NUTRITIONAL RISK SCREENING AND DIETARY INTAKE

AMONG ELDERLY HOME-DELIVERED

MEAL PARTICIPANTS

by

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1. REVIEW OF LITERATURE

Introduction

The US is currently poised to experience unprecedented growth in its elderly population, as the oldest members of the generation known as the "baby boomers" begin to transition into the "elderly" age range of 65 years and older (1). This ongoing demographic shift is well documented by current US Census data, which shows that the over-65 age group is growing at a faster rate than the US population as a whole (15.1% growth versus 9.7% growth, between 2000 and 2010), with the 65-69 year age group and all age groups above 85 (the "oldest old") experiencing the fastest rates of growth (1). Indeed, per 2013 estimates, there are now almost 45 million Americans age 65 or older, representing 14.1% of the total population (2). There has been a concurrent decline in age-adjusted death rates among this age group, with the CDC estimating that the remaining longevity at age 65 is close to 20 years (1).

This demographic shift toward an aged population has profound implications for the healthcare system, which must adjust to address the needs of the burgeoning elderly population in the coming years. The elderly are the primary consumers of healthcare, accounting for over a third of all hospital stays and for 42% of inpatient hospital costs (3). The most recent estimates of total healthcare costs for the elderly suggest that 2011 expenses amounted to $414.3 billion, which was over $100 billion more than inflation-adjusted expenses from 2001. Additionally, over 96% of elderly reported health care expenses in 2011, with an average annual cost of $9,863 (4).

These demographic changes are of particular relevance to the Austin and Travis County areas. While Travis County currently has a lower percentage of older adults than the nation as a whole, it has a significantly higher growth rate in the number of older adults (1). Austin is home to the second largest growing senior population among the top 100 metropolitan areas in the United States, exhibiting a 53% increase in the number of adults over age 65 between 2000 and 2010. Austin has also seen the fastest growth (+110%) in the number of adults ages 55-64 in this time period, suggesting that 2010-2020 will be a decade of explosive growth in the Austin-area elderly population (5).

Research is urgently needed to mitigate the impact of the impending population growth of the elderly sector, particularly in Austin and Travis County. Specifically, research should focus on how to best assess the health status of older adults, prevent health decline to the extent possible, prioritize healthy aging, optimize quality of life, and concurrently contain healthcare costs. Home-delivered meal (HDM) programs, the most well-known of which is the Meals on Wheels program, are ideally suited to assist with these goals.

Home-Delivered Meal (HDM) Programs: Legislation and Impact

HDM Legislation and Funding

HDM programs were created as part of the Older Americans Act (OAA) of 1965 under Title III, *Grants for State and Community Programs on Aging*. HDM programs are now administered as part of the OAA Nutrition Program, originally authorized in 1972 as the Elderly Nutrition Program, by an agency known as the Administration on Aging (AoA) (6, 7). The goal of HDM programs and its two counterpart Title III-authorized OAA programs, congregate meal programs and nutrition services incentive grants, are threefold, and include: (1) to lessen hunger and food insecurity rates among elderly who may be economically challenged and vulnerable to these problems; (2) to increase socialization among elderly; and (3) through improvements in nutrition status, to prevent or delay the onset of health problems and improve general health and wellness of program participants (8).

Federal OAA funding requirements mandate that HDM programs must deliver at least 5 hot meals to participants each week, except in rural areas where this number of deliveries may not be feasible (8). Additionally, meals must fulfill one third of the participant's daily nutrient needs, as determined by the Institute of Medicine's (IOM) Food and Nutrition Board (FNB), and must comply with the Dietary Guidelines for Americans. In reality, meals may frequently meet close to half of a participant's daily nutrient needs, suggesting that many participants may be reliant on HDM as a primary source of food and nutrients (9).

While Title III programs continue to receive the most federal funding of all OAA programs, their funding levels have fluctuated in the last 5 years (6, 10). Funding fell in 2007 and 2008 during the US recession, but increased to $217.7 million in 2010 due to a special funding package. Since that time, funding has declined slightly, with $216.8 million provided in 2012 (6). The recent lack of growth in Title III funding poses a significant budgetary constraint on HDM programs, and some HDM programs have reported difficulties with remaining financially stable along with increased reliance on alternate funding sources (11).

The most recent data from the AoA shows that Texas serves more HDM-meals than any other state. In 2011 alone, over 12.1 million meals were served to 59,108 individuals, including 27,046 individuals at high nutritional risk (12). Approximately

38% of the $41.1 million in service expenditures used to provide those meals came from federal Title III appropriations, with the remaining funding provided by private and state and local public sources (13). Fluctuating or unstable Title III funding has the potential to significantly challenge the ability of Texas to meet current HDM demands, much less to expand HDM services as the elderly population increases in the coming years.

Evaluation of HDM Programs

Nutritional impact. HDM have an established record of improving various nutritional parameters (14), including macronutrient and micronutrient intake (15, 16), intake of specific food groups (16), nutritional risk level (17), and nutrition status (18). The ability of HDM services to improve nutritional parameters also has important quality of life implications (7). In light of these benefits, the constant threat of underfunding of HDM is particularly distressing (19).

The nutritional impact of HDM programs is especially important to consider because HDM services support the elderly who are most vulnerable to nutritional risk (20-23). HDM participants are typically homebound and unable to prepare meals themselves, so the ability of HDM to meet a large proportion of their nutritional needs plays a considerable role in improving their dietary intake (24). Yet, perhaps because of their increased level of vulnerability, many HDM participants may still fail to meet nutrient recommendations. (15, 25, 26). Of specific concern is overall energy intake, as well as intake of nutrients such as calcium, zinc, and magnesium, which have been found to be low in the diets of HDM participants (15, 24-26). Individuals of lower socio-economic status, less educated participants, minority participants, and the disabled appear to be at greater risk of nutrient inadequacies (26-28).

Because some HDM participants are at higher levels of nutritional risk, some researchers have proposed targeted expansion of HDM services, such as the addition of home-delivered breakfasts (29), the addition of supplementary foods to delivered meals (25, 30), or the alteration of meals to increase nutrient density (31). These extra services may help the highest risk individuals improve their nutrition status more quickly. However, incorporating expanded services into HDM programs may require a compromise between providing more in-depth service to fewer people, and providing at least some level of service to more people. This dilemma must be considered carefully as HDM funding levels decline or stagnate (19).

Cost effectiveness. Traditional HDM services appear to be highly cost effective due to their ability to delay or prevent an escalation of care. HDM services allow elderly to "age in place" – meaning, to remain in their homes as they age instead of progressing to long-term care facilities (19). An AoA-funded study focused on "aging in place" noted that Title III participants, including Title III-C HDM participants, were characterized by many of the same factors associated with nursing home entry. Namely, HDM participants were more likely to live alone, be of low socioeconomic status, report difficulty with more activities of daily living (ADLs) and instrumental activities of daily living (IADLs), and have a history of prior hospitalization than the elderly population as a whole. Yet, despite the presence of many characteristics indicating a high risk for institutionalization, 91% of HDM participants in this study reported that HDM services allowed them to stay in their homes (23).

Another observational study conducted by Thomas and Mor (32) noted that higher state investments in HDM programs were associated with fewer residents in low-care nursing homes. Low-care nursing home residents are those that do not require assistance with bed mobility, transferring, toileting, or eating. The researchers suggest that HDM services may fulfill needs similar to low-care nursing home facilities, and thus provide an alternative for persons in need of some assistance, but not 24-hour skilled care (32). A cost analysis conducted by the same researchers further suggested that state Medicaid programs could realize a savings of $109 million annually spent on low-care nursing residents by expanding HDM programs to an additional 1% of their over-65 population, as this expansion would promote aging in place. After accounting for how this expansion would increase HDM program expenses, 26 states would realize a net savings (33).

Resource Management of HDM Programs

Given the funding uncertainties faced by HDM programs, combined with the many demands for and potential benefits of HDM services, a thorough understanding of the nutritional risk factors that affect the elderly is necessary to ensure that resources are directed toward those most in need (19). These risk factors are discussed in the next section.

Nutritional Risk among the Elderly

Dietary Intake Trends among Elderly

Overall caloric intake declines over the course of healthy aging as both basal metabolic rate and physical activity levels decline (34, 35). This decline in intake makes diet quality increasingly important in order to ensure that nutrient needs are met (19). Unfortunately, elderly individuals frequently consume a low quality diet, marked by high intake of refined carbohydrate, added sugars, and fats (35, 36). For example, Hsiao et al. studied the diets of 416 community-dwelling elderly and found three dietary patterns: a "Western-like" diet marked by high intake of starchy vegetables, refined grains, meats, fried foods, and fats and oils; a "low produce, high sweets" diet marked by high intake of sweets and saturated fat, and low intake of vitamin C, fiber, fruits, and vegetables (including starchy vegetables); and a "more healthful" diet marked by higher intake of desirable food groups, such as fruits and vegetables, whole grains, and dairy. About 40% of the subjects consumed a "Western-like" diet; another 40% consumed a "low produce, high sweets" diet, and only about 20% of subjects consumed a "more healthful" diet. This suggests significant room for improvement in the type of foods elderly consume, and especially a need to moderate intake of refined carbohydrate and to increase fruit and vegetable consumption (37).

Healthy Eating Index (HEI) scores, which quantify the quality of a diet, provide additional evidence that poor quality diets are widespread among the elderly. Hsiao et al. found that even the HEI score of the "more healthful" dietary pattern group only averaged 70.3 out of 100, while the other two groups both had average HEI scores below 60 (37). Nationwide, HEI scores among elderly tend to average between 60-70, with some variation in scores between regions (36, 38-40). Traditional interpretation of HEI scores suggests that scores in this range are indicative of a diet that "needs improvement" (38).

Combined with the fact that elderly consume fewer calories, the consumption of a poor quality diet can make it difficult for elderly individuals to meet the dietary recommendations for protein and several micronutrients, as these needs do not diminish with age (19). The potential micronutrient problems of greatest concern are calcium and vitamin D inadequacies, followed by zinc inadequacy, or, less commonly, zinc deficiency (41, 42). Additionally, elderly are at risk for vitamin B12 inadequacy or even frank deficiency as a result of low intake of foods with high B12 bioavailability, or more often, age-related changes in B12 absorption (43, 44). Each of these inadequacies is discussed below.

Protein inadequacy and sarcopenia. The current dietary references intakes, developed by the IOM, set the estimated average requirements (EAR) for protein intake at 0.66 g/kg per day, and the recommended dietary allowance (RDA) at 0.8 g/kg per day (45). Based on a recent analysis of NHANES data, over 25% of women age 51 and above and men age 71 and above have daily protein intakes below the RDA. Although the precise estimates of inadequacy vary depending on whether an individual's actual or adjusted body weight is used to calculate protein needs, this analysis clearly suggests that low protein intake is widespread among the elderly (46). Among HDM participants, rates of inadequacy are even higher, with nearly 35% of individuals over age 60 failing to meet the RDA for protein (26).

Inadequate protein intake can lead to severe consequences. One consequence is suppressed immune response. Given that elderly individuals already have a weakened immune system relative to younger adults, this can further exacerbate their already high risk of illness, and can lead to poor wound healing (47). Of greater concern, inadequate protein intake can lead to decreased muscle mass (48). This loss of muscle mass, if accompanied by a loss of strength and function, can result in age-related conditions known as sarcopenia or, if obesity is also present, sarcopenic obesity (49, 50). While there is still no consensus on the precise criteria that define these conditions, many researchers have operationally defined sarcopenia as a muscle mass index (represented by appendicular skeletal mass over height squared) greater than or equal to 2 standard deviations below the sex-specific mean of a healthy young adult reference population (51). Other possible definitions involve using muscle cross-sectional area (52), muscle strength (53), or the ratio of fat to fat-free mass (51). New evidence-based guidelines that set thresholds for what constitutes a low grip strength and low muscle mass may help standardize future research on and definitions of sarcopenia (49).

Incidences of both sarcopenia and sarcopenic obesity appear to increase with age and to be greatest among those of white ethnicity, but comprehensive estimates on the prevalence of these conditions vary considerably depending on the criteria used. Estimated prevalence of sarcopenia among US adults age 60 and above ranges from approximately 12% to 96%, while prevalence of sarcopenic obesity ranges from around 4% to over 90% (50). This wide variation again highlights the need for standardized definitions of sarcopenia.

Even with the lack of a standardized definition, a variety of studies have associated sarcopenia with an array of adverse outcomes, including lower quality of life (54), increased functional decline and disability (51, 55-57), higher incidence of falls and fractures (58), and increased surgical costs and complications (52). Additionally, while a more recent cost analysis is not available, sarcopenia was estimated to account for $18.5 billion in direct healthcare costs in 2000 due to its role as a risk factor for disability (59). These adverse effects may be further exacerbated in individuals with sarcopenic obesity as there appears to be a synergistic effect when both sarcopenia and obesity are present (53).

There are a few mechanisms that could explain how inadequate protein intake may promote sarcopenia. First, older adults appear to break down their protein stores more readily than younger adults, and this breakdown primarily draws from muscle (48, 60). Additionally, essential amino acids (EAAs) such as leucine appear to have less of a stimulatory effect on protein synthesis in elderly adults than they do in younger adults. This attenuation is specifically evident when-small amounts of protein or EAAs are consumed, indicating that elderly individuals may need to include larger amounts of protein in their meals to promote muscle health (61). Accordingly, the most implementable method of preventing or managing sarcopenia may simply be to include a moderate sized serving of high quality protein at each meal (62). Animal proteins, including milk, are suggested over vegetable proteins because of their higher EAA content (60).

Literature also suggests that elderly individuals should strive for a protein intake above the current RDA, as the level of protein intake needed to optimize muscle mass or function may be greater (48, 63). Many researchers have suggested that 1.0-1.2 g/kg per day or higher represents a more appropriate protein intake for healthy elderly, as this level of intake has been found to have positive effects on the maintenance and accretion of lean mass (47, 48, 61, 64, 65). Recently published evidence-based recommendations for protein intake among elderly support this consensus and note that even greater intakes of protein may be needed by elderly individuals with acute or chronic conditions and by those who are losing weight (66).

Calcium and vitamin D. Low intakes of calcium and vitamin D are seen in all age groups in the US, but are particularly common among the elderly. Fewer than 25% of all adults over age 51 meet the adequate intake (AI) levels for calcium, and fewer than 10% meet the AI levels for vitamin D (67). HDM recipients appear to be even less likely to reach AI levels (26). Low vitamin D intake in particular can be also be compounded by age-related physiological changes that promote poor vitamin D status, including decreased synthesis of endogenous vitamin D precursors in the skin, decreased bioavailability of vitamin D, and decreased conversion of vitamin D to its active form (68).

