The validity of the Minimum Data Set for assessing nutritional status in nursing home residents

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Running Head: Validity of MDS

Abstract

The Minimum Data Set (MDS), a Health Care Financing Administration (HCFA)-mandated resident assessment system used in community nursing homes, is potentially useful to assess nutritional status. Our study had two purposes: (1) To compare anthropometric measures of nutritional status available in the MDS (weight and body mass index) to other anthropometric and bioelectric measures of nutritional status, not available on the MDS and (2) to evaluate the associations of MDS-measured clinical characteristics of nursing home residents with anthropometric and bioelectrical measures of lower nutritional status and higher nutritional status, defined as measures in the 25th percentile and below, and 75th percentile and above, respectively. The measures studied were: body weight, body mass index (BMI), mean arm muscle circumference, percent body fat and fat free mass. Data were from a sample of residents of an academic long term care facility (n=186, mean age 89.9 ± 5.6 years, 75% female). MDS evaluations were done simultaneously with the anthropometric/bioelectrical measures. Results were: (1) MDS measures of weight and BMI were significantly correlated with all the anthropometric and bioelectrical measures of nutritional status in women, and most measures in men; (2) Some MDS variables, including poor oral intake and advanced cognitive decline, were significantly associated with at least two anthropometric/bioelectrical measures of lower nutritional status; and (3) complaints of hunger were significantly associated with at least two anthropometric/bioelectrical measures of higher nutritional status. Results suggest: (1) Weight and BMI, available on the MDS, are correlated with other measures of nutritional status not available, and (2) MDS clinical variables are associated with measures of lower and higher nutritional status, and may be useful to identify patients at nutritional risk.

Key Words: undernutrition, overnutrition, nutritional status, long term care

Introduction

Undernutrition in nursing home residents is an important clinical and public health problem. Malnourished residents are likely to experience worsening of their chronic conditions and function, increased infection rates, poor wound healing and pressure ulcers [1-5]. Several studies have found that they also have a higher risk of hospitalization and mortality [6-8].

It is not known whether it is possible to improve nutritional status in some or all undernourished nursing home residents, or whether such improvement would lead to improved functional status, decreased hospitalizations, or decreased mortality. Such improvements are complicated by the intertwining of poor nutritional status and chronic illness and poor functional status. A recent randomized trial in frail elderly nursing home residents found that multinutrient supplementation without exercise did not improve frailty or muscle weakness [9]. However, observational research suggests that nutritional status may independently affect resident outcomes [6,7,10-12] and that some of the risk factors for development of poor nutritional status may be modifiable [13,14,15].

Much less is known about obese nursing home residents. Some authors have described characteristics of residents with overnutrition [16], and outcomes have only occasionally been addressed [2]. In community-dwelling elders, obesity is associated with increased disability and mobility impairment [17], outcomes potentially relevant to nursing home residents as well.

The Minimum Data Set (MDS) may be useful to study the nutritional status of nursing home residents and how it affects clinical status and health services utilization. The MDS is the assessment instrument that constitutes the core of the Resident Assessment Instrument (RAI) system used in virtually all US community nursing homes [18]. Several papers have documented the inter-rater reliability of MDS items, including the level of agreement between research teams and staff nurse assessors [18,19,20,21]. The MDS allows the uniform collection of resident clinical information longitudinally, and that information can be linked to data concerning health services utilization and mortality. However, before the MDS is used for such evaluations, it is important to assess the validity of an MDS assessment of nutritional status. Although there is no defined "gold standard" measure of nutritional status in older adults against which MDS measures can be compared, it is possible to assess two measures of validity. First, we can study how resident clinical characteristics measured by the MDS are associated with several different biomedical measures of nutritional status (convergent validity), and secondly, we can study how the anthropomorphic measures of nutritional status that are available on the MDS, the weight and the body mass index (BMI, or weight corrected for height) are associated with both other MDS clinical characteristics and other biomedical and anthropometric measures of nutritional status (construct validity). Therefore, we designed a study to compare the associations of MDS-measured resident characteristics hypothesized to affect nutritional status, with anthropometric and bioelectrical impedance assessments (BIA) of body composition.

