levels of CRP and the effects of inflammation may be seen at the higher end of the spectrum.

On the other hand, a higher fat content was associated with higher CRP and lower albumin values in our study population. The former observation is consistent with the report by Axelsson et al [19] showing that CRP was positively associated with body fat mass and truncal fat mass

but not LBM in 157 ESRD patients. In terms of serum albumin and somatic protein stores, a report by Aparicio et al [20] examined nutritional status in 7123 French hemodialysis patients and did not find a correlation between BMI and serum albumin levels however the authors did not specifically examine the relationship between LBM and serum albumin. Jones et al [21] examined body composition variables, as measured by bioelectrical impedance, and serum albumin concentrations in 57 peritoneal dialysis patients and found no association between LBM and %FM with serum albumin. While it appears there are conflicting reports of the relationship between body composition and serum albumin, the patient population and ethnicity of all of these studies must be taken into account. Additionally, many studies have shown that a higher BMI is associated with better survival in CHD patients [22,23]; however there is controversy as to whether the composition of the body size (fat mass vs. LBM) adds additional information in regards to survival outcomes [24,25]. These factors should be considered before a final conclusion can be made regarding the adverse consequences of increased adiposity in CHD patients. This study shows that adiposity was associated with higher CRP and lower albumin levels. It is also important to distinguish the determinants and the consequences of inflammation from a biological point of view. For example, serum albumin is a negative acute phase protein, which is known to change as a consequence of inflammation. On the other hand, the adipose tissue is likely the determinant of the increased levels of biomarkers of inflammation. Therefore, the relationship between serum albumin and fat mass is probably an epiphenomenon rather than a biological association.

It has been suggested that CHD patients have considerable muscle atrophy when compared to matched sedentary controls and this atrophy has been associated with poor physical performance [6] which is associated with low quality of life [7] and decreased survival [26]. Additionally, studies have shown that CHD patients lose approximately 1.5 kg of LBM during the initial year of chronic hemodialysis [14,27], which is linked to increased hospitalization and mortality [2,5]. Our results showed that physical activity and TPI predicted the amount of LBM, but not the amount of fat mass in this CHD population. A recent report by Johansen et al [28] showed that simply increasing muscle mass via anabolic steroids does not necessarily improve physical functioning, while interventions such as resistance exercise does improve physical functioning, although the effects on muscle mass are not as significant. Future studies examining physical activity and nutritional interventions are warranted to assess whether these factors can overcome the detrimental effects of LBM loss in the CHD population.

Another interesting finding from this study was that TPI was positively correlated to LBM and, as previously mentioned, was a significant predictor of LBM. Energy, carbohydrate, and lipid intake were not correlated to any body composition components in this study. This is of particular interest when taking into account that in the general population, as adiposity increases there is an increase in lipid and protein intake whereas carbohydrate intake decreases [29,30]. Perhaps the lack of association between some dietary components and body composition in the CHD population is due to their overall low dietary intake [31–33]. Adequate energy and protein intake for stable CHD patients is considered to be between 30 and 35 kcals/kg/day and 1.2 g/kg/day respectively [34]. In this study, the CHD patients' DEI and DPI was remarkably low consisting of 19.5 kcals/kg/day and 0.71 g/kg/day. Of note, dietary recall has been consistently found to underestimate actual intake and it is likely that despite the use of the multiple pass procedure for these diet recalls, our efforts fell short in terms of measuring the actual dietary intake. Nonetheless, TPI was positively correlated to LBM and was a significant predictor of LBM even at this low level.

In spite of the significant correlation between TPI and LBM, DEI and DPI were not correlated to LBM. This finding is somewhat consistent with a recent report by Beddhu et al [35] suggesting that TPI may be a better marker for nutritional status and survival compared to DPI. In a study of 5,059 CHD patients, the authors found that the patients in the lowest quartile for

TPI (≤ 32.4 g/day) had significantly higher odds for lower serum albumin, muscle mass, BMI and an 18% increase in risk of death when compared to patients in the highest quartile (> 60.2 g/day). Most interestingly, the low DPI (< 0.8 g/kg/d) group had a 15% decrease in the risk of death compared to the high DPI group. The exact mechanisms underlying these associations need to be examined in future studies.