Poor calcium or vitamin D status is of concern because of the role these two nutrients play in preventing or slowing osteoporosis, which affects 9% of adults over age 50 and becomes increasingly prevalent with age (41, 69). The estimated total US healthcare costs attributable to osteoporosis, as reported by Becker et al (70), may be as high as $20 billion annually, with costs expected to grow as the population becomes older. Many of these costs can be traced to short-term and long-term care costs following fractures (70). Fortunately, a meta-analysis of the effects of vitamin D and calcium supplementation suggests that simultaneous supplementation with these two nutrients at or slightly above their recommended daily amounts may reduce the risk of fracture in older adults (71, 72). The Academy of Nutrition and Dietetics also suggests that calcium and vitamin D supplementation may need to be considered for elderly individuals (73).

Zinc. As summarized in a review by Haase and Rink (74), several studies examining changes in zinc status have found that zinc levels decline with age, and it appears that marginal zinc status may be fairly common among elderly. Exact prevalence of deficiency is difficult to pinpoint due to difficulties with measuring zinc status and inconsistencies in defining what serum or plasma zinc levels constitute deficiency (74). Regardless, zinc is particularly a nutrient of concern to HDM participants given that their zinc intake tends to be low, even with HDM-meals supplying a regular source of zinc (24-26).

Zinc plays a complex role in immunity, with involvement in several immune-related pathways, including T-cell function (74). Accordingly, one of the clinical manifestations of zinc deficiency is decreased immune response (42). Marginal zinc status may also depress immune response, and may progress to frank zinc deficiency during times of acute illness when demand on zinc stores is highest (74). Aside from affecting immunity, zinc also has important roles in appetite and wound healing, as well as preventing the progression of acute macular degeneration (41, 42).

Vitamin B12. Vitamin B12 inadequacy is estimated to affect almost 20% of older adults, while an estimated 6% may be affected by frank deficiency (75). Among Title III-C participants (including both HDM participants and congregate meal participants), estimates of deficiency are even higher, with one study finding a 23% prevalence of B12 deficiency (44). While low intake of foods rich in B12— namely, meat and dairy foods— are more likely to be seen among those who are B12 deficient (44), rarely is inadequate intake the primary cause of poor B12 status among elderly (43). Rather, several physiological factors associated with aging may cause deficiency, including food-bound B12 malabsorption or medication-B12 interactions (43).

Food-bound B12 malabsorption occurs when B12 is not cleaved from protein found in food (43). This cleavage, which is carried out by gastric acid, is necessary because B12 must be in its free form for absorption to occur. However, over 30% of adults over age 51 may be affected by atrophic gastritis, a chronic inflammatory condition that can damage the parietal cells responsible for secreting gastric acid and result in decreased gastric acid secretion (76). Many medications commonly used by the elderly may also decrease B12 absorption by changing gastric acid secretion or stomach pH (43). These include H_2-receptor antagonists and proton pump inhibitors, or even antacids if used long-term (76).

The clinical results of B12 deficiency can include macrocytic anemia, neurological symptoms, and hyperhomocysteinemia, the latter of which is linked with cardiovascular risk (43). Of specific interest to elderly, neurological symptoms may include cognitive impairment, and B12 deficiency may be an overlooked cause of some cases of dementia (41).

While nutrient intake-related problems may have adverse effects on healthy elderly, their effects may be more pronounced in elderly who have health conditions that further alter dietary intake or nutrient metabolism. Thus, chronic diseases are another factor that can influence the nutritional risk level of elderly individuals.

Chronic Health Conditions and Nutrition-Related Consequences

The percentage of adults with multiple chronic health conditions has increased throughout the last decade, with almost half of adults over age 65 reporting 2 to 3 chronic health conditions and another 16% reporting 4 or more conditions in a CDC survey (77). Consequences of chronic disease are especially salient to HDM participants, as most diseases commonly seen in the elderly, including heart conditions, respiratory conditions, diabetes, stroke, and memory-related diseases, are observed more often among HDM participants than among the general elderly population (21). Indeed, one study reports that over 75% of HDM clients over age 75 reported 3 to 7 different diseases or disabilities, and a surprisingly large proportion (8.7%) reported 8 or more (25). The relationship between poor nutrition status and chronic disease is complex and bidirectional, and may be further complicated by the use of medications that affect diet.

Influence of nutrition on chronic disease. Nutrition impacts several chronic disease-related outcomes, the most prominent of which is disease-related mortality. In a recent study attempting to estimate the burden of disease in the US, composition of the diet was associated with over a quarter of deaths, making it the top-ranked mortality risk factor (78). Poor nutrition can also relate to poorer disease prognosis and increased incidence of and vulnerability to disease or disease-related complications (7). For example, poor or malnourished nutrition status has been associated with poorer functional outcomes following stroke (79, 80), earlier cancer recurrence (81), and longer length of hospitalization in chronic obstructive pulmonary disease patients (82) and cancer patients undergoing surgery (83). It has additionally been linked to secondary disease-related outcomes, including decreased self-reported quality of life (84).

Therapeutic diets, a critical part of disease management for many conditions, can also influence the outcomes of disease. They may have beneficial effects on overall health and quality of life, but if they are too restrictive, they may be associated with reduced or poorer quality intake and decrease an individual’s enjoyment of foods (85). If they reduce intake to the extent that it becomes inadequate, therapeutic diets may cause more harm than good and may worsen the prognosis of chronic diseases. As such, the

Academy of Nutrition and Dietetics advocates evaluating therapeutic diets for elderly individuals on a case-by-case basis (85).

Influence of chronic disease on nutrition. Disease states can influence nutrition directly or indirectly. These effects are most obviously apparent in metabolic diseases like type 2 diabetes, where nutrient metabolism is inherently altered. Diseases can also indirectly affect nutrition when disability results from a chronic disease such as arthritis, or an acute condition such as stroke. Because arthritis is associated with functional impairment, it may impact an individual’s ability to physically shop for or prepare food, and result in altered intake patterns (41). The disabilities that often result from stroke can have similar effects, and may furthermore be associated with self-feeding, chewing, or swallowing difficulties. These changes in dietary intake can lead to poor nutrition status.

Other diseases may have more subtle effects on nutrition status. For instance, chronic diseases that are catabolic in nature, such as chronic heart failure or cancer, or acute conditions such as infections, may increase resting metabolic rate, leading to increased energy needs (86-88). Depending on how much energy needs are increased and whether an individual’s appetite or ability to consume food is also affected, meeting caloric needs may become challenging.

Influence of medications and polypharmacy on nutrition. Medications may affect absorption, distribution, metabolism, or excretion of specific nutrients, or may affect overall diet and nutrition status 89). For example, drugs may increase or decrease appetite, leading to changes in caloric intake. Side effects caused by drugs such as dry mouth, altered sense of taste or smell, nausea, diarrhea, and constipation, among many others, may make foods unappealing, and thereby also affect intake (90). Additionally, many drugs frequently used by elderly, including antihypertensive medications, diabetic medications, and anticoagulants, may require nutritional counseling to avoid food-drug interactions or altered medication effects (90). Over-the-counter drugs and supplements, which are also commonly used by elderly, may also contribute to food-drug or drug-drug interactions, and may be contraindicated with the use of certain medications (89).

The effects of medication are further complicated by polypharmacy. In a recent CDC survey, two-thirds of adults over age 65 reported using 3 or more prescription drugs in the last 30 days (91). Among HDM participants, the percentage of individuals taking 3 or more drugs daily appears to be even higher, with one study observing that 84% of participants used 3 or more drugs daily (28). Risk of adverse drug interactions or side effects increases as the number of medications an individual is taking increases (90). Because of this, polypharmacy is a well-recognized nutritional risk factor and routinely used in screening tools that assess nutritional risk level (92).

The abilities to use medications appropriately and to self-manage dietary intake in the face of chronic diseases may be altered by the presence of cognitive impairment, further increasing risk for food-medication interactions and a variety of other nutritional problems.

Effects of Cognitive and Psychological Changes on Nutrition

Cognitive impairment and dementia are not a normal part of aging, but both frequently affect elderly and both have nutritional implications. Cognitive impairment involves slight cognitive and memory changes that do not interfere with functional ability and daily activities, whereas dementia does impact daily activities (93). Most often, dementia is associated with Alzheimer’s disease, although other causes of dementia may include vascular changes following stroke, advanced Parkinson's disease, chronic alcoholism, and prolonged vitamin B12 deficiency (41, 93).

Once the signs and symptoms of Alzheimer's disease or dementia begin to manifest themselves, the primary nutritional focus is to manage the nutritional risk factors associated with the disease in order to avoid potential deficiencies or other adverse effects. For example, progressive dementia is associated with inability to prepare food, decreased appetite, and behavioral changes, all of which can contribute to protein-energy malnutrition and micronutrient inadequacies (94). Additionally, in the later stages of dementia, swallowing difficulties or impaired mobility may also be present, further decreasing intake (93).

Aside from dementia, depression is another psychosocial issue that may affect nutrient intake of older adults. The most recent CDC survey examining depression suggests that 4.4% of elderly age 65 and above are depressed (91), with rates even higher among elderly with lower socioeconomic status and those who are homebound (95). Depression has been correlated with increased nutritional risk in a number of studies and across cultures (96-101). This correlation in part stems from the fact that depression is often linked with decreased appetite (102). Social isolation and loss of a spouse or loved one may contribute to depression-related nutritional changes (103).

Effects of Physiological Age-Associated Changes on Nutritional Risk

The "anorexia of aging." Appetite and satiety may both change as part of normal aging, resulting in a phenomenon known as the "anorexia of aging" (104). There have been several mechanisms proposed to explain this phenomenon, many of which center on changes in the secretion and sensitivity of various appetite-regulating hormones (105).

For example, production of hormones like cholecystokinin that are associated with satiety and appetite suppression may increase with age, while appetite-stimulating hormones such as gherlin may decrease (102, 105).

Other mechanisms that have been proposed to explain the anorexia of aging include physiological changes in digestion, and changes in the senses of taste and smell (102). Regarding physiological changes in digestion, the rate of gastric emptying has been consistently found to be slower among elderly. Prolonging the amount of time that food spends in the stomach can in turn prolong the transmission of satiety signals to the hypothalamus via vagal nerve endings within the stomach, which are sensitive to the presence of food (105). Regarding chemosensory changes, the sense of taste in elderly may be slightly diminished, although smell is more likely to be diminished and to have some effect on food choices (106, 107). Sensory changes are most likely to affect intake when they are rapidly induced, as from medication use (106).

Weight loss. Although weight increases gradually through young and middle-aged adulthood, by older adulthood it begins to slowly decline, with a disproportionate amount of weight loss coming from lean mass (108). Some weight loss may be considered a part of normal aging, but past a certain threshold, it becomes cause for concern. This threshold varies among researchers, with some setting it as low as a 5% weight loss in the last three years (109), and others setting it as high as 5% in the last month (110).

Decreased appetite is one of many factors that may underlie weight loss in the elderly; others include chronic diseases, cognitive impairment, medication use, disability, poor oral health, problems with dentition, depression or bereavement, reduced social activity, and food insecurity (27, 111). As discussed above, therapeutic diets can also promote weight loss if they are too restrictive, resulting in lower intake or decreased enjoyment of food (112). Often, the reason for weight loss may be unknown (111).

Many adverse outcomes have been linked with weight loss. One longitudinal study conducted with over 4,000 community-dwelling elderly found that a weight loss of greater than or equal to 5% of baseline weight in 3 years was associated with increased mortality. Similar results were not seen among those who gained more than 5% of their baseline weight (113). Weight loss has also been linked with increased fracture risk and frailty, and may lead to increased infections, anemia, and alterations in the effects of medications (114). Even in older adults who lose weight intentionally, weight loss has been linked with poor outcomes. However, case-by-case evaluations of an individual's functionality, health status, and ability to perform resistance exercises (which help lessen the loss of lean mass during weight loss) should be performed to help determine if the potential benefits of weight loss outweigh the risks (115).

Evaluation of unintentional weight loss should seek to understand and address the underlying causes. This can generally be accomplished by obtaining a dietary and medical history, and conducting a physical exam (111). Once a cause is determined, appropriate medical or dietary treatment can begin. Because HDM services may address several of the underlying causes of weight loss, they may be included in interventions targeted at preventing weight loss (116).

Sociodemographic risk factors. Sociodemographic risk factors related to nutritional risk include age, sex, ethnicity, income, food insecurity, education level, living arrangement, and prior use of healthcare and nutritional services. These risk factors can be used to target nutritional and HDM services to those who are most vulnerable, to proactively prevent nutritional problems (27). Some of these factors have been strongly and consistently linked with nutritional risk, while research on others is more variable.

Three closely related factors consistently related to higher nutritional risk and increased incidence of dietary inadequacies are lower education level, low income, and food insecurity (26, 38, 65, 117-120). Low income and food insecurity are particularly relevant to HDM recipients because as a group they experience a high prevalence of food insecurity and are often low income, even though means testing is not a requirement for HDM services (8). Whereas 1 in 4 seniors within the general population experience food insecurity (121), above 1 in 2 HDM participants are reportedly food insecure (28).

Other sociodemographic variables consistently correlated with nutritional risk are ethnicity and prior use of healthcare and nutritional services. Studies examining ethnicity have observed poorer nutrition-related outcomes in minority groups, including African Americans and Mexican Americans (26, 28, 35, 38, 122, 123). Prior hospitalization and, interestingly, HDM service usage, are also associated with increased nutritional risk (124). Although it seems counterintuitive that HDM service usage would be associated with a higher nutritional risk level, it is important to consider that increased nutritional risk is a determining factor in eligibility for HDM services (21).

The impact of other factors on nutritional risk level is less clear. Regarding sex, some studies have found that elderly women are more likely to exhibit certain nutritional risk factors and nutrition-related problems, such as disability (27), micronutrient inadequacies (26), and poorer scores on nutritional risk screening instruments (125). Conversely, men have been found to have lower diet quality scores (36), and appear to be more likely to fail to meet their caloric needs (117). Other studies have failed to find any significant sex differences in nutrition-related variables (126, 127). Notably, HDM participants are more likely to be female (21).

Changes in living situations, which often occur with age, have been associated with both increased and decreased nutritional risk. Most often, living or eating alone appears to be associated with heightened risk of poor nutrition-related outcomes such as decreased caloric or protein intake (38, 103), while living with a spouse appears to be linked with better nutrition-related outcomes, including better diet quality (128). Yet, overall, results of several studies have not consistently linked a particular living situation with heightened nutritional risk, and results appear to vary between age, sex, and ethnic groups (128). These inconsistent results reflect how the nutritional, social, and functional situation of each elderly individual is unique. For example, an elderly individual living alone because they are highly functionally independent would have a very different nutritional risk level than an elderly individual who is living alone following the death of a spouse.

Implications of Nutritional Risk Factors on Nutritional Assessment

Because elderly are prone to a variety of nutritional risk factors, assessing their current nutrition status or nutritional risk level is complicated, and many traditional means of nutritional assessment, such as BMI and food records, may be of limited use among the elderly. Nevertheless, finding an appropriate assessment method is essential for HDM programs to effectively screen their clients. Methods that are potentially useful for assessing elderly individuals in a community setting are discussed next.