Subjects and Methods

This study was a cross-sectional observational study of a sample of residents in a large long term care facility (Hebrew Rehabilitation Center for the Aged or HRCA) affiliated with an academic medical center in Boston. This facility has multiple levels of care, with residents ranging from functional to very debilitated. The study sample (n=186) was a stratified probability sample selected to reflect the clinical diversity of the residents of the facility. Informed consent was obtained from the residents or their responsible party. The study was approved by the Institutional Review Board of the HRCA.

MDS-Measured Clinical Characteristics

The MDS was administered to all study subjects by a research nurse. As always with the MDS, all sources of information about the residents were used, including the resident, the nursing staff, the medical record, and the family. The resident characteristics of interest were those which have been shown in other studies [13] or would be expected clinically to affect nutritional status. These included: (1) eating-related characteristics, such as dentition, ability to chew and swallow, oral intake, and feeding dependency; (2) functional characteristics (Activities of Daily Living, or ADL's); (3) cognitive performance and behavioral problems; (4) affective status; and (5) chronic and subacute conditions (recent urinary tract infection, presence of pressure ulcers). MDS measures of these clinical characteristics were analyzed either as single item or composite measures. Oral and dental problems were considered present if MDS variables indicated any of the following problems: presence of mouth pain, presence of broken teeth, or gum inflammation. Chewing and swallowing problems were assessed by the corresponding MDS questions. Functional characteristics were measured by summing the level of dependency in ADLs, excluding eating dependency, which was evaluated separately. ADL dependency was further categorized into a two-level variable for severe dependency vs. otherwise. Severe dependency was defined as being very dependent or totally dependent in those ADL measures considered the "late lost" functions, including bed mobility, transfer and toilet use [22]. Cognitive performance was measured by the cognitive performance score (CPS) [23]. This scale combines five MDS cognitive items into a multilevel variable (0-6) that has been validated against the Mini Mental Status Examination (MMSE) [24] and Test for Severe Impairment (TSI) [25]. CPS Levels 5 and 6 are distinguished by eating dependency (evaluated separately in this study), so they were combined. In this study we further categorized the CPS into a two level variable for severe impairment (levels 4 and 5) vs. otherwise. Affective status was measured by a variable indicating presence or absence of depressed behaviors, such as "crying", "thinks about death", and "stays in room." Behavioral problems were considered present if any one of the following behaviors were present daily: wandering, verbal abuse, physical abuse, inappropriate behavior; or if hallucinations/delusions were noted. All other measures were single items taken directly from the MDS. Data on all MDS measures were available on all but one of the 186 study subjects.

The MDS also measures height and weight, and specifies how they are to be measured ("Measure after voiding, before meal, with shoes off, and in nightclothes.") [18]. Weight and height are measured in pounds and inches. Height is measured on all new residents, and then once a year. Weight is measured on all new residents and then once a month. The MDS research nurse measured height and weight if possible, regardless of the time period, but took weights from the chart if they were within one month and the resident could not be weighed by one person. If there was no height within one year, and measured height could not be obtained, the MDS nurse did not record historical height. The scale available on the clinical floor was used, along with the attached rod to measure height. No special calibration was done. Of the 186 study subjects, height was obtained only on 86, and weight on 181. Therefore, an MDS-BMI could be calculated (see appendix for formula) on only 86 residents.

In this study, disease diagnoses for each subject were specified by the personal physicians of the study subjects, using a standardized checklist. We evaluated chronic diseases and conditions present in 5% or more of the study subjects for their associations with measures of nutritional status.

No biochemical measures were consistently available for study subjects, so they were not considered in our study.