When examining physical activity, TEE was correlated to all components of body composition and EEact was correlated to body weight and LBM. These associations are not unexpected since energy expenditure estimates from the activity monitor incorporates weight into its calculation. PA count is an objective measure of physical activity, in that it does not rely on subject demographic information. PA counts were not correlated to any components of body composition in the univariate analysis whereas it was a significant predictor of LBM in the multivariate analysis (i.e. CHD patients who were more active had more LBM or vice-versa). Johansen et al [36] examined predictors of physical activity in 34 CHD patients. They also found no correlation between “raw units” from their activity monitor and body composition but did find that LBM, as measured by DEXA, was an independent predictor of physical activity. Conversely, Zamojska, et al [37] found that number of steps taken measured by pedometers over a 48-hour period in 60 CHD patients was positively correlated to fat mass, BMI, and LBM. However, these variables did not predict the number of steps taken when examined via multiple regression analysis. It should be noted that pedometers may not fully reflect physical activity as measured by more sophisticated accelerometers, as in the current study [36], and that the number of steps taken was only measured over a 2-day period, which might not have been long enough to reflect habitual physical activity [38].

Our results must be interpreted in lieu of certain limitations. First, the study sample size was relatively small and clinically stable and the patients were relatively younger than most CHD patients. Additionally, the results of this study may not be readily extrapolated to all CHD patients due to differences in demographic characteristics, especially given the higher percentage of African American patients in this study. We also utilized only a single measure of body composition, i.e. DEXA although this methodology has been proposed as the best research tool available. Nevertheless, we believe that our results have important clinical and practical application as there are only very limited number of studies that have examined this issue as comprehensively as reported herein.

In summary, the results of this study show that the association between LBM and visceral protein stores are weak in CHD patients. Whereas increased levels of physical activity and TPI are associated with higher LBM in CHD patients, higher adiposity is associated with higher CRP and lower albumin values. Further detailed studies are needed to examine the effects of physical activity and nutritional interventions simultaneously on LBM and visceral protein stores and extrapolate these findings to clinically important patient outcomes such as hospitalization and death.

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Table 1
Patient Characteristics

Demographics (n=55)	
Gender (M/F)	33(60%)/22(40%)
Race (African American/Caucasian/Asian)	45(82%)/9(16%)/1(2%)
Age (years)	47.0 ± 1.6
Diabetes Mellitus (%)	23 (42%)
Body Composition (n=55)	
Body Weight (kg)	83.1 ± 2.6
Percent Fat Mass (%)	33.1 ± 1.7
Lean Body Mass (kg)	52.1 ± 1.3
Fat Mass (kg)	28.3 ± 2.0
Bone Mineral Content (kg)	2.7 ± 0.1
Body Mass Index	30.3 ± 1.0
Physical Activity (n=25)	
TEE (kcal/day)	2222 ± 82
EEact (kcal/day)	386 ± 48
PA Counts (* 1000 ⁻¹ /day)	123.8 ± 14.6
Physical Functioning (n=29)	
Sit-to-Stand	20 ± 1.2
6-minute Walk (ft)	1394 ± 66
One-Repetition Maximum (kgs)	216.2 ± 12.4
Dietary Intake (n=46)	
Total Energy (kcal/day)	1538.9 ± 73.1
Protein (g/day)	57.2 ± 2.6
Carbohydrate (g/day)	189.4 ± 11.4
Lipid (g/day)	63.2 ± 3.4
Total Energy Body Weight (kcal/kg/day)	19.5 ± 1.2
Protein Body Weight (g/kg/day)	0.71 ± 0.04
Laboratory Values (n=50)	
Serum Albumin (g/dL)	3.98 ± 0.05
Serum Prealbumin (mg/dL)	35.9 ± 1.3
Serum CRP (mg/L)	11.6 ± 3.1
Serum Creatinine (mg/dL)	9.4 ± 0.4

Table 2

Body composition variables according to gender

Body Composition	Men (n = 33)	Women (n = 22)	P value
Body Weight (kg)	80.4 ± 3.2	87.1 ± 4.2	0.198
Percent Fat Mass (%)	27.3 ± 1.9	41.8 ± 2.0	0.001
Lean Body Mass (kg)	54.8 ± 1.8	47.9 ± 1.5	0.009
Fat Mass (kg)	22.6 ± 2.1	36.8 ± 3.1	0.001
Body Mass Index	28.3 ± 1.3	33.3 ± 1.4	0.005