Nutritional Assessment of the Elderly in a Community Setting

Anthropometric Assessment Methods

Many anthropometric measures are easy to implement in a community setting, but may require special consideration, such as the use of alternative measures for individuals who are wheelchair-bound or bedridden. Table 1 highlights several common anthropometric measures. Many measures, including several methods of determining body composition, are not recommended for assessing elderly in a community setting due to practical limitations or poor performance, and will not be discussed.

Traditional anthropometric measurements. Several traditional anthropometric methods, especially height and weight, are considered a routine part of any nutritional assessment. Weight is generally measured using a calibrated scale, but this equipment is not portable and requires an individual to be able to stand. Specialized equipment is available for measuring weight in individuals who are not able to stand, but this equipment is even more costly and less portable than traditional scales. Thus, weight measurements may rely on self-report, even though self-reported weight may be inaccurate (129). Despite these limitations, weight remains an important parameter to assess because of the well-established adverse effects of weight loss.

Measuring height also traditionally relies on equipment that is not portable and requires an individual to stand. If height cannot be measured for these reasons, it can be calculated using alternative methods that rely on knee height or arm-span, although the indirect nature of these methods makes them inherently less accurate (130, 142). Self-reported height is another alternative method, but it appears to be even more inaccurate

Table 1. Anthropometric Assessment Methods

Measure	Description	Advantages	Disadvantages	Practical for elderly in a community setting?
		Traditional anthropometric measurements		
Weight (129, 130)	Measured in kg (or lb) using calibrated scale. May use chair scale or bed scale for non-ambulatory individuals	Easy to measure, inexpensive, no specialized training	Individual must be able to stand (unless specialized scale is used), healthy weight ranges are not well established for the elderly, self-reported weight inaccurate	Yes
Height (129, 130)	Measured in cm (or in), without shoes, using stadiometer. May use knee height in non-ambulatory individuals	Easy to measure, inexpensive, no specialized training	Individual must be able to stand (unless alternative method is used), height may decrease with age, self-reported height inaccurate	Yes
Waist circumference (WC) (41)	Measured on standing individual at top of the iliac crest, holding measuring tape parallel to the floor. Considered a measure of abdominal fat	Easy to measure, inexpensive, little-to-no specialized training, clear cut-off linked with chronic disease risk in younger adults	Measured in standing position, may be skewed by fat redistribution, unclear if cut-offs found in younger adults apply to elderly	Mixed
Waist-to-hip-ratio (41, 131)	Ratio of circumference around waist to circumference around hips (taken at widest portion of buttocks)	Easy to measure, inexpensive, little-to-no specialized training	Measured in standing position, may be skewed by fat redistribution that occurs with age, poor predictor of chronic disease risks compared to WC	Mixed
		Body composition measurements		
Body Mass Index (BMI) (108, 130, 132)	Calculated as weight (kg) over height (m) squared. Considered an indirect measure of body fat	Easy to measure, inexpensive, no specialized training	Controversy over what constitutes healthy BMI range for elderly, subject to error from inaccurate height or weight	Mixed, due to unclear interpretation
Bioelectrical impedance analysis (BIA) (130, 133, 134)	Uses mild electrical current and body's resistance to the current to calculate body water, fat-free mass, and percent body fat	Easy to measure, equipment is portable, little-to-no specialized training	Skewed by dehydration, ethnicity specific, relies on regression equations that are not accurate in elderly, equipment can be expensive	No
Bioelectrical impedance vector analysis (134, 135)	Uses raw parameters provided by BIA, but plots them as a vector and compares the vector's length to a reference population	More accurate than BIA, circumvents the use of BIA formulas	Requires height (prone to inaccuracy), specific software, and equipment that uses electrodes (may be invasive); expensive; requires well-matched reference group	No

Table 1 Continued.

Measure	Description	Advantages	Disadvantages	Practical for elderly in a community setting?
Underwater weighing (130, 132)	Uses an individual's mass and volume of water displaced to calculate body density	High accuracy	Not appropriate for frail elderly, requires specialized training, not portable, expensive	No
Air displacement plethysmography (Bod-Pod) (132)	Uses an individual's mass and volume of air displaced in a specialized chamber to calculate body density	High accuracy	Expensive, requires specialized training and equipment, not portable	No
Dual-energy X-ray absorptiometry (DXA) (131)	Uses x-rays to measure bone mineral density; also measures lean mass and fat mass	High accuracy	Extremely expensive, requires specialized training and equipment	No
Skinfold (caliper) measurements (130)	Uses calipers to measure thickness of a fold of skin and subcutaneous adipose tissue. Indirect measure of body fatness	Inexpensive, equipment is portable	Requires specialized training, limited accuracy in elderly due to redistribution of fat and changes in thickness of skin	No
Mid-arm circumference (MAC) (130, 136, 137)	Measures circumference (in cm) of the upper arm midway between the acromion process of the shoulder, and olecranon process of the elbow	Minimal training and equipment required, accepted measure of nutrition status, can predict mortality	Cut-offs may overlook risk among the obese and vary between ethnicities	Yes
Calf circumference (CC) (131,136-138)	Measures circumference (in cm) of the calf, using the area of greatest circumference	Minimal training and equipment required, accepted measure of nutrition status, can predict mortality	Cut-offs may overlook risk among the obese and vary between ethnicities	Yes
Hand grip strength (139-141)	Uses dynamometer to measure hand grip strength as a surrogate of muscle strength	Inexpensive, equipment is portable, minimal training, linked to important outcomes	Not appropriate for elderly with arthritis in hands, lack of consistent methodology, not consistently linked to nutrition status	Mixed

than self-reported weight, possibly because height decreases markedly with age (129, 130).

Waist circumference and waist-to-hip ratio are other possible anthropometric measures. The goal of these measurements is to determine visceral fat levels, given that visceral fat is a well-established risk factor for many chronic diseases. Both waist circumference and waist-to-hip ratios have sex-specific cutoffs past which an individual is considered at risk. However, fat is redistributed towards the waist with age, and it is unclear if these cutoffs are valid for the elderly (131). Additionally, both measures are generally taken in the standing position and hence may be difficult to measure for some elderly individuals.

Body composition measurements. As noted, body composition changes with age as muscle mass decreases and fat mass increases. These changes complicate the ability to measure body composition in elderly persons, given that some body composition methods, such bioelectrical impedance analysis (BIA), rely on assumptions set using younger adults. Others, such as bioelectrical impedance vector analysis, underwater weighing, air displacement plethysmography, dual-energy X-ray absorptiometry (DXA), and skinfold (caliper) measurements, are simply not practical for use in a community setting due to subject burden or limited time, labor, or financial resources. Nevertheless, body composition can be an important indicator of nutritional risk, and there are several indirect ways to measure body composition in the elderly.

BMI is probably the most popular measure of body composition, as it can be easily calculated using height and weight measurements. Traditionally, BMI categorizes individuals as underweight (BMI<18.5), normal weight (BMI 18.5-24.9), overweight

(25-29.9), and obese (BMI>30), but many researchers speculate these BMI categories and the risk levels they imply may not be valid for the elderly (108, 130, 132). This is supported by research demonstrating that BMIs toward the lower end of the normal weight range (BMI<22) are associated with increased disability and mortality among the elderly (143). According to a systematic review of studies examining body fat and BMI in elderly subjects, an overweight or mildly obese BMI (25<BMI<35) is associated with the lowest mortality risk (132). A recent meta-analysis similarly suggests that a BMI <23 or >33 is associated with increased mortality risk (144). Correspondingly, many researchers who examine BMI among the elderly set the threshold for a “normal weight” BMI somewhere in the range of 22 to 25 (20, 145). Because uncertainty remains over what constitutes a healthy BMI for the elderly, the Academy on Nutrition and Dietetics specifically calls for more research investigating BMI among elderly individuals (41). Until evidence-based recommendations are set, BMI should be interpreted with caution.

BIA, another fairly common method of assessing body composition, is not recommended for use in the elderly. While it is noninvasive and can be determined relatively easily, it relies on the use of equations incorporating height, weight, and resistance to determine fat-free mass. All of these parameters are prone to measurement errors in elderly individuals, as resistance may be skewed by hydration status, and dehydration is common among the elderly (146, 133). Furthermore, BIA equations are specific to the age and ethnic group from which they are developed (133, 147, 147), and must be validated in a population prior to use (149).

A more accepted method for assessing the body composition of elderly individuals is to measure their calf circumference (CC), which reflects the amount of muscle present in the calf and is a reliable indicator of overall muscle mass (150). CC has been shown to be a reasonably sensitive and specific indicator of malnutrition (151). Numerous studies examining the CC of elderly persons have also found that low CC is strongly linked with increased risk of disability and functional problems (152-154), as well as increased frailty (153) and mortality (136, 137). A CC of 31cm has been proposed as the threshold below which adverse outcomes are most likely to occur (152), and some nutritional risk screening tools (see MNA-SF, in Appendix) have adopted this cut-off. However, one disadvantage of using any cutoff is a failure to identify nutritional risk in individuals with a high BMI. Regardless, the ease of measuring CC and its correlation with important outcomes make it appealing as a potential anthropometric method for use in a community nutrition setting (152).

Similar to CC, mid-arm circumference (MAC) appears to be a viable and relevant anthropometric measure for use among elderly. It too has been linked with malnutrition (155) and mortality risk (136, 156), with evidence mixed as to whether it may is a stronger or weaker indicator of mortality risk than CC (136, 137). MAC is subject to the same limitations as CC, given the similarity between the two methods, and additionally may be less strongly correlated with muscle mass than CC (150).

Another promising method of anthropometric assessment is hand grip strength (HGS), which serves as a surrogate measure of lean body composition. Evidence from a systematic review on HGS in the elderly indicates that low HGS is linked with mortality, disability, and increased post-surgical complications and length of hospitalization, suggesting that HGS provides valuable prognostic information (139). HGS has been found to correlate with nutrition status in a number of studies (98, 157, 158), although results have not been consistent across sexes (159, 160). It has also been examined in several studies employing nutritional interventions, but while HGS may improve following nutritional interventions in younger adults, it is unclear if it can be similarly improved in elderly (140, 141, 161). Because of the mixed evidence relating HGS to nutrition, more research is needed before it is considered a reliable indicator of nutrition status. Even with more research, however, practical considerations may limit the adoption of HGS assessment in a community-setting focused on elderly, given that arthritis is highly prevalent among community-dwelling elderly and may skew HGS measurements (162).

Biochemical and Clinical Assessment Methods

Although biochemical and clinical assessment methods are generally included in nutritional assessments, they are not practical in a community setting due to time, labor, and cost constraints. They will not be reviewed here. Extensive information on biochemical assessment of the elderly can be found in a review paper on malnutrition authored by Omran and Morley (163).

Dietary Assessment Methods

Any dietary assessment of elderly individuals must be able to account for and accommodate factors such as hearing or visual impairments, physical disabilities, memory or cognitive changes, and increased susceptibility to fatigue. Elderly individuals may also not be directly involved in preparing their food, limiting their ability to accurately report their intake (164). Many methods of dietary assessment, such as weighed food records and food diaries, may not be appropriate for use among the elderly in light of these factors.

Table 2. Dietary Assessment Methods.

Measure	Description	Examples	Advantages	Disadvantages	Practical for elderly in a community setting?
Dietary intake assessment methods					
Weighed food record (164, 168)	Individual (or nutrition professional) weighs and records all items consumed, generally for 3-7 days	N/A	Accuracy	Highly labor intensive, requires food scale	No
Food diary (164)	Individual records everything he or she consumes (including estimated portion size) for later analysis by nutrition professional	N/A	Ease of completion, no specialized equipment, does not involve recall	Individual may leave off or add foods based on their perceived desirability, requires ability to estimate portion sizes	No
24-hour recalls (24-HRs) (169, 170)	Individual is asked to recall all items (including estimated portion size) consumed in the last 24-hours	N/A	Accuracy (if multiple 24-HR are conducted); may be less prone to reporting errors vs. FFQs and intake screeners	Time intensive, requires training, expensive software required for analysis, relies on short-term memory (may be problematic for elderly), prone to underreporting	Yes, depending on labor availability
Food frequency questionnaires (FFQs) (169-171) Validation: (172)	Individual is asked how often he or she has consumed a food over a given time period; "whole diet" FFQs often include 100+ foods and portion size estimations	Block Brief FFQ, Block 2005 FFQ, Diet History Questionnaire (DHQ), Willet FFQ, NHANES FFQ	Inexpensive, easy to implement, minimal training required, predefined list of foods may make recall easier	More involved estimation of intake (i.e., across months), can be time intensive, prone to reporting errors	Yes
Picture sort FFQs (173, 174)	Similar to a regular FFQ, but uses pictures instead of written format	N/A	Similar to FFQ; useful for low-literacy groups, makes portion size estimation easier	Prone to underreporting, minimally researched	Mixed due to minimal research
Dietary intake screeners (185)	Assess intake of a nutrient or food group of interest (e.g., saturated fat or vegetable intake)	MEDFICTS, NCI 5-A-Day screener	Inexpensive, easy to implement, minimal training required, fast	Only measure selected nutrients and not whole diet, limited accuracy	Mixed due to limited accuracy

Table 2 Continued.

Measure	Description	Examples	Advantages	Disadvantages	Practical for elderly in a community setting?
Diet quality assessment methods					
Healthy Eating Index (HEI) score (176-179) Validation: (180-183)	Captures how closely an individual's diet meets food group and nutrient recommendations set by Dietary Guidelines for Americans	HEI-2010, HEI-2005	Well-validated, provides useful data beyond quantity of intake, lower scores linked with disability in elderly	Requires specific data on food categories and nutrients to calculate, calculation can be time-intensive	Yes
Alternative HEI (AHEI) score (179, 184, 185)	Alternative version of HEI targeted toward food and nutrients that predict chronic disease risk	N/A	Associated with reduced chronic disease risk, provides useful data beyond quantity of intake	Less well-researched than HEI, requires specific data on food categories and nutrients to calculate, calculation can be time-intensive	Mixed due to limited research among elderly
Diet quality index (DQI) (179, 186) Validation: (187)	Similar to HEI, with some variation in food groups and nutrients targeted	DQI-revised, DQI	Provides useful date beyond quantity of intake	Includes many components that are related and may influence one another, does not measure all food groups	Mixed due to limited foods and nutrients included

Table 2 summarizes several dietary intake and diet quality assessment methods, and the advantages and disadvantages of using each to assess an elderly individual's diet. Overall, the relative lack of research specifically validating dietary assessment methods among elderly, combined with evidence that the most commonly used methods may still be only moderately accurate at best when used among elderly, makes it difficult to designate any one particular method as a preferred means of dietary assessment. Even so, assessing the diet of elderly applying for or receiving HDM services is vitally important for providing information on need for services and on the nutritional outcomes of HDM participation (19). The most promising methods for dietary assessment of the elderly that may be practical for use in a community setting are briefly discussed below.