Anthropometric/BIA Measures of Nutritional Status

Anthropometric/BIA measures of nutritional status were obtained by a separate nutritional research team (NRT); the same team obtained all measurements. Measurements were made on the right side of the body with residents in the seated or supine position. Weights and BIA measurements were obtained in the morning with the resident fasting, wearing light indoor clothing and no shoes. Standard technique was followed for anthropometric measures (Chumlea, 20). The measures obtained were body weight, height , knee height, triceps skin fold (TSF), mid-arm circumference (MAC), and bioelectrical impedance(BIA) [26-28]. A specially calibrated scale was used for weights, and knee height was measured by a Ross anthropometer (Columbus, Ohio). Standing height was measured by having the resident stand against a flat wall in stocking feet, marking where the top of the head meets the wall with a lucite plane held parallel to the floor, and then measuring that vertical distance to the nearest millimeter with a flexible tape measure. From these measures we calculated body mass index (BMI), mean arm muscle area (MAMA), predicted height from knee height [29-31], percent body fat (%BF), and fat free mass (FFM) using gender-specific prediction equations when indicated [26,27]. (The equations used are provided in the appendix). No anthropometric measure collected by the NRT was obtained on every study subject. Of the 186 subjects, body weight was obtained on 165, TSF and MAC were obtained on 166, BIA on 143, knee height on 155, and height on 113. (The MDS research nurse obtained height only on 86 residents because she worked alone and could not adequately stabilize the frailest residents. Two members of the NRT performed anthropometric measurements on frail residents). Because so few sample residents had height measured by the NRT, a prediction equation for height, based on knee height, [30] was derived for our sample for males and females separately, using data from the 76 women and 37 men who had both measured. This predicted height was used for those 55 residents who had only knee height available. For those 113 who had measured height available, measured height was used. To maximize sample size, this combined height variable was used for all calculations and analyses that required height. However, we also ran all analyses described below using predicted height from knee height for all 155 residents. The results were not different, and reported results used the combined height variable, i.e., measured height when available and predicted height when necessary.

We evaluated seven different anthropometric/BIA measures of nutritional status for their associations with MDS measured clinical characteristics. Specifically, we studied which characteristics were associated with a resident's presence at or below the 25th percentile on any anthropometric measure, or at or above the 75th percentile on any anthropometric measure. The anthropometric/BIA measures studied were body weight and BMI from both the MDS research nurse (MDS-WT and MDS-BMI) and the NRT (NRT-WT and NRT-BMI) calculated as discussed above; and MAMA, fat free mass (FFM) and percent body fat (%BF), all calculated from measures collected by the NRT. For FFM and %BF, gender specific equations were calculated using bioelectrical impedance measures and the combined height measure (see appendix).

Data Analysis

MDS-measured resident characteristics and anthropometric/BIA measures were evaluated by standard descriptive statistics, frequencies for categorical variables and univariate analysis for continuous variables. Correlations among the MDS-WT and MDS-BMI and the five anthropometric/BIA measures collected by the NRT were evaluated, as were the correlations among the NRT measures. The MDS-WT and MDS-BMI, and the five NRT anthropometric/BIA measures chosen as indicators of nutritional status were categorized into a lower and higher nutritional status group for each of the indicators. The lower nutritional status group for any anthropometric/BIA measure was defined as those whose MDS or NRT measure was at or below the 25th percentile, and the higher group as those at or above the 75th percentile.

We used the chi square of association to evaluate the relationships of the MDS clinical variables with different lower nutritional status and higher nutritional status groups defined for each of the two MDS and five NRT anthropometric/BIA measures of nutritional status. Those variables with the strongest bivariate associations ($p >/= .1$) were evaluated in separate multivariate logistic regression models, one for each variable. Each model explored the relationship with three measures of lower and higher nutritional status representing different methods and difficulties of measurement, (BMI, MAMA, and %BF) and adjusted for age and gender.

Extensive information from the MDS was available from residents with missing anthropometric/BIA measures. This was used to evaluate collection bias for the anthropometric/BIA measures.

The statistical program used was SAS for Windows (SAS Institute, Cary, NC) [32].

<u>Results</u>

Resident characteristics measured by the MDS and frequencies of major chronic diseases are shown in Table 1. The mean age of the study sample was 89.9 years ± 5.6. Ages ranged from 75 to 104 with 20% of the sample over 95 years old. Seventy five percent of the residents were female, 26% had poor oral intake and 19% were eating dependent (required extensive or total assistance with feeding). Over 30% had poor cognitive performance, nearly 11% had problems with chewing, and 7% had oral-dental problems.