Bolded values denote $p < 0.05$

Table 3

Body composition variables according to diabetes status

Body Composition	DM (n = 23)	Non-DM (n = 32)	P value
Body Weight (kg)	88.5 ± 4.1	79.2 ± 3.2	0.083
Percent Fat Mass (%)	39.1 ± 2.1	28.8 ± 2.2	0.001
Lean Body Mass (kg)	51.5 ± 2.4	52.4 ± 1.5	0.336
Fat Mass (kg)	34.4 ± 2.9	23.9 ± 2.5	0.005
Body Mass Index	32.4 ± 1.4	28.8 ± 1.4	0.023

Bolded values denote $p < 0.05$

Table 4
Univariate correlations among body composition and other study variables

Variable	Weight	%FM	FM	LBM	BMI
Body Weight (kg)	----	0.606	0.822	0.649	0.749
Percent Fat Mass (%)	0.606	----	0.925	-0.165	0.766
Fat Mass (kg)	0.822	0.925	----	0.155	0.842
Lean Body Mass (kg)	0.649	-0.165	0.155	----	0.175
Body Mass Index	0.749	0.766	0.842	0.175	----
TEE (kcal/day)	0.799	0.410	0.583	0.770	0.581
EEact (kcal/day)	0.448	0.165	0.225	0.408	0.379
PA Counts (* 1000 ⁻¹ /day)	0.137	-0.121	-0.068	0.198	0.062
Sit-to-Stand	-0.178	-0.077	-0.110	-0.149	-0.154
6-minute Walk (ft)	-0.125	-0.085	-0.037	-0.031	-0.183
One-Repetition Maximum (kg)	-0.040	-0.161	-0.121	0.123	-0.069
Total Energy (kcal/day)	-0.064	-0.239	-0.163	0.148	-0.147
Protein Intake (g/day)	0.281	-0.028	0.121	0.398	0.084
Carbohydrate Intake(g/day)	-0.210	-0.280	-0.260	0.012	-0.248
Lipid Intake (g/day)	-0.036	-0.217	-0.142	0.150	-0.071
Total Energy Body Weight (kcal/kg/day)	-0.576	-0.555	-0.614	-0.208	-0.518
Protein Body Weight (g/kg/day)	-0.366	-0.419	-0.423	-0.088	-0.348
Serum Albumin (g/dL)	-0.100	-0.338	-0.286	0.237	-0.225
Serum Prealbumin (mg/dL)	-0.017	-0.054	-0.004	0.089	-0.041
Serum CRP (mg/L)	0.385	0.335	0.383	0.117	0.399
Serum Creatinine (mg/dL)	-0.007	-0.230	-0.106	0.204	-0.023

Bolded values denote $p < 0.05$

Table 5

Multivariate linear regression analysis of predictors of lean body mass

Variable	Coefficient	P value
Gender	-1.49	0.568
PA Counts (* 1000 ⁻¹ /day)	0.060	0.01
6-minute Walk (ft)	0.003	0.532
Protein Intake (g/day)	0.423	0.003
Carbohydrate Intake (g/day)	-0.039	0.09
Lipid Intake (g/day)	0.012	0.866
Serum Albumin (g/dL)	-2.90	0.50
Serum CRP (mg/L)	0.492	0.054

Bolded values denote $p < 0.05$

Table 6

Multivariate linear regression analysis of predictors of fat mass

Variable	Coefficient	P value
Gender	10.3	0.097
Presence of Diabetes	10.5	0.205
PA Counts (* 1000 ⁻¹ /day)	0.048	0.306
6-minute Walk (ft)	0.005	0.603
Protein Intake (g/day)	0.342	0.187
Carbohydrate Intake (g/day)	0.012	0.796
Lipid Intake (g/day)	-0.089	0.562
Serum Albumin (g/dL)	-5.26	0.566
Serum CRP (mg/L)	1.06	0.054

Bolded values denote $p < 0.05$