Twenty-four hour recalls (24-HRs). There is significant precedence for the use of 24-HRs to assess intake among elderly, including homebound and community-dwelling elderly (26, 122, 165, 166). Because the accuracy of the 24-HR method improves as more recalls are conducted (167), most researchers conduct three nonconsecutive recalls and average them together to obtain an estimate of daily dietary intake (e.g., 26). However, 24-HRs are prone to reporting errors, especially in the form of underreporting, and may only correlate weakly or moderately with overall energy and protein intake even when multiple 24-HRs are conducted (188). Both the number and portion sizes of foods may be underreported (189), and elderly may be more likely to underreport on 24-HRs than other age groups (190). The reliance of 24-HRs on short-term memory and open-ended questions may also pose a problem for elderly individuals, as they may have more difficulty with tasks involving short-term versus long-term memory and open-ended versus more structured questions (191). Adding a short list of commonly skipped foods to the end of a 24-HR may help address these problems, although this method has not yet been systematically validated through research (169).

The labor investment of 24-HRs is also high, especially if multiple recalls are conducted. In addition to the time spent collecting each recall, time is required to enter recalls into specialized nutrient analysis software. This software is generally costly. Training is also needed prior to collecting and entering recalls (192). Taken together, these issues may limit the practicality of 24-HR depending on the resources available. Subject burden may also become a limiting factor when multiple 24-HRs are conducted (171).

Food frequency questionnaires (FFQs). Like 24-HRs, FFQs have been frequently used in studies with elderly subjects as a method of determining overall dietary intake (171). There are several versions of FFQs available, each including a slightly different number and variety of foods, as well as questions regarding portion sizes commonly consumed. Because there are many versions of FFQs available, including several that are specific to certain cultures, it is difficult to assess the validity of FFQs as a group. This assessment is even more difficult among the elderly, as most validation studies of FFQs have been conducted with younger adults.

In general it appears that, like 24-HRs, FFQs tend to underreport intake and to exhibit weak or moderate correlations with energy and protein intake. Whether they underreport more or less than 24-HRs is unclear and may depend on the subject pool characteristics and the nutrient examined (188). Research conducted with adults age 40-69 suggests FFQs underreport energy and protein more than 24-HR (193), while research focused exclusively on elderly (age 65 and above) suggests FFQ and 24-HR perform similarly as energy reporters (170). Another study that assessed dietary intake of elderly age 85 and above found that FFQs over-reported energy intake relative to 24-HRs (192). Overall, a meta-analysis examining different FFQs suggests that underreporting on FFQs is somewhat lower for elderly age groups than for younger age groups (188).

There are several advantages to using FFQs to assess dietary intake of elderly individuals. FFQs assess intake of a predefined list of commonly consumed foods (usually around 120 foods), and hence do not rely on open-ended recall. FFQs also assess intake over a longer time period- generally, anywhere from one month to one year. While asking an elderly individual to determine his or her intake of individual foods over the last year may be conceptually difficult (192), using a FFQ recall period of one to three months may help avoid problematic reliance on short-term memory while ensuring that the task of recall is manageable. Additionally, because FFQs assess dietary intake over a period of time rather than a single day, they are less subject to within-person variation than 24-HRs (167). The labor investment of FFQs is also considerably lower because they do not require specialized training, and though FFQs are long and may take over an hour to administer, they can be completed in a single visit as opposed to multiple 24-HRs (192). Using electronic versions of FFQs that automatically skip questions determined to be inapplicable to a particular individual may help mitigate the length of time required to administer a FFQ.

Three of the most commonly used FFQs are Harvard FFQs developed by Willett et al (e.g., 194), Block FFQs developed by Block et al (e.g., 195), and National Cancer Institute’s Diet History Questionnaires (e.g., 196). Each of these FFQs has been revised since their original versions were developed, and the most recent versions of these FFQs are the 2007 Harvard FFQ, the 2005 Block FFQ, and the Diet History Questionnaire II (DHQ II), respectively. Validation studies examining multiple age groups, including elderly, have examined older versions of each of these FFQs, but have not yet been conducted on the most recent versions (197-199). There is some evidence that the DHQ may outperform Block and Harvard FFQs in estimating absolute intake of nutrients (199).

Picture-sort food frequency questionnaires (PSFFQs). PSFFQs also rely on a predetermined list of foods to assess dietary intake, but use photographs rather than written questions to represent foods. Specifically, PSFFQs are administered by giving an individual a stack of food photographs to sort according to whether the individual has consumed each food within a given time frame. The person administering the PSFFQ then asks questions about the foods the individual has consumed in order to determine frequency of consumption and portion size (173).

The visual nature of PSFFQs may make this method especially well-adapted for individuals with low literacy level, hearing impairments, or memory impairments, all of which may affect elderly individuals (174). Studies comparing PSFFQs to other dietary assessment methods, including 24-HRs and traditional FFQs, suggest that PSFFQs may be associated with more accurate reporting of energy intake among the elderly, although their performance varies between sexes (170, 173). To date, it does not appear that PSFFQs have been validated against nutritional biomarkers or weighed food records using elderly subjects. As such, while this method of dietary assessment is intriguing, more research is needed to fully assess its performance.

Dietary intake screeners. Dietary intake screeners follow a similar format to whole-diet FFQs by asking about the consumption of foods from a predetermined list, but are aimed at particular food groups or nutrients rather than comprehensive diet. For example, the MEDFICTS screener asks an individual about his or her intake of meats, eggs, dairy, fried foods, fat in baked goods, convenience foods, and table fats to approximate total fat, saturated fat, and cholesterol intake (200). Several screeners are aimed at fruit and vegetable intake, such as the Eating at America's Table Study (EATS) Fruit and Vegetable Screeners (201). While screeners are easy to implement and impose minimal subject burden, their low correlations with food and nutrient intake measured by 24-HRs and lack of validation against nutritional biomarkers poses a major limitation to their use in assessing diet at the individual level (175, 200). They may be more suited for assessing dietary trends of groups or as a prelude to further assessment.

Healthy Eating Index (HEI) score. In addition to characterizing a diet quantitatively by assessing dietary intake, a diet can be qualitatively described using a metric known as diet quality. Developed by the National Cancer Institute, HEI score quantifies a diet's concordance with dietary recommendations from the Dietary Guidelines for America (DGA), which outline nutritional goals aimed at chronic disease prevention and the maintenance of optimal health (202, 203). Among its many uses, HEI score is specifically indicated as a tool for evaluating nutritional interventions (176) and may also be used to determine where nutritional interventions should be targeted (204).

The method for calculating HEI score has changed over time to reflect updates to the DGA, and the current version (HEI-2010; see Appendix) involves assessing and scoring 9 dietary components for adequacy and 3 for moderation. Adequacy components include intake of total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acids, while moderation components include refined grains, sodium, and empty calories. All components are calculated on an energy-adjusted (per 1000 calorie) basis, and function autonomously (177).

While few studies have examined HEI-2010 score because of its recent development, it has recently been validated by using it to score expert-designed menus that are known to be of high quality (180). The previous version of HEI score (HEI-2005) has been used frequently in studies examining the diets of elderly individuals (37, 38, 40, 178, 205) and has also been repeatedly validated using several different methods (181-183, 206). HEI score appears to be the foremost method of determining diet quality, given its extensive use in nutritional research.

Alternative Healthy Eating Index (AHEI) score. Created in 2002, the AHEI score also seeks to address dietary factors associated with chronic disease risk by scoring the intake of several food groups and nutrients (207). The most recent version of the AHEI (the AHEI-2010) scores intake of fruits, vegetables, whole grains, and sodium, like the HEI-2010 score, but it also scores intake of sugar-sweetened beverages and fruit juice, nuts and legumes, red/processed meat, *trans* fat, omega-3 fatty acids, poly-unsaturated fatty acids, and alcohol (208). Although AHEI score does appear to be associated with chronic disease risk (207, 208) and risk of mortality (184), its failure to assess meat and dairy intake, which are important sources of high quality protein for elderly individuals, may limit its usefulness to assess diet quality among elderly.

Diet Quality Index (DQI). Yet another measure of diet quality, the DQI incorporates dietary recommendations from multiple sources, including the IOM, the Food Guide Pyramid (the DQI was developed prior to the introduction of ChooseMyPlate), and the DGA. The most recent version of the DQI (the DQI-R) was developed in 2003, and incorporates total fat, saturated fat, dietary cholesterol, fruit, vegetable, grain, calcium, and iron intake, as well as dietary diversity and dietary moderation, into its scoring criteria (209). Like the AHEI, it fails to assess meat and dairy intake. Additionally, because total fat, saturated fat, and dietary cholesterol intake are highly correlated, having separate components for each of these may skew scoring accuracy (210). Combined with the fact that it has not been recently updated, these limitations suggest the DQI-R may not be well suited for use among the elderly.

Nutrition Status and Nutritional Risk Screening Tools

There are a variety of instruments available that incorporate several nutritional risk factors and assessment methods into a single tool intended to determine an individual's nutrition status or nutritional risk level. These include nutrition assessment instruments like the Mini Nutritional Assessment (MNA) and Subjective Global Assessment (SGA), which are longer and more comprehensive assessments of nutrition status, and nutritional risk screeners, which are brief tools intended to flag individuals who are likely malnourished or at risk of malnutrition. A sampling of these instruments is given in Table 3. Notably, several of the instruments described in this table are intended for use in a clinical setting or were not developed to specifically assess the elderly, and thus are not appropriate screening tools for use by HDM programs. The screening and assessment tools most relevant to HDM programs are the Nutrition Screening Initiative

Table 3. Nutrition Screening and Assessment Tools.

Measure	Description	Advantages	Disadvantages	Practical for elderly in a community setting?
Geriatric Nutrition Risk Index (GNRI) Validation: (211)	Formula that uses albumin levels and ratio of actual to ideal body weight to determine nutrition-related risk	Strong ability to predict morbidity and mortality	Requires measurement of albumin levels, meant for hospitalized elderly	No
Malnutrition Universal Screening Tool (MUST) (212, 213) Validation: (214)	5-step screening tool to assess risk of malnutrition in adults in community, institutional, or clinical settings; completed by a care professional	Ease of completion, takes less than 5 minutes, shown to predict mortality and length of hospitalization in elderly patients	Not specific to elderly; only assesses BMI, weight loss, and acute disease; only fair agreement with MNA and MNA-SF (well-validated)	Mixed
Malnutrition Screening Tool (MST) (215)	2-question instrument developed for use by healthcare workers	East of completion, takes less than 5 minutes, high inter-rater reliability, reasonably correlated with nutritional parameters	Not specific to elderly, only assesses weight loss and appetite, not intended for community setting	No
Subjective Global Assessment (SGA) (216)	Tool developed to assist clinicians in evaluating patients for malnutrition, using medical history and physical examination	Able to predict mortality and nutrition-related complications in long-term care settings, considered a "gold standard" for the validation of nutrition screening tools	Intended for use in a clinical or long-term care setting, subjective scoring criteria, requires training and experience for use, not sensitive to small changes in nutrition status	No
Mini Nutritional Assessment (MNA) Validation: (217-219)	18-item screening and assessment tool used to determine nutrition status in research, community, institutional, or clinical settings; administered by clinician	Correlates with morbidity and mortality, well-validated, also considered a "gold standard" for the validation of nutrition screening tools	Requires in-depth assessment of an individual's diet, requires height and weight measurements (may be difficult in homebound individuals)	Not recommended due to length
Mini Nutritional Assessment- Short Form (MNA-SF) (220, 221) Validation: (222-227)*	6-item screening tool to assess nutritional risk level in community, institutional, or clinical settings; administered by a care professional	Ease of administration, only takes 5 minutes, well-validated, correlated with morbidity and mortality, preferred over full-MNA	Not a comprehensive nutritional assessment, does not address quality of diet, some factors not modifiable by nutritional intervention	Yes

Table 3 Continued.

Measure	Description	Advantages	Disadvantages	Practical for elderly in a community setting?
Self- Mini Nutritional Assessment (Self-MNA) Validation: (228)	6-item screening tool that can be completed by an individual or his or her caregiver; results can be taken to health care provider if they indicate nutritional risk	Self-administered, can be used to raise awareness of nutritional health in a variety of settings	New tool, not well researched	Unclear
Nutrition Screening Initiative DETERMINE Checklist (NSI) (92, 229, 23) Validation: (231)	10-item questionnaire developed by the Nutritional Screening Initiative from the National Institute of Aging to serve as a self-administered nutritional awareness and educational tool	Ease of administration, only takes 5 minutes, currently used by many HDM service providers	Intended to be used as an awareness and not a screening tool, low specificity (over-identifies individuals at risk) and low reliability	Mixed, due to poor performance
Short Nutritional Assessment Questionnaire (SNAQ ©) Validation: (227, 232)	3-item questionnaire developed for nurses to assess presence of malnutrition at hospital intake	Ease of administration and cross-validation in a healthcare setting	Not specific to elderly, not intended for community setting, limited agreement with validated nutritional risk screeners	No

DETERMINE Checklist (NSI), the MNA, and the Mini Nutritional Assessment- Short Form (MNA-SF). These 3 tools are discussed in greater detail below, along with a fourth screening tool known as the Self-Mini Nutritional Assessment (Self-MNA).

The Nutrition Screening Initiative DETERMINE Checklist (NSI). The NSI is a 10-item yes or no checklist designed in 1993 by the Nutrition Screening Initiative, a collaborative task force of several professional organizations developed to create tools for detecting nutritional problems among the elderly. Originally designed to function as a self-administered nutritional risk awareness tool, the NSI assesses nutritional risk factors that were identified as predictors of inadequate nutrient intake or poor self-perceived health status among a sample of non-institutionalized, primarily white elderly aged 70 and above (92). Individuals can be classified as having a nutritional health score that is “0-2: good,” “3-5: moderate nutritional risk,” or “6 or more: high nutritional risk” (see Appendix).

Several problems have been noted with the NSI. Only 5 of its 10 questions are correlated with either of the outcomes it is intended to predict. Of these 5, only 3 (“I eat fewer than 2 meals per day,” “I eat few fruits or vegetables, or milk products,” and “I don’t always have enough money to buy food”) are significantly correlated with inadequate nutrient intake (92). Overall NSI scores likewise do not correlate with nutrient adequacies (233). The failure of the NSI to correlate with the outcomes it is intended to measure suggests that it may be prone to identifying risk where none exists (231). Evidence also suggests that its ability to predict other important outcomes, such as mortality, may be limited (229, 234).

Despite these drawbacks, Texas Department of Aging and Disability Services requires all HDM programs to administer the NSI to its applicants, as per OAA funding requirements that all HDM providers identify individuals with high nutritional risk (235). Used in this capacity, the NSI essentially functions as a screening tool, in contrast to its original purpose as an awareness tool. Yet, its efficacy as a screening tool appears to be greatly limited by its low sensitivity and specificity (160, 231), as well as by poor reliability (230). Indeed, one study that examined the ability of the NSI to group HDM participants by their risk level found that the NSI classified 98% of applicants as at risk, including 83% at high nutritional risk. In the same study, traditional nutrition assessment conducted using anthropometric, dietary, and biochemical criteria found that only 74% of applicants were actually at risk (20).