Missing data analysis was performed to investigate collection bias in the sample. Height was the item most often missing. Body weight and arm measures were most often obtained, while bioelectrical measures and knee height were in the middle. MAC and TSF had little associated bias. The more dependent residents were significantly less likely in our study to have measured MDS height, NRT-HT, bioelectrical impedance, and knee height. For example, of residents with advanced ADL dependency, 14% had NRT height and 55% had BIA measurements. However, of residents with mild to moderate ADL dependency, 82% had NRT height and 86% had BIA measurements, a statistically significant difference. Eating dependent residents were particularly poorly characterized; fewer than half had bioelectrical impedance measures and only 11% had measured NRT height.

Table 2 shows means, ranges, and values for the 25th and 75th percentiles for the two MDS and five NRT anthropometric/BIA variables considered in this study for women and men. As expected, gender differences are apparent (and statistically significant, analysis not shown) for both body weight variables, MAMA, FFM and %BF, but not for BMI.

Table 3 shows the correlations between the MDS-WT and BMI, and the NRT anthropometric and bioelectrical measures of body composition (weight, BMI, MAMA, FFM and %BF) by gender. For women, correlations between the MDS measures and the NRT measures are relatively high and statistically significant. For men, the MDS-BMI was significantly correlated only with the NRT-BMI, although the MDS-WT correlated well with all NRT measures. The NRT measures were significantly correlated among themselves, except for FFM and MAMA in men, and FFM and %BF in women. As Table 3 shows, different sample sizes are available for different correlation analyses.

Table 4 demonstrates the relationship of MDS measures of clinical status and chronic diseases with the MDS-WT and BMI, and NRT anthropometric/BIA measures of lower nutritional status. Results were combined for men and women because no significant or even borderline gender differences were noted. This table is organized so that the first column gives the percent of the total sample of residents with the stated characteristic, and thus serves as a reference. Subsequent columns give the percent of residents with the particular characteristic out of all who were in the lower nutritional status group (lowest quartile) for each of seven anthropometric measures. For example, 26% of the total sample had poor oral intake, but 36% of the lower nutritional status group as defined by the lowest quartile of the NRT-BMI had poor oral intake. This increased association was statistically significant at $p<.05$. An asterisk indicates a statistically significant association by chi square ($p<.05$), a B indicates a borderline association ($p=.05-.1$). As Table 4 shows, poor intake, eating dependency, history of weight loss, poor cognitive performance, and presence of a pressure ulcer had significant or borderline associations with >/= 2 measures of lower nutritional status. Other clinical characteristics had borderline or significant associations with 1 or 2 anthropometric/BIA measures (examples include swallowing problems, and diagnosis of stroke). Although the MDS-WT and MDS-BMI did not have statistically important associations except with poor intake, they generally echoed the trends of the NRT variables. It is important to remember when reading this table that different sample sizes were available for each analysis involving an anthropometric variable, and that dependent residents were under-represented except for analyses involving MAMA and weight. Among resident characteristics that did not show significant relationships with measures of undernutrition were advanced ADL dependency, depressed behaviors, behavior problems, and diagnosis of depression.

Table 5 shows the associations of MDS-measured resident characteristics and chronic diseases with anthropometric/BIA measures of higher nutritional status. Results for men and women were again combined because no gender differences were noted, and the table is constructed in the same way as table 4. Those with poor oral intake, eating dependency, poor cognitive performance, and advanced ADL dependency were significantly less likely to have anthropometric/BIA indices in the 75th percentile and above. The only MDS characteristic predicting higher nutritional status was "complaints of hunger", but disease diagnoses of CHF and diabetes mellitus were associated with several measures. Note that residents with certain clinical characteristics were rare in the higher nutritional status group. For example, few or even no residents with weight loss, swallowing problems or pressure ulcers were in certain higher nutritional status groups.

Table 6 gives the odds ratios adjusted for age and sex, and the 95% confidence intervals, for certain clinical variables associated with lower and higher nutritional status as assessed by BMI, MAMA, and %BF (including some variables with borderline effects). Poor oral intake and, to a lesser extent, eating dependency, increased the odds of being in the lower nutritional status groups and decreased the odds of being in the higher nutritional status group. Complaints of hunger and presence of CHF increased odds of being in a higher nutritional status group (BMI and %BF). Diabetes mellitus significantly increased odds of being in the upper quartile of percent body fat (not shown in table) with odds ratio of 2.75, 95% confidence interval 1.1-7.2, but was not significantly associated with other measures of higher nutritional status.

Discussion

This study showed that some nutritionally-related and dependency variables measured by the MDS are significantly associated with anthropometric/BIA measures of nutritional status in nursing home residents. Poor oral intake, poor cognitive performance, eating dependency, and pressure ulcers were significantly more likely to be present in residents with lower nutritional status, and conversely, less likely to be present in those with higher nutritional status. Chronic diseases measured by attending physician clinical diagnoses were not generally associated with lower nutritional status, although Alzheimer's Disease and presence of CVA were marginally and significantly associated with the lowest quartile of MAMA, respectively. However, CHF and diabetes mellitus were associated with some anthropometric measures in the 75th and higher percentile. Higher values for residents with CHF may be due to edema, which was not otherwise measured in this study. However, the BIA estimates of FFM and %BF are derived from an estimate of total body water, which may be elevated in these subjects, thus giving a false impression of high FFM when it may really be increased extracellular water. Thus, our BIA data indicates that the MDS, and traditional anthropometric measures in general, may miss undernutrition in people with CHF or other conditions leading to edema.

The only other MDS variable that was useful to identify residents in the highest quartile of anthropometric measures was "complaints of hunger". Although this variable could theoretically be a measure of lower nutritional status, it turns out to be a good measure of higher nutritional status, and demonstrates that well- or over-nourished people often feel hungry and want to eat, whereas anorexia is a more common symptom in chronic under nutrition.

An important issue to consider is our definitions of lower nutritional status and higher nutritional status, and how these groups, (the lower and upper quartile of anthropometric/BIA measures, respectively), might relate to clinically relevant undernutrition and obesity. In his reanalysis of the Build data, Andres found that a BMI=26.6 kg/m^2 was associated with lowest mortality in people 60-69 (insufficient data was available for those older), and mortality began to increase both below and above this value [33]. Although our use of the lowest and highest quartiles of BMI and other anthropometric/BIA measures (see table 3) represented arbitrary cut-points for study, most of the residents in the NRT-BMI group (all but 1 man and 2 women) had a BMI < 22.5 kg/m^2, which has been associated with a higher mortality rate in older community-living adults [34]. Residents in the highest quartile of BMI, however, were not all extremely obese, although for both genders about half of the HNS group had BMI ≥ 30 kg/m^2. Future research is needed to determine mortality and morbidity outcomes associated with different values for BMI and other anthropometric variables in nursing home residents and the oldest old in general.

In addition, different anthropometric measures represent differences in body composition, and thus may have different clinical implications. Although it is beyond the scope of this study to address this issue, most associations were noted with %BF and BMI, followed closely by

MAMA. Weight alone, whether collected by the MDS nurse or the NRT, also had similar, although not always statistically significant, associations with clinical variables. In addition, the anthropometric/BIA measures represented different methods and difficulty of collection: BMI, which requires weight and height assessment, MAMA, which requires measures (TSF and MAC) that are relatively easy to do in dependent people, and %BF, which requires both height and bioelectrical measures.

Our findings regarding the relationships of MDS clinical variables to lower nutritional status are consistent with previous research regarding undernutrition in nursing home residents. Studies have found that poor oral intake [2,13,29,35,36], cognitive decline, ADL and/or eating dependency [2,13,35,36] and pressure ulcers [5] were associated with poor nutritional status in nursing home residents. In another study involving MDS nutritional variables, depressed behaviors were shown to be related to weight loss, but not to low BMI [13].

Our research, however, makes a unique contribution because measurements of resident clinical characteristics are taken from the Minimum Data Set and related to anthropometric/BIA measures of nutritional status, thereby addressing the validity of using the MDS to assess and/or study nutritional status in nursing home residents. Our results have two important implications: (1) They demonstrate that the MDS is a valid clinical tool to identify many residents with lower nutritional status (convergent validity), although it may be less useful to identify residents with higher nutritional status. (2) They demonstrate that weight and BMI, anthropometric measures available on the MDS, can be appropriately used as measures of nutritional status, since they are generally significantly correlated with other potential anthropometric/BIA measures not available on the MDS (construct validity). In addition, associations between MDS clinical variables and MDS-WT and MDS-BMI were similar in direction and magnitude (although not usually statistically significant in our sample) to associations between clinical variables and NRT variables.