The Mini Nutritional Assessment (MNA) and Mini Nutritional Assessment-Short Form (MNA-SF). The MNA was developed in the early 1990s to function as an early detector of nutritional risk so that nutritional interventions could be targeted to help prevent the development of more severe problems. It was designed to assess both frail and healthy elderly and to be usable within several settings, including general practices, nursing homes, and the community (236). It consists of 18 questions that assess multiple domains, including anthropometrics, diet, perceived health and nutrition, and lifestyle factors. In the current version of the MNA, the first 6 questions are used to screen individuals, so that those who are flagged as potentially malnourished or at risk of malnutrition may be further assessed using the remaining questions (217). Once the full assessment is complete, scores for all of the questions are added together to derive an overall score that can be used to classify individuals as either “<17: malnourished,” “17-23.5: at risk of malnutrition,” or “24-30: normal nutrition status” (see Appendix).

The MNA has proven to be a highly useful tool that has been validated against nutritional biomarkers, clinical assessments conducted by physicians, anthropometric measures, and functional capabilities (160, 210, 211, 236, 237). Because of its repeated validation and its ability to provide prognostic information, the MNA has been declared a “gold standard” among nutrition assessment tools (238). Yet, while the MNA is an excellent nutrition assessment tool, its length (when fully administered) and the training that may be required for its administration limit its practicality as a screening tool in a community setting (222). Fortunately, the initial 6-question screening portion of the MNA may be used as a stand-alone tool known as the MNA-SF if a full nutrition assessment is not desired or practical (219, 222, 238). The vast majority of research examining the MNA-SF suggests that it is highly sensitive, specific, and accurate, and it demonstrates a strong correlation with MNA score in validation studies (222-227).

Revisions to the original MNA-SF have resulted in the version currently in use, which includes 5 questions assessing appetite, weight loss, mobility, presence of acute disease/stress, and psychological status, respectively, as well as a sixth question that uses anthropometric assessment. Either BMI or CC may be used for the last question. Providing an option other than BMI for the last question is intended to circumvent problems associated with height and weight measurement, as well as uncertainties over what constitutes an appropriate BMI for the elderly (223). The composite score of these 6 questions is used to classify an individual as “0-7: malnourished,” “8-11: at risk of malnutrition,” or as having “12-14: normal nutrition status” (see Appendix).

Research has largely supported the usefulness of the MNA-SF across diverse elderly subject groups, indicating that risks of mortality (239-243), frailty (244, 245), falls (246), and hospitalization (240, 247) are all higher among elderly who are malnourished or at risk of malnutrition according to MNA-SF criteria. At risk or malnourished individuals have also been shown to have more disability and functional impairment, on average, compared to well-nourished individuals (220, 248). Lower MNA-SF scores have additionally been linked to longer hospital stays and higher scores have been linked with better health-related quality of life, which represents an important and often overlooked metric that should be prioritized as part of healthy aging (249, 250). Finally, MNA-SF risk level is linked with several nutritional biomarkers, including albumin (220, 251). In a systematic review of several nutritional screening methods, the authors conclude that the MNA-SF appears to be the most suitable tool for screening nutritional risk among community-dwelling elderly (252).

The Self-Mini Nutritional Assessment (Self-MNA). The Self-MNA was only recently developed, and is intended to function as a self-administered screening tool for determining nutritional risk level. A side-by-side comparison with the MNA-SF reveals that it essentially asks the same questions as the MNA-SF, with rewording to reflect its self-administered nature (see Appendix). Currently, only one study has examined the Self-MNA, with promising results. Namely, it demonstrates high sensitivity and specificity compared against the MNA-SF (228). However, this study primarily consisted of elderly and elderly caregivers who were self-selected respondents to advertisements and who were recruited by a marketing research company, and thus the Self-MNA has yet to be examined among a general elderly population. Prior to the widespread adoption of this screening tool, more research is needed to confirm its efficacy.

Rationale

Clearly, elderly nutritional assessment can be a complex process. For HDM providers, this process is further complicated by limited time, labor, and financial resources, all of which prohibit an in-depth nutritional assessment. Yet, as demand for HDM services continues to grow and more providers are forced to waitlist potential clients (19), it is increasingly important to accurately assess the nutritional risk level of applicants to ensure that services are directed to those most in need.

While the screening tool currently used by HDM providers in Texas (the NSI) fulfills the need for a tool that is fast, easy to implement, and inexpensive, it may do so at the expense of accuracy. By classifying the majority of HDM applicants as experiencing moderate or high nutritional risk (20), the NSI does not provide a useful way for HDM programs to stratify applicants by their level of need. Recent research suggests that the MNA-SF may be able to more accurately estimate an elderly individual's nutritional risk level, given its strong ties to nutrition-related outcomes and its extensive validation against other nutritional assessment tools (252). Yet, there does not appear to be any research simultaneously examining the performance of the NSI and MNA-SF among the homebound elderly. The primary intent of this research was to fill this gap in knowledge, and determine which tool provides the most useful information to HDM providers.

Because Texas and especially the Travis county area are experiencing unprecedented growth in their senior population, Austin represents an ideal location to examine the performance of these two tools. Additionally, Austin is home to Meals and Wheels and More (MOWAM), a multi-service organization established in 1972 that currently serves over 5000 residents of the greater-Austin area, including over 2800 HDM clients (253). In 2012 alone, MOWAM served over 850,000 meals, and helped 75% of its clients maintain or improve their nutritional risk level (254). These statistics provide excellent testimony on the value of MOWAM's services. However, the threat of funding instability still poses a threat to the ability of MOWAM and other HDM providers to maintain their current level of service. Additional research demonstrating the impact of HDM services such as those provided by MOWAM will provide compelling evidence in support of HDM programs, which can be used to encourage funding of HDM and other OAA programs. This study sought to provide such evidence.

MOWAM HDM clients also represent an ideal population for examining the efficacy of the Self-MNA, as it is intended for use by all community-dwelling elderly. If the Self-MNA proves to be a valid indicator of nutritional risk, it could be used in a community context to raise awareness about nutritional risk, and potentially stimulate individuals to seek out healthcare services prior to the onset of nutritional problems. The lack of research on the Self-MNA represents another gap in knowledge that this study sought to address.

Objectives

The primary objectives of this study were to determine: 1) how MOWAM HDM services affect nutritional risk level, dietary intake, and diet quality; and 2) whether the MNA-SF demonstrates a greater ability than the NSI to distinguish clients by their nutritional risk level, after 3 months of meal services. For the second primary objective, changes in dietary intake data and diet quality from before and 3-months after receiving meals were used as objective standards to support whether a change in nutritional risk level had occurred. This research builds upon a pilot study conducted by a prior graduate student (Seanna Marceaux) under the guidance of Drs. Sylvia Crixell and BJ Friedman (255).

The secondary objectives of this study focused on characterizing the ability of the Self-MNA to serve as a self-screening tool, by determining: 1) whether the Self-MNA accurately classifies nutritional risk level, using the well-validated MNA-SF as a reference standard; and 2) whether the Self-MNA can be easily used by HDM recipients. To our knowledge, this is the first study to examine the performance of the Self-MNA among a sample that primarily consists of homebound elderly.

The specific aims and hypotheses of this research were as follows:

Primary Objective 1, Specific Aim 1

To examine changes in nutritional risk level following 3-months of MOWAM meal services.

Hypothesis: Nutritional risk level (indicated by numerical score and by nutritional risk category) as measured by both the MNA-SF and the NSI will improve.

Primary Objective 1, Specific Aim 2

To examine changes in dietary intake (as indicated by DHQ*Web dietary intake data) following 3 months of MOWAM meal services.

Hypotheses:

1. Overall caloric intake will improve.

2. Intake of the following nutrients of concern will improve:
    - Protein
    - Calcium
    - Vitamin D
    - Zinc
    - Vitamin B12.
3. Intake of the following additional nutrients will improve:
    - Beta-carotene
    - Thiamin
    - Vitamin B6
    - Vitamin C
    - Vitamin E
    - Folate
    - Iron
    - Magnesium
    - Phosphorus
    - Fiber.

Primary Objective 1, Specific Aim 3

To examine changes in diet quality (as indicated by HEI score and HEI score components) following 3 months of MOWAM meal services.

Hypotheses:

1. Overall HEI score will improve.

2. Scores of each of the HEI sub-components will increase. These include:
    - Adequacy components: total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, fatty acids; and
    - Moderation components: refined grains, sodium empty calories.

Primary Objective 2, Specific Aim 1

To determine if nutritional risk level as measured by the MNA-SF changes more (or less) than nutritional risk level as measured by the NSI, after 3 months of MOWAM meal services.

Hypothesis: More individuals will move from a higher nutritional risk category to a lower nutritional risk category based on the MNA-SF than based on the NSI.

Primary Objective 2, Specific Aim 2

To examine how changes in nutritional risk level (measured by the MNA-SF and NSI scores and categories) are related to changes in caloric intake (as indicated by DHQ*Web dietary intake data).

Hypotheses:

1. Increases in caloric intake will be correlated with improvements in nutritional risk level (as indicated by improved NSI or MNA-SF score or category).
2. Correlations between increased caloric intake and improved nutritional risk level will be stronger with MNA-SF scores than with NSI scores.

Primary Objective 2, Specific Aim 3

To examine how changes in nutritional risk level (measured by the MNA-SF and NSI scores and categories) are related to changes in protein intake (as indicated by

DHQ*Web dietary intake data).

Hypotheses:

1. Increases in protein intake will be correlated with improvements in nutritional risk level (as indicated by improved NSI or MNA-SF score or category).
2. Correlations between increased protein intake and improved nutritional risk level will be stronger with MNA-SF scores than with NSI scores.

Primary Objective 2, Specific Aim 4

To examine how changes in nutritional risk level (measured by the MNA-SF and NSI scores and categories) are related to changes in diet quality (as indicated by HEI score and HEI score components).

Hypotheses:

1. Increases in HEI score and the scores of HEI components will be correlated with improvements in nutritional risk level (as indicated by improved NSI or MNA-SF score or category).
2. Correlations between improved diet quality and improved nutritional risk level will be stronger with MNA-SF scores than with NSI scores.

Secondary Objective 1, Specific Aim 1

To examine the sensitivity and specificity of the Self-MNA as compared to the MNA-SF.

Original hypothesis: The Self-MNA will demonstrate high sensitivity and specificity at classifying individuals by their nutritional risk level.

Revised hypothesis, following initial experiences with the Self-MNA: The Self-MNA will not demonstrate high sensitivity and specificity at classifying individuals by their nutritional risk level.

Secondary Objective 1, Specific Aim 2 (Exploratory)

To examine how calf circumference (as indicated by calf circumference score and numerical calf circumference) as measured by participants (during the Self-MNA) compares to calf circumference as measured by researchers (during the MNA-SF).

Secondary Objective 2, Specific Aim 1 (Exploratory)

To examine the ability of participants to complete each question of the Self-MNA using only the instructions provided on the tool.

Secondary Objective 2, Specific Aim 2 (Exploratory)

To examine which Self-MNA questions participants perceive as difficult, as indicated by self-reported difficulty.

Secondary Objective 2, Specific Aim 3 (Exploratory)

To examine whether participants correctly followed instructions for adding their scores, for each box that requests adding numbers.

Secondary Objective 2, Specific Aim 4 (Exploratory)

To examine whether participants measured their calf circumference using the correct method (i.e., whether clients measured the correct area) and metric of measurement (i.e., whether clients measured their calf circumference in centimeters as specified by Self-MNA instructions).

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2. METHODS

Design

The primary objectives of this research were investigated using a quasi-experimental design. All subjects underwent the same intervention (3 months of MOWAM HDM services), and baseline data was compared to follow-up data. The secondary objectives of this research used a cross-sectional design (Self-MNA data was only collected at baseline) and included both a validation component and an observational component.

Subjects

Recruitment and Consent

To recruit for this study, telephone interview data was screened by the Assistant Vice President of Client Services and the Supportive Case Management Team Leader at MOWAM to identify MOWAM applicants who met the study's eligibility criteria. When MOWAM caseworkers scheduled intake home visits for applicants eligible for the study, they requested permission from the applicant to have a researcher attend the visit. Trained researchers then accompanied the MOWAM caseworkers on these home visits. All researchers completed CITI training prior to any home visits.

During these home visits, the caseworker conducted all usual MOWAM intake assessments except the NSI and MNA-SF (both of which are routinely administered at MOWAM intake visits) to confirm applicant qualifications for HDM services. Upon certification of eligibility, the caseworker allowed the researcher to briefly describe the study and invite the new clients to participate. Clients who were interested were provided with a more extensive verbal and written description of the study and asked to sign a consent form and given a copy if they agreed to participate (See Appendix). If a client declined to participant, the caseworker completed the NSI and MNA-SF for MOWAM's records and concluded the visit.

Eligibility Criteria

All MOWAM applicants who were: (1) eligible to enroll for HDM services (following the MOWAM caseworker's intake assessment); (2) over the age of 65; (3) free of cognitive impairment that could have interfered with data collection; and (4) able to speak English, were eligible for this study. The presence of cognitive impairment was assessed by MOWAM during the preliminary telephone interview with the client, as per usual MOWAM protocol. The criteria for cognitive impairment were a diagnosis of Alzheimer's disease or another form of dementia, or the presence of severe memory problems, determined via self-report from the client, the client's caregiver, or a family member of the client.

Exclusion Criteria

Applicants eligible for MOWAM enrollment were excluded from the study if they: (1) were under the age of 65; (2) exhibited cognitive impairment; (3) were scheduled to receive less than 5 meals per week; or (4) did not speak English. The reason for excluding those who did not speak English was that the DHQ is only available in English. Additionally, the pilot study revealed that only about 3% of MOWAM clients contacted did not speak English.

Risks

The primary risk associated with the study was participant fatigue, specifically due to the length of the DHQ*Web FFQ. The length of each visit was carefully considered to preemptively address the potential for participant fatigue. However, if researchers perceived a participant to be fatigued during a visit, they advised the participant on how much time remained to complete the visit and asked the participant if he or she preferred to finish the visit or to reschedule the remainder of the visit for another day. The participant's right to end and reschedule a visit due to fatigue was also explicitly expressed in the research consent form.

Data Collection

Figure 1 summarizes the data collection process. After a MOWAM client gave informed consent, he or she officially became a study participant. A trained researcher then administered the NSI (5 minutes) and the MNA-SF (5 minutes). Once these were completed, researchers scheduled a second home visit to finish collecting baseline data (the Self-MNA and the DHQ*Web). Baseline data collection was split into two visits to account for the fact that the routine MOWAM intake assessments completed by caseworkers could last up to 2 hours, and visits any longer than this were expected to cause fatigue. When permitted by the participant's schedule, the second baseline visit was scheduled within 4 weekdays of the initial home visit, so that all baseline data collection could be completed before MOWAM meal service began. Study participants were given a reminder sheet with the date and time scheduled for the second baseline visit, and a number to call if they needed to reschedule the visit (see Appendix).