Our study has certain limitations. First, an instrument for the comprehensive assessment of nutritional status has not been uniformly accepted, so there is no way to assess criterion validity of the MDS or any other measure. Secondly, there was no systematic collection of albumin or cholesterol on a routine basis on these patients, so it was not possible to have a value closely linked in time to the data collected for this study. However, marasmus may be more commonly encountered than protein malnutrition in nursing home residents and is clearly associated with morbidity [37,38,39], hence the emphasis in our study on anthropometric evidence of wasting. Third, some anthropometric/BIA measures were not collected on the most dependent residents, as described in the results section. Obtaining height and bioelectric measures on very dependent residents was a problem in our study. However, the NRT measured knee heights, which allowed us to develop a prediction equation for height relevant to our sample. However, even knee height was significantly less available for those with eating dependency and other advanced ADL dependencies, and tended to be less available for those with poor intake and advanced cognitive impairment. Although this collection bias would be expected to lead to bias in our results, any associations found should be weaker than are actually likely to be present.

Our experience also suggests that height may be missing on routine MDS determinations, or worse, may be inaccurately collected or noted. Researchers using MDS data must take care to investigate potential bias or measurement error in height measures. Also, consideration should be given to including knee height measures in the MDS or other studies where anthropometric/BIA measures are being collected in dependent residents.

A final limitation concerns the fact that the community long term care facility where our study was done is an academic and teaching nursing home and may not be typical of many community nursing homes. However, nursing homes are so heterogeneous that no one home can be considered typical. Our use of the MDS and several anthropometric/BIA measures of nutritional status allows us to characterize our study subjects in sufficient detail so that future researchers can compare their study population to ours. Part of the usefulness of the Resident Assessment System (RAI) and MDS is that consistent clinical information can be collected on residents of very different facilities.

The ability of the Resident Assessment System to identify resident characteristics associated with undernutrition has important implications for quality of care in nursing homes, prevention of medical and functional complications related to malnutrition, and possible decrease in acute hospital utilization. Because the RAI is used in virtually all community nursing homes in the US (and is being developed for home care and acute care use), and is connected to care planning and clinical interventions, it may be useful to identify resident groups demonstrating undernutrition (and perhaps overnutrition). If so, the RAI would provide an important opportunity to study medical outcomes related to nutritional risk and nutritional status, and potentially to evaluate interventions directed toward improving nutritional status of nursing home residents.

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Table 1. Resident Characteristics (n=186)

Characteristics	Number	Percent
Demographics		
Age (mean +/- sd)	89.9 +/-5.6	
Female Gender	139	74.7
MDS Variables		
Eating Dependent	36	19.4
Poor Oral Intake	53	26.2
Chewing Problems	23	10.8
Swallowing Problems	13	7
Complaints of Hunger	17	9.2
Oral/Dental Problems	14	7.6
Advanced ADL Dependency	58	31.2
Depressed Behaviors	68	36.6
Behavior Problems	51	27.4
Advanced Cognitive Impairment	57	30.6
Pressure Ulcers	15	8.1
Bedfast	34	16.8
Diagnoses from Physician Checklist		
Congestive Heart Failure	53	28.5
Stroke	24	12.9
Diagnosis of Alzheimer's	74	39.8
Diagnosis of Depression	46	24.7
Diabetes Mellitus	32	17.2

Table 2. Anthropometric and Bioelectrical Measures of Nutritional Status

	MDS Weight (lbs)	NRT[1] Weight (lbs)	MDS BMI (kg/m^2)	NRT BMI (kg/m^2)	MAMA[2] (cm^2)	%BF[3]	FFM[4] (kg)
				Female			
Total= 139	(n=135)	(n=120)	(n=65)	(n=109)	(n=118)	(n=99)	(n=99)
Mean +/- sd	120.5+/-22.0	118.8+/-20.7	24+/-4.3	25.5+/-3.8	36.7+/-9.3	35.2+/-8.7	34.9+/-5.3
Range	63.0-190.0	76-174	16.2-38.9	17.9-36.2	20.9-66.5	10.6-58.2	25.3-48.9
25th Percentile	107	107	21.4	23.1	29.5	29.7	30.6
75th Percentile	136	132.7	26.5	28.1	43.1	41.4	38
				Male			
Total=47	(n=46)	(n=45)	(n=21)	(n=45)	(n=45)	(n=41)	(n=41)
Mean +/- sd	144+/-27.8	143.8+/-29.1	23.4+/-3.6	25.7+/-4.1	43+/-11.6	31.5+/-8.8	44.5+/-5.0
Range	83-246	82.3-253	19.1-33.6	20.0-40.9	19.9-81.6	12.6-52.9	32.7-55.8
25th Percentile	126	125.5	21.1	23.1	36.1	25.5	41.5
75th Percentile	155	159	23.7	27.8	49.2	37.7	48.1

[1]=Nutritional Research Team
[2]=Mean Arm Muscle Area
[3]=Percent Body Fat
[4]=Fat Free Mass

Table 3. Correlations: Females and Males, All Ages

Females (n=139) Males (n=45)	MDS WT	MDS BMI	NRT[1] WT	NRT BMI	MAMA[2]	%BF[3]	FFM[4]
					FEMALES		
MDS WT			.88***	.74***	.60***	.49***	.60***
			(n=117)	(n=106)	(n=115)	(n=97)	(n=97)
MDS BMI			.56***	.73***	.40**	.38**	.42***
			(n=60)	(n=56)	(n=59)	(n=52)	(n=52)
NRT WT	.99***	0.22			.64***	.58***	.67***
	(n=44)	(n=20)			(n=117)	(n=99)	(n=99)
NRT BMI	.84***	0.48			.62***	.57***	.48***
	(n=44)	(n=20)			(n=107)	(n=99)	(n=99)
MAMA	.78***	-0.6	.75***	.64***		.23*	.55***
	(n=44)	(n=20)	(n=45)	(n=45)		(n=99)	(n=99)
%BF	.83***	0.2	.82***	.78***	.59***		-0.19
	(n=40)	(n=19)	(n=41)	(n=41)	(n=41)		(n=99)
FFM	.75***	0.06	.75***	.51**	0.28	.63***	
	(n=40)	(n=19)	(n=41)	(n=41)	(n=41)	(n=41)	
		MALES					

[1]=Nutritional Research Team
[2]=Mean Arm Muscle Area
[3]=Percent Body Fat
[4]=Fat Free Mass

* $p<.05$
** $p<.01$
*** $p<.001$

Note different sample sizes (in paretheses) available for correlation analysis.

Correlation coefficients for females are shown in top diagonal of matrix, and those for males are shown in bottom diagonal of matrix.

The correlation coefficients for MDS WT and MDS BMI, and NRT WT and NRT BMI are not shown because weight is used to calculate BMI.

Table 4. Percent of Residents with Selected Clinical Characteristics in Lowest Quartile of Anthropometric/BIA[1] Measures (male and female combined)

Clinical Characteristics	Percent in Total Sample for Reference	MDS WT (n=181)	MDS BMI (n=86)	NRT[2] WT (n=165)	NRT BMI (n=154)	MAMA[3] (n=163)	FFM[4] (n=140)	%BF[5] (n=140)
Age >95	20	28	17	30^{B}	20	33*	26	21
Poor Intake	26	36^{B}	48*	45***	36*	40*	38*	36*
Eating Dependence	19	25	22	30^{B}	23	30^{B}	15	21*
Weight Loss	5	9	9	12**	11*	9	9	9
Swallowing Problems	7	11	17^{B}	15^{B}	13	9	15*	9
Oral/Dental Problems	8	13	8	15^{B}	8	12	12	6
Advanced Cognitive Impairment	31	34	30	40	41*	40	18	42**
Advanced ADL Dependence	31	34	35	40	33	40	26	26
Pressure Ulcers	8	13	9	12	13*	15^{B}	9	12^{B}
CHF	29	23	39	27	23	33	38	26
Diabetes	17	15	13	10	15	9	9	6^{B}
Alzheimer's Disease	40	43	35	50	41	55^{B}	38	35
CVA	13	15	22	12	13	21*	9	21