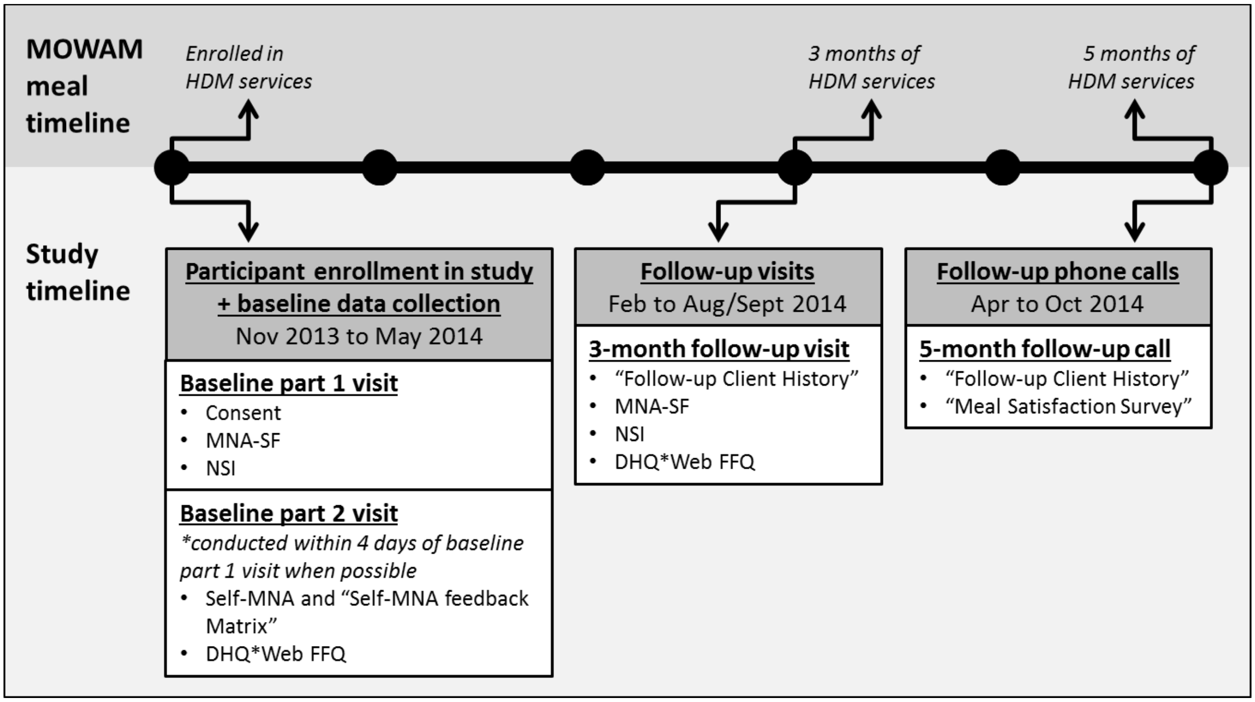

Figure 1. Data Collection Timeline.

Two trained researchers, one of whom attended the initial home visit and was familiar to the client, attended the second baseline visit. During this visit, the client was first asked to complete the Self-MNA (10-15 minutes; see Table 1 for summary of Self-MNA questions). Given that the Self-MNA is intended to be self-administered, researchers did not provide any instructions on how to complete the assessment. Once the participant finished the Self-MNA, a researcher checked it over and recorded on the "Self-MNA Feedback Matrix" (see Appendix) which questions were completed and whether any items were completed incorrectly. After recording Self-MNA data on the "Self-MNA Feedback Matrix," researchers highlighted any blank questions and prompted participants to finish the highlighted questions. In order to compare screening scores for both options of question F (see Table 4), researchers asked participants to complete both options during their second attempt (contrary to instructions) if the participant had not

Table 4. Summary of Self-MNA Questions and Instructions.

Instructions on form	Question		Scoring
Front page – “Complete the screen by filling in the boxes with the appropriate numbers. Total the numbers for the final screening score.”	A	“Has your food intake declined over the past 3 months?”	0 = severe decrease in food intake 1 = moderate decrease in food intake 2 = no decrease in food intake
	B	“How much weight have you lost in the past 3 months?”	0 = weight loss greater than 7 pounds 1 = do not know the amount of weight lost 2 = weight loss between 2 and 7 pounds 3 = no weight loss or weight loss less than 2 pounds
	C	“How would you describe your current mobility?”	0 = unable to get out of a bed, a chair, or a wheelchair without the assistance of another person 1 = able to get out of bed or a chair, but unable to go out of my home 2 = able to leave my home
	D	“Have you been stressed or severely ill in the past 3 months?”	0 = yes 2 = no
	E	“Are you currently experiencing dementia and/or prolonged severe sadness?”	0 = yes, severe dementia and/or prolonged severe sadness 1 = yes, mild dementia, but no prolonged severe sadness 2 = neither dementia nor prolonged severe sadness
Back page – Instructions: “Now, please CHOOSE ONE of the following two questions – F1 or F2 – to answer… DO NOT ANSWER QUESTION F2 IF QUESTION F1 IS ALREADY COMPLETED.”	F1	Height and weight chart (see instrument in Appendix for full chart) – “Please refer to the chart on the left and follow these instructions: …”	Group number = 0, 1, 2, or 3 (see instrument in Appendix for full chart)
	F2	Calf circumference (CC) measurement – “Measure the circumference of your LEFT calf by following the instructions below: …”	CC $<$31cm = 0 CC $\geq$31cm = 3

already done so. Additionally, participants were asked to write down the number and units they measured for their calf circumference so that client-measured calf circumference could be compared to researcher-measured calf circumference. After participants completed the second run-through of the Self-MNA, researchers filled out remaining items on the “Self-MNA Feedback Matrix.”

Next, the researchers administered the DHQ*Web FFQ (60-90 minutes). This questionnaire was administered from a laptop that was set up to act as a “hotspot,” given that the DHQ*Web FFQ requires an active internet connection. In cases where an effective internet connection could not be established, paper copies of the DHQ*Web FFQ were administered and entered into the DHQ*Web respondent site at a later time. While administering this questionnaire, researchers used household measuring cups and spoons to help each participant determine what portion sizes had been consumed for a given food. Once administration of the DHQ*Web FFQ was complete, researchers thanked the client for his or her time and ended the visit. The end of this visit marked the completion of baseline data collection.

Approximately 3 months after meal delivery service had begun, researchers called each participant to schedule a final home visit to collect follow-up data. Two researchers (including, when possible, at least one researcher who was present during one of the baseline visits) attended each follow-up visit. During these visits, clients were asked (see Appendix – “Follow-up Client History” form) 1) if any significant events (e.g., hospitalization, improvement in health, etc.) had occurred since participants started receiving meals; and 2) whether participants had used any other MOWAM services during this time period. The purpose of this assessment was to collect information to help control for any potential variables besides normal HDM services that may have influenced a participant's nutritional risk level. The NSI, MNA-SF, and DHQ*Web FFQ were then re-administered following the same procedures used during baseline data collection. This home visit lasted from 60-120 minutes.

Two months after the final home visit, researchers called participants and re-administered the "Follow-up Client History" form. Researchers then asked the participant 10 questions (see Appendix – "Meal Satisfaction Survey" form) about their experiences with MOWAM's HDM services. These questions were intended to determine how satisfied each participant was with the HDM-meals and to assist in the qualitative interpretation of our results.

Confidentiality

To ensure that participant data is kept confidential, all data were de-identified through a coding process, and each participant was assigned a numerical ID. Only the principal investigators have access to the key with participant IDs. All documents refer to participants by their numerical ID, and are stored in a locked file cabinet in the Community Nutrition Lab (room 269) in the FCS building. These records will be shredded three years after data collection is complete. All digital data used for statistical analysis and project administration is password protected and kept on secured computers located within the Community Nutrition Lab. Only the principal investigators have passwords to access the electronic data.

Statistical Design and Analysis

DHQ*Web data was analyzed using Diet*Calc, version 1.5.0, a software program developed by the National Institutes of Health (NIH) for the analysis of the DHQ*Web questionnaires. The output of this analysis quantifies the intake of specific nutrients and food groups. This information was then used to calculate the HEI score, using the scoring criteria specified by Guenther et al. (see Table 5) (1). Note that when the amount of a nutrient or food group consumed falls between the criteria for a minimum or maximum score, the scoring for each component is calculated to be proportional to the intake of that component. For example, consumption of 0.4 cup equivalents per 1000 calories of total

Table 5. Criteria for Calculating the HEI-2010 Score.

Component	Maximum	Maximum score criteria	Minimum score criteria
Adequacy components			
Total Fruit	5	≥0.8 c equivalents/ 1000 kcal	No fruit
Whole Fruit	5	≥0.4 c equivalents/ 1000 kcal	No whole fruit
Total Vegetables	5	≥1.1 c equivalents/ 1000 kcal	No vegetables
Greens and Beans	5	≥0.2 c equivalents/ 1000 kcal	No dark-green vegetables, beans, or peas
Whole Grains	10	≥1.5 oz equivalents/ 1000 kcal	No whole grains
Dairy	10	≥1.3 oz equivalents/ 1000 kcal	No dairy
Total Protein Foods	5	≥2.5 oz equivalents/ 1000 kcal	No protein foods
Seafood and Plant Proteins	5	≥0.8 oz equivalents/ 1000 kcal	No seafood or plant proteins
Fatty Acids	10	(PUFAs + MUFAs) / SFAs ≥2.5	(PUFAs + MUFAs) / SFAs ≤1.2
Moderation components			
Refined grains	10	≤1.1 oz equivalents/ 1000 kcal	≥4.3 oz equivalents/ 100 kcal
Sodium	10	≤1.1 g/ 1000 kcal	≥2.0 g/ 1000 kcal
Empty Calories	20	≤19% of energy	≥50% of energy
Abbreviation key: c= cup, kcal = calories, oz= ounce, PUFAs= poly-unsaturated fatty acids, MUFAs= mono-unsaturated fatty acids, SFAs= saturated fatty acids			

fruit would earn a score of 2.5 for that component. Total HEI score is derived from combining the scores of all components.

All statistical tests were performed using the Statistical Package for the Social Sciences (SPSS, version 22.0, 2013). Dependent and independent variables for each objective are listed in Table 6. Because of the small sample of the study and spread within the dietary data, certain variables were not used for analysis. Those that were used are bolded in Table 6. For all dependent variables, baseline data (pre-test) was compared to 3-month follow-up data (post-test) unless otherwise specified.

McNemar's test and the Freeman-Halton extension of the Fisher's exact test were used to analyze the categorical data from the MNA-SF and NSI screening tools, to determine if more participants improved nutritional risk level categories using one tool over the other, and to determine if the number of participants in each nutritional risk category significantly changed following intervention (2). An odds ratio was also calculated to determine if more participants improved according to one tool over the other. To compare pre-test and post-test continuous data (i.e., caloric intake, protein intake, HEI score, and nutritional risk scores), paired t-tests were performed. Independent samples t-tests were used to determine if changes in dietary variables (i.e., caloric and protein intake, and HEI score) after receiving MOWAM services were associated with improvements in nutritional risk level (indicated by NSI and MNA-SF scores). Differences in intake and nutritional risk levels before and after starting MOWAM services were used for the independent samples t-tests. For all tests, a p-value of <0.05 was considered to be significant.

Table 6. Dependent and Independent Variables, by Objective.			
	Independent variable(s)	**Dependent variable(s) - continuous**	**Dependent variable(s) - categorical**
Primary objectives	• MOWAM meal services	• **NSI score** • **MNA-SF score** • **Caloric intake** • **Protein intake** • Intake of each nutrient of concern: calcium, vitamin D, zinc, vitamin B12 • Intake of each additional nutrient: beta-carotene, thiamin, vitamin B6, vitamin C, vitamin E, folate, iron, magnesium, phosphorus, and fiber • **Composite HEI score** and score of all HEI components	• **NSI nutritional risk category** • **MNA-SF nutritional risk category**
Secondary objectives	• MOWAM meal services • For validation: MNA-SF score (continuous) • For validation: MNA-SF nutritional risk category (categorical)	• Self-MNA score • Participant-measured calf-circumference (number) • Researcher-measured calf-circumference (number) • All dietary intake and HEI variables listed under primary objectives	• **Self-MNA nutritional risk category** • **Participant-measured calf-circumference score** • **Researcher-measured calf-circumference score**

For the specific aims of the first secondary objective, sensitivity, specificity, false positive rate, and false-negative rate were not able to be calculated because of the small sample of individuals with usable Self-MNA scores. Calf-circumference scores taken by participants (in the Self-MNA) and researchers (in the MNA-SF) were compared using descriptive data, to examine the percentage of scores that matched or did not match. For the specific aims of the second secondary objectives, descriptive data were compiled to quantify the number and percentage of participants who 1) completed each question, 2) perceived each question as difficult, 3) did not correctly add in each question that required addition, 4) did not measure their calf circumference using the correct method, and 5) did not measure their calf circumference using the correct units.

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3. NUTRITIONAL RISK SCREENING AND DIETARY INTAKE AMONG HOME-DELIVERED MEAL PARTICIPANTS [1]

Introduction

The United States is in the midst of a demographic shift toward an aged population, with the proportion of individuals age 65 and above expected to rise from 13% (40.2 million) as of 2010 to nearly 20% (72.1 million) by 2030 (1). This growth has spurred demand for age-related social services, such as those provided by home-delivered meal (HDM) programs. Legislated under Title III-C of the Older Americans Act (OAA), HDM programs provide eligible homebound older adults with at least five meals a week, each of which supplies at minimum one third of the Recommended Daily Allowance of nutrients (2). In 2012 alone, over 137 million meals were delivered to over 850,000 individuals nationwide by these programs (2, 3). Research examining HDM recipients has consistently supported that they represent a uniquely vulnerable group within the older adult population, as evidenced by high levels of nutritional risk, high levels of poverty and food insecurity, and an a high prevalence of many risk factors associated with institutionalization (4-6). Yet, federal Title III-C funding of HDM programs has stagnated in recent years, forcing HDM providers to become increasingly reliant on alternate funding sources (7). Because of these funding difficulties, many HDM providers have struggled to sustain or grow their current level of services and often report being forced to wait-list individuals eligible for services (7).

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Given the rise in wait-listing, it is essential to ensure that HDM services reach individuals with the greatest need. Current Title III-C funding requirements dictate that HDM applicants be comprehensively screened to determine their level of need from a social, functional, and nutritional perspective (2). The primary screening tool used to assess nutritional need is the DETERMINE Your Nutritional Health Nutrition Screening Initiative (NSI) checklist, which categorizes individuals into one of three nutritional risk categories based on a composite score: "high nutritional risk" (score of 6 and above), "moderate nutritional risk" (score of 3-5) or "good" (score of 0-2) (8). Despite its widespread use as a screening tool, the NSI checklist was originally developed to serve as an educational and awareness tool, and several problems have been noted with using it for screening purposes (9, 10). For example, it appears to demonstrate low sensitivity and specificity relative to other validated nutrition assessment tools, and to over-identify high nutritional risk (10-12). Research also suggests the NSI correlates poorly with dietary indicators (9, 13). In light of these issues, other nutritional risk screening tools should be evaluated as potential replacements for the NSI checklist.

One candidate for replacing the NSI checklist is the Mini Nutritional Assessment-Short Form (MNA®-SF), a 6-question tool that was specifically developed for screening purposes. Similar to the NSI, the MNA®-SF categorizes individuals into three possible nutritional risk categories, each associated with specific composite scores: "malnourished" (0-7 points), "at risk of malnutrition" (8-11 points), or "normal nutritional status" (12-14 points) (14). Unlike the NSI, the MNA®-SF has been validated against diverse nutritional and functional indicators, and has been shown to predict important outcomes like mortality and hospitalization (15-18). Because it demonstrates high sensitivity and specificity relative to “gold standard” nutrition assessment methods, such as the full-length Mini Nutritional Assessment, the MNA®-SF would be expected to outperform the NSI as a screening tool, although the two have not been directly compared among homebound elderly (14, 19, 20). Thus, the MNA®-SF may provide more useful data to HDM providers to assist with service allocation.

The lack of funding growth for HDM services also highlights the need to provide outcomes-based evaluations detailing their impact (21). Several recent analyses have focused on the apparent cost effectiveness of HDM programs, suggesting that they allow individuals to “age in place” and thus defer the costs associated with long-term care (22, 23). Yet, despite the expected nutritional benefits of HDM programs, relatively few studies have examined how they impact the diet of meal recipients. Zhu et al. recently conducted a systematic review on the nutritional outcomes of HDM programs and found only eight such studies (24). Most of these support that provision of HDM has a positive impact on diet, as demonstrated by outcomes such as increased nutrient intake, improved diet regularity, and better diet quality, but results were inconsistent across the studies examined. Whether HDM services influence caloric and protein intake, in particular, remains unresolved.

This study sought to examine nutritional risk screening and dietary intake among HDM recipients to promote informed service allocation and to better quantify the nutritional outcomes of HDM service use. Specifically, we sought to determine: 1) whether the MNA®-SF demonstrated a greater ability to separate HDM clients by their nutritional risk level than the NSI; and 2) how HDM services affect nutritional risk level, dietary intake, and diet quality. We hypothesized that more individuals would fall into higher nutritional risk categories on the NSI than on the MNA®-SF before they began receiving HDM services, and that after receiving meals for 3 months, more individuals would improve their nutritional risk category using the MNA®-SF than the NSI. We also hypothesized that nutritional risk level, dietary intake (specifically, caloric and protein intake), and diet quality would improve following HDM service use. Finally, we hypothesized that improved scores on the MNA®-SF, but not the NSI, would be associated with increased caloric and protein intake after 3 months of HDM services.

Materials and Methods

Study Design

This research builds upon a pilot study conducted in 2012 (25). In both the pilot study and the current study, a pre-test/ post-test design was used to assess HDM recipients before and 3-months after they began receiving HDM services. All procedures described were approved by the Texas State University Institutional Review Board and the participating HDM provider.

Sample

Study participants were clients of Meals on Wheels and More (MOWAM), a HDM provider located in Austin, TX. Recruitment took place during routine MOWAM service enrollment visits conducted between November 2013 and May 2014. With permission from individuals meeting the study eligibility criteria, researchers accompanied MOWAM caseworkers on these visits, and invited individuals to join the study after they officially became MOWAM clients. Informed consent was obtained from those who agreed to participate.

Individuals were eligible for the study if they were: 1) enrolled to receive 5 home-delivered meals a week; 2) free from cognitive impairment; 3) at least 65 years of age (required for the MNA®-SF); and 4) able to speak English (required for the dietary assessment instrument). Cognitive impairment was defined as either diagnosed dementia, or the presence of severe memory problems as determined via self-report or via caregivers or family members.

We aimed to recruit up to 150 participants for the study, but only 55 participants were enrolled, and 23 participants dropped out prior to completing a post-test visit. Reasons for participant drop-out included changes in health status (n=8), cessation of meal services prior to post-test data collection (n=5), no longer wishing to take part in the study (n=4), inability to contact participants after repeated attempts (n=4), and unreliable dietary assessment (e.g., participants displayed memory problems during assessment, despite initial screening; n=2). In addition, 4 participants did not have usable dietary data (1 participant was severely ill prior to enrolling in HDM services and had unusually low dietary intake; 1 participant developed memory problems between pre-test and post-test dietary assessment; and 2 participants were unable to complete the post-test dietary assessment in a single visit and could not be reached to schedule a second visit), and 1 participant was a double amputee, and was not eligible to complete anthropometric assessment questions on the MNA®-SF. Because participant drop-out ultimately resulted in a small sample size, data from the current study was pooled with pilot study data (N=40) to yield a combined sample. Final sample sizes for the current study, the pilot study, and the combined sample are summarized in Figure 2.

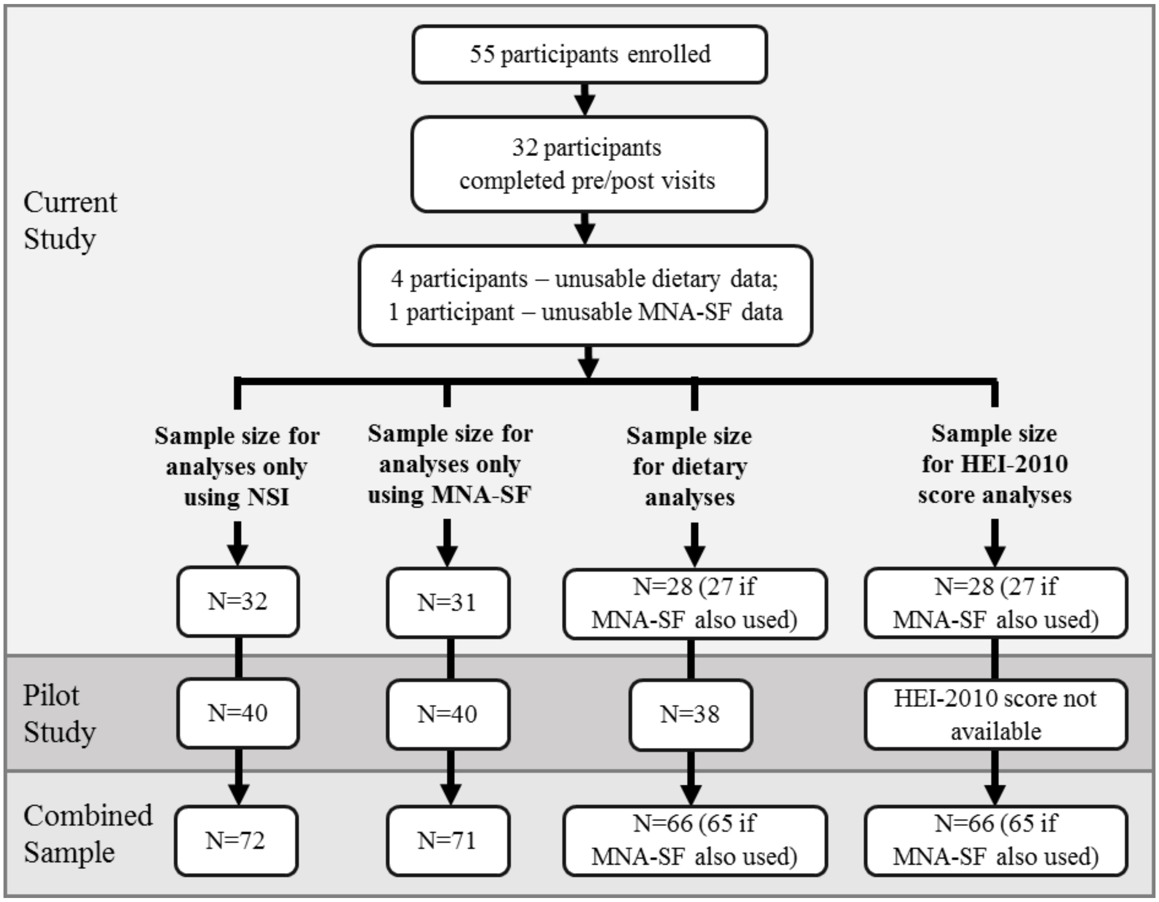

Figure 2. Overview of Recruitment and Final Sample Size for Current and Pilot Studies.

Research Protocol and Instruments

Following informed consent, demographic information and self-reported height and weight were obtained from participants. Researchers then administered both the NSI and the MNA®-SF. To avoid participant fatigue due to the length of HDM enrollment visits, another home visit was scheduled to complete pre-test data collection. During the second visit, dietary assessment was conducted using the “past month” Web-based Diet History Questionnaire (DHQ), a free web-based version of the DHQ food frequency questionnaire developed by the National Cancer Institute (NCI) (26). This questionnaire assesses the frequency and serving sizes of items consumed in the past month from a list of approximately 157 foods and supplements. Prior paper-based versions of the DHQ have been validated against 24-hour recalls and nutritional biomarkers among a sample that included older adults (27). In the pilot study, the 92 question paper-based Block Brief 2000 Food Frequency Questionnaire was used instead of the DHQ; the Block questionnaire could not be repeated in the current study due to budgetary constraints.

After participants had been receiving HDM services from MOWAM for approximately 3 months, a home visit was scheduled to collect post-test data. The NSI, MNA®-SF, and DHQ were completed during this visit.

Once data collection was complete, data from the DHQ was analyzed using the NCI's Diet*Calc software (version 1.5.0, released in 2012). This software provides detailed intake data for a variety of nutrients and foods groups, including calories and protein. Output from Diet*Calc was also used to calculate the Healthy Eating Index (HEI)-2010 score, which quantifies a diet's quality by examining its adherence to the 2010 Dietary Guidelines for Americans. The HEI-2010 score represents a composite measure of 12 component scores, each of which rates the intake of a specific food group or nutrient by its adequacy or excessiveness (28). Possible HEI-2010 scores range from 0 to 100, with 100 representing the highest quality diet. Although the HEI-2010 score was only recently developed and validated, earlier versions (i.e., the HEI-2005 score) have been used frequently in studies examining the diets of older adults (29). HEI-2010 scores were calculated using the criteria published by Guenther et al. (28).

Data Analysis

For all analyses except those involving HEI-2010 scores, testing was conducted separately on both the sample from the current study and the combined sample. This method of analysis was chosen to account for the differences in timing and dietary assessment instrument used between the current and pilot studies. The HEI-2010 score could not be calculated from pilot study dietary data, and thus was only available for participants in the current study with complete dietary data.

All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS, version 22.0, 2013). McNemar's test (30) with continuity correction was used to determine if pre-post improvements changes in nutritional risk category as measured by the MNA®-SF and NSI were in agreement. Odds ratios were calculated to determine if more participants improved nutritional risk category using the MNA®-SF compared to the NSI. Pre-test and post-test nutritional risk categories on each the MNA®-SF and NSI were compared using the Freeman-Halton extension of the Fisher's exact test, and mean numerical scores on each tool were compared using paired t-tests or, for non-normally distributed data, Wilcoxon signed-rank tests. To examine the nutritional outcomes of HDM services, pre-test/ post-test caloric and protein intake and pre-test/ post-test HEI-2010 scores were compared using paired t-tests. Paired t-tests were also used to determine whether improvements in nutritional risk category using either the MNA®-SF or NSI were related to changes in caloric intake, protein intake, or HEI score. For all analyses, improvements in nutritional risk category were defined as moving to a lower risk category, or maintaining a status classified as "normal" or "good" from pre-to-post. Significance was set at $p<0.05$ for all tests.

Table 7. Demographic Characteristics of Study Participants

	Current study (N=32)		Combined sample (N=72)	
	n	**%**	***n***	**%**
Gender				
Male	14	43.8	23	31.9
Female	19	56.3	49	68.1
Age				
65-74	12	37.5	31	43.1
75-84	13	40.6	33	45.8
85-94	6	18.9	6	8.3
95-100	1	3.1	2	2.8
Ethnicity				
White	19	59.4	35	48.6
Hispanic	3	9.4	11	15.3
Black/ African American	10	31.3	25	34.7
Native American	0	-	1	1.4

Results

Demographic information for the current combined samples is displayed in Table 7. In both samples, study participants were primarily female, under age 85, and either white/ Caucasian or black/ African American.

Comparison of the MNA®-SF and NSI

McNemar's test indicates that the proportion of participants who improved or did not improve their nutritional risk category did not vary between the MNA®-SF and the NSI checklist in the current study (p=0.267). In the combined sample, the MNA®-SF was more likely to indicate that a participant improved category when the NSI checklist did not indicate improvement, than vice versa (p=0.001; see Table 8). Similarly, in the combined sample, the odds of improving category on the MNA®-SF were almost 3 times greater than the odds of improving on the NSI checklist (OR [95%CI]= 2.98 [1.48,6.01]), although there was no difference in these odds in the current sample.

Table 8. Comparison of Pre-Post Improvements in Nutritional Risk Categories using the MNA-SF vs. NSI.

		MNA-SF				
Current study (N=31)		Category improved[A]	Category did not improve	Row total	**p-value**	**OR (95% CI)[B]**
NSI	Category improved	8 (25.8)	4 (12.9)	12 (38.7)	0.267	1.92 (0.70,5.29)
	Category did not improve	9 (29.0)	10 (32.3)	19 (61.3)		
	Column total	17 (54.8)	14 (45.2)	31 (100)		
Combined sample (N=71)						
NSI	Category improved	13 (18.3)	6 (8.5)	19 (26.8)	0.001*	2.98 (1.48,6.01)
	Category did not improve	24 (33.8)	28 (39.4)	52 (73.2)		
	Column total	37 (52.1)	34 (47.9)	71 (100)		

A=data are displayed as n (%)
B=OR indicated odds of improving on the MNA-SF compared to odds of improving on the NSI
*indicates significance

Table 9. Pre-Post Differences in Nutritional Risk Categories for the MNA-SF and NSI.

	Current study			**Combined sample**		
Category	**Pre[A]**	**Post**	**p-value**	**Pre**	**Post**	**p-value**
MNA-SF						
Malnourished	12 (38.7)	3 (9.7)	0.031*	22 (31.0)	6 (8.4)	0.001*
At risk of malnutrition	11 (35.5)	15 (48.4)		30 (42.3)	33 (46.5)	
Normal nutrition status	8 (25.8)	13 (41.9)		19 (26.8)	32 (45.1)	
Total (N)	31 (100)	31 (100)		71 (100)	71 (100)	
NSI						
High nutritional risk	23 (71.9)	16 (50.0)	0.241	54 (75.0)	44 (61.1)	0.104
Moderate nutritional risk	8 (25.0)	13 (40.6)		17 (23.6)	23 (31.9)	
Good	1 (3.1)	3 (9.4)		1 (1.4)	5 (6.9)	
Total (N)	32 (100)	32 (100)		72 (100)	72 (100)	

A=data are displayed as n (%)
*indicates significance

Comparison of Pre-test and Post-test Data

As shown in Table 9, the number of individuals characterized as “malnourished” or at “high nutritional risk” decreased from pre-to-post for both the current and combined samples and for both screening tools, while the number of individuals with a “good” or “normal” nutrition status increased. However, pre-post differences in nutritional risk categories were only significant for the MNA®-SF ($p=0.031$ for the current sample; $p=0.001$ for the combined sample). In both the current study and the combined sample, numerical scores significantly increased on the MNA®-SF ($p=0.008$ for the current study; $p<0.001$ for the combined sample) and significantly decreased on the NSI from pre-to-post ($p=0.014$ for the current study; $p=0.007$ for the combined sample; see Table 4). Both of these changes in score are indicative of decreased nutritional risk after receiving HDM services.

Pre-test and post-test caloric and protein intake scores were not significantly different in either sample, although protein intake showed a trend toward improvement in the current sample only ($p=0.091$ for change in protein intake; see Table 10). HEI-2010 scores also showed a trend toward improvement in the current sample, but did not vary from pre-to-post ($p=0.096$). Changes in dietary intake and HEI-2010 scores were not significantly related to improvements in nutritional risk category for either the MNA®-SF or NSI (see Table 11).

Discussion

Comparison of the MNA®-SF and the NSI checklist suggests that they perform differently, despite being intended to measure the same underlying concept. Variations

Table 10. Pre-Post Differences in Nutritional Risk Scores and Dietary Variables.

	Current study						Combined sample					
		Pre		Post				Pre		Post		
	N	*Mean*	*SD*	*Mean*	*SD*	**p-value**	**N**	*Mean*	*SD*	*Mean*	*SD*	**p-value**
Nutritional risk score												
MNA-SF	31	8.9	3.1	10.9	2.1	0.008[A]*	71	8.7	3.1	10.9	2.1	<0.001[A]*
NSI	32	8.3	4.1	6.3	3.4	0.014*	72	8.5	3.7	7.2	3.6	0.007[A]*
Dietary intake												
Kcalories	28	1426.4	578.2	1531.6	708.1	0.424	66	1533.9	687.5	1562.8	624.9	0.733
Protein (g)	28	52.9	25.4	60.1	29.8	0.091[†]	66	61.5	25.8	58.8	23.4	0.346
HEI-2010 score	28	62.1	12.7	65.6	12.6	0.096[†]	N/A	N/A	N/A	N/A	N/A	N/A

A=difference in means was not normally distributed. Means compared using Wilcoxon signed-rank test in place of paired t-test.

*indicates significance

[†] indicates trend toward significance

Table 11. Relationship between Changes in Nutritional Risk Level and Changes in Dietary Variables.

	Category improved			Category did not improve			
Screening tool	***n* (%)**	**Mean difference**	**SD**	***n* (%)**	**Mean difference**	**SD**	**p-value**
MNA-SF							
Current study (N=27)	15 (55.6)			12 (44.4)			
Kcalories		164.3	731.5		-5.5	659.0	0.537
Protein (g)		11.4	23.6		1.0	19.6	0.235
HEI score		6.0	12.0		-0.7	7.6	0.101
Combined sample (N=65)	34 (52.3)			31 (47.7)			
Kcalories		54.1	606.0		-138.4	761.9	0.262
Protein (g)		5.8	22.3		-1.1	24.6	0.239
NSI							
Current study (N=28)	9 (32.1)			19 (67.9)			
Kcalories		313.1	614.0		6.6	709.9	0.277
Protein (g)		10.2	17.6		5.8	23.9	0.627
HEI score		4.9	14.3		2.8	8.8	0.637
Combined sample (N=66)	16 (24.2)			50 (75.8)			
Kcalories		128.3	547.5		-79.2	720.7	0.295
Protein (g)		4.9	15.4		2.1	25.5	0.678

between the tools in nutritional risk categorization are evident both before and after provision of meal services, and appear to be amplified after HDM intervention. For example, while data from the combined sample shows that the NSI was over twice as likely as the MNA®-SF to characterize participants in the highest nutritional risk category at pre-test, it was more than seven times as likely to do so at post-test. Such variations are reflected in the finding that pre-test nutritional risk categories were different from post-test categories using the MNA®-SF but not the NSI. Given these discrepancies, it is perhaps not surprising that the tools did not agree in their assessment of pre-to-post category improvements.

These results could indicate that the MNA®-SF is more responsive to nutrition intervention than the NSI, but the fact that improvements in nutritional risk category were not related to improvements in caloric intake, protein intake, or HEI-2010 score for *either* tool contradicts this idea. More likely, the discrepancies in nutritional risk categorization between the tools are a result of the NSI's tendency to over-classify high nutritional risk (10,12). Because a "gold standard" nutrition assessment method was not used to objectively gauge the performance of each tool, however, it remains possible that the differences between the tools may stem from the MNA®-SF under-classifying risk. This explanation seems less likely, given that the MNA®-SF has been validated across a range of settings, including community and institutional settings (20).

The variable performances of the MNA®-SF and NSI confirm the need to evaluate whether the NSI is a useful screening tool for HDM providers. Other researchers have suggested that the NSI should only be used as a nutrition education and awareness tool as per its original purpose, and our results seem to support this claim (31). By classifying approximately three-quarters of participants as having high nutritional risk when they enrolled in meals at pre-test, the NSI does not provide a practical means of stratifying applicants by their level of need. Because the MNA®-SF grouped study participants into the possible nutritional risk categories more evenly, the information it provides may be of greater practical use to HDM providers.

Although other studies examining HDM services have examined their impact on diet quality, to our knowledge, this is the first study quantify improvements in diet quality using the HEI-2010 score. Because meals provided by HDM programs are mandated to be nutrient dense, the HEI-2010 score represents a logical tool for examining the nutritional outcomes associated with HDM. The potential value of using HEI-2010 score in such a capacity is highlighted by the observed trend toward increased pre-to-post HEI-2010 score, but a larger sample is needed to confirm this trend.

Protein and caloric intake did not appear to change following the provision of HDM services. Other studies examining the impact of HDM on caloric and protein intake have also been mixed, with some reporting that intake increases after provision of meals, and others reporting no effect (32, 33). The lack of change observed in this study may be due to the wide inter-individual variation in dietary intake, as evidenced by the large standard deviations for dietary variables. Nonetheless, it is promising that there was a trend toward increased protein intake in the current sample, even though this trend was not observed in the combined sample. Any changes in dietary intake in the combined sample may have been obscured by the different dietary assessment methods used in the pilot and current studies. Thus, a larger sample using a uniform method of dietary assessment may have revealed significant changes, although this needs to be examined through future research.

The lack of dietary changes observed in the current study reflects some of the challenges involved with evaluating the nutritional impact of HDM programs. Few methods of dietary assessment have been specifically validated among the elderly, and even fewer are practical to use in a community nutrition setting. There is a strong precedent for using multiple 24-hour recalls to assess the diets of HDM participants (e.g., 4), but the time and labor resources required to conduct recalls may limit their use and they appear to underestimate nutrient intake (34). Their use of open-ended questions that rely on short-term memory may also pose a problem among the elderly (35). Ultimately, we used a food frequency questionnaire in this study given that these do not rely exclusively on short-term memory, and can be administered in a single visit (36). However, like 24-hour recalls, food frequency questionnaires underestimate nutrient intake (35).

Because of the unique health status and living situation of each HDM client, it may also be difficult to control for the many factors besides meal service that could promote or hinder positive nutritional outcomes (37). The high attrition rate of the current study is a testament to the dynamic nature and overall poor health of HDM clients, as almost 15% of the participants originally enrolled in the research had a change in health status between pre-test and post-test that resulted in them dropping from the study. Interestingly, researchers observed that participants in the current sample, as a group, seemed to be in poorer health than participants in the pilot sample despite less than a two year time lapse between studies. What may have caused this relative decline in general health is unclear, though it is possible that individuals are waiting longer to apply for HDM services than in the past, resulting in a poorer status at the time of application.

This research is subject to several limitations, most notably the small sample size and the difference in dietary assessment methods between the current and pilot studies. The high attrition rate represents another limitation, as it is possible that participants who dropped out differed from participants who completed the study. However, the fact that many participants had to drop from the study due to health and other issues arguably represents an interesting finding.

Measuring the nutritional outcomes of HDM services remains an important goal to ensure that HDM programs are able to maintain or increase their current levels of funding. While the results of this study are inconclusive regarding the nutritional impact of HDM services, they do provide direction for future research. Specifically, HEI-2010 score may be a useful outcome measure for characterizing the impact of HDM. Regarding nutritional risk screening, this study suggests that the MNA®-SF may be a more appropriate screening tool for HDM providers compared to the NSI. Research comparing the performance of these tools to an objective, standardized nutrition assessment method is needed to confirm our results.

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4. USABILITY OF THE SELF-MINI NUTRITIONAL ASSESSMENT AMONG ELDERLY HOME-DELIVERED MEAL RECIPIENTS[2]

Introduction

The elderly population in the United States (age 65 and above) is currently growing at a faster rate than the population as a whole, with growth rates expected to further increase over the coming decades (Werner, 2010). In light of this demographic shift, the healthcare system and social service programs are faced with a dramatic rise in demand for services accompanied by an increase in healthcare spending. One way to promote healthy aging, and thus help mitigate this demand, is to encourage the use of preventive care services, which seek to address potential health conditions prior to their onset or progression (Moyer, LeFevre, & Siu, 2013). Malnutrition represents one of the main conditions affecting older adults that can be addressed proactively through preventive care. If older adults are not aware of their need for nutritional intervention, however, they may fail to seek out nutrition services until symptoms emerge (Kane, Talley, Shamliyan, & Pacala, 2011). Encouraging older adults at risk of malnutrition to seek preventive care thus represents an important goal. The purpose of this research was to determine the efficacy and ease of use of a nutrition self-screening tool designed for older adults.

[2] This chapter will be submitted to the *Family and Consumer Sciences Research Journal* for potential publication. Its style is formatted to match the requirements for this journal, which uses APA 6th edition formatting.

Review of Literature

Nutritional Risk Self-Screening Tools

Using screening methods to determine whether an older adult is malnourished or at risk of malnutrition is often referred to as assessing their "nutritional risk level." In part because of the heterogeneity of the older adult population, there are few validated screening tools for assessing nutritional risk among the elderly. Of the available validated tools, many are designed for use by healthcare professionals and oriented toward a clinical setting. Only two instruments, the Nutrition Screening Initiative DETERMINE Checklist (NSI) and the Seniors in the Community: Risk Evaluation for Eating and Nutrition (SCREEN©) tools, have been validated as nutritional risk self-screening tools for use in a community setting (Posner, Jette, Smith, & Miller, 1993; Keller, Hedley, & Brownlee, 2000; Keller, McKenzie, & Goy, 2001; Keller, Goy, & Kane, 2005). However, application of the NSI outside of the primarily white, non-institutionalized individuals initially used to develop and validate the tool suggests that it demonstrates low sensitivity and specificity, and tends to over-classify individuals as being at "high nutritional risk" (Coulston, Craig, & Voss, 1996; Charlton, Kolbe-Alexander, & Nel, 2007; Sinnet et al., 2010). Additional research examining the efficacy of the NSI suggests that it lacks reliability (Sinnet et al., 2010). The original SCREEN© tool and its current iteration, the SCREEN© II, are also subject to limitations as self-screening tools since many elderly are unable to complete these tools without assistance (Keller et al., 2001; Keller et al., 2005). Given the shortcomings of both the NSI and the SCREEN© tools, the need for a practical, universally accessible nutritional risk self-screening tool for older adults remains unmet.

The Self-Mini Nutritional Assessment® (Self-MNA®)

A new nutritional risk self-screening tool that could potentially meet this need was developed in 2012 by Nestlé Nutrition Institute. Known as the Self-MNA®, this tool is modeled after a well-validated nutritional risk screening tool designed for use by healthcare professionals, called the Mini Nutritional Assessment® - Short Form (MNA®-SF) (Nestlé Nutrition Institute, 2012). The Self-MNA® consists of 5 questions that assess dietary intake, weight loss, functional status, stress and illness, and cognitive/ mental status, and a sixth question that involves anthropometric assessment (see Figure 1). For the anthropometric assessment question, individuals can choose to either find their height and weight and an associated "group number" in a chart, as a surrogate measure of body mass index, or measure their calf circumference. Each question on the tool has a unique scoring system, and scores for individual questions are added when the tool is completed to yield a total nutritional risk score. This "screening score" places individuals into one of three possible nutritional risk categories: "malnourished" (total score 0-7), "at risk of malnutrition" (total score 8-11), or "normal nutrition status" (total score 12-14). Individuals who receive scores of 11 or less are advised to seek consultation with a healthcare professional to discuss their results. Through this call to action, the tool seeks to increase the use of preventative care services and timely nutritional intervention.

The only published research examining the Self-MNA® to date suggests that it is a highly sensitive and specific indicator of nutritional risk compared to the MNA®-SF, but this research was restricted to a sample of self-selected individuals recruited from market research facilities and newspaper ads (Huhmann, Perez, Alexander, & Thomas, 2013). Because this sample may not be reflective of the general elderly population, these results need to be replicated among diverse groups of older adults. Additionally, information on the ease of use of the Self-MNA® is needed to ensure that the tool can be completed by older adults and their caregivers without additional assistance. The goals of this research were to examine the efficacy of the Self-MNA® by determining 1) its performance compared to the MNA®-SF, and 2) the completion rates, perceived difficulty, and ability of users to follow instructions for each of the tool's questions. This research was conducted as part of a larger study examining diet and nutritional risk among homebound older adults receiving home-delivered meals.

Methodology

Participants

Following approval from the Institutional Review Board at Texas State University, participants were recruited from Meals on Wheels and More (MOWAM), a home-delivered meal provider located in Austin, TX. Recruitment took place in two steps. First, MOWAM caseworkers obtained permission from individuals applying for meal services to have a trained researcher accompany them during a routine MOWAM service enrollment visit conducted at the applicant's home. During these visits, researchers discussed the study with newly enrolled MOWAM clients who met the research eligibility criteria, and provided these individuals with written information detailing the purpose, risks, and benefits of the study. Written informed consent was obtained from individuals who agreed to participate.

Specific criteria used to determine research eligibility included: (a) being at least 65 years of age; (b) being enrolled to receive home-delivered meal services for 5 days a week; (c) absence of cognitive impairment that might interfere with data collection; and (d) ability to speak English (required for another assessment used in the study). The presence of cognitive impairment was assessed by MOWAM staff when individuals applied for meal services. An individual was considered cognitively impaired if he or she had received a diagnosis of Alzheimer’s disease or another form of dementia, or was affected by severe memory problems, determined via self-report from the client, the client’s caregiver, or a family member of the client.

Study Protocol

Following consent to join the study, demographic information was collected, and participants were assessed by researchers using