1 = Bioelectrical Impedance Analysis
2 = Nutritional Research Team
3 = Mean Arm Muscle Area
4 = Fat Free Mass
5 = Percent Body Fat

B $p<.05$-1
* $p<.05$
** $p<.01$
*** $p<.001$

Table 5. Percent of Residents with Selected Clinical Characteristics in Highest Quartile of Anthropometric/BIA[1] Measures (male and female combined)

Clinical Characteristics	Percent in Total Sample for Reference	MDS WT (n=181)	MDS BMI (n=86)	NRT[2] WT (n=165)	NRT BMI (n=154)	MAMA[3] (n=163)	FFM[4] (n=140)	%BF[5] (n=140)
Age >95	20	12	17	10*	18	12	17	8B
Poor Intake	26	17B	17	10**	8**	12B	14	11*
Eating Dependency	19	12	-	12B	5*	9B	8	11
Weight Loss	5	-	4	-	-	-	-	-
Swallowing Problems	7	-	4	-	5	-	-	5
Oral/Dental Problems	8	6	-	8	7	6	-	14*
Complaint of Hunger	9	17*	9	17*	18*	12	14	19*
Advanced Cognitive Impairment	31	23	4*	21B	12*	29	25	17
Advanced ADL Dependency	31	23	13B	19*	15B	29	11B	22
CHF	29	40B	35	43*	42B	35	33	47*
Diabetes	17	23	22	26B	20	11	11	28*
Alzheimer's Disease	40	33	35	36	45	50	30	36
CVA	13	21B	22	19	12	8	17	14

[1] = Bioelectrical Impedance Analysis
[2] = Nutritional Research Team
[3] = Mean Arm Muscle Area
[4] = Fat Free Mass
[5] = Percent Body Fat

B p<.05-1
* p<.05
** p<.01
*** p<.001
\- 0 or 1 resident with characteristic

Table 6. Odds Ratio (Adjusted for Age and Gender) for Association of Clinical Characteristics with Lower and Higher Nutritional Status

Lower Nutritional Status	Intake			Eating Dependence			Advanced Cognitive Impairment			Pressure Ulcer		
	Estimate	Odds Ratio	95% Conf Int	Estimate	Odds Ratio	95% Conf Int	Estimate	Odds Ratio	95% Conf Int	Estimate	Odds Ratio	95% Conf Int
Lowest Quartile												
BMI	0.92	2.50	1.10, 5.70		NS		0.82	2.27	1.04, 5.00	1.70	5.60	1.30, 24.8
%BF[1]	0.89	2.43	1.00, 5.80[B]	1.14	3.13	1.02, 9.58	1.27	3.55	1.48, 8.54	1.22	3.40	
MAMA[2]	1.02	2.78	1.80, 6.53	0.90	2.47	0.99, 6.19[B]	0.63	1.88		1.21	3.40	0.90, 12.0[B]

Higher Nutritional Status	Intake			Eating Dependence			Complaint of Hunger			CHF		
	Estimate	Odds Ratio	95% Conf Int	Estimate	Odds Ratio	95% Conf Int	Estimate	Odds Ratio	95% Conf Int	Estimate	Odds Ratio	95% Conf Int
Highest Quartile												
BMI	-1.58	0.20	0.06, 0.72	-1.56	-0.21	0.05, 0.94	1.26	3.50	1.10, 11.1	0.67	2.00	0.90, 4.20[B]
%BF	-1.14	0.30	0.10, 1.0[B]		NS		1.18	3.20	1.00, 10.3[B]	0.95	2.60	1.20, 5.80
MAMA	-1.06	0.35	NS	-1.16	0.31	0.10, 1.10[B]		NS			NS	

[1]=Percent Body Fat
[2]=Mean Arm Muscle Area
[B]=Border-line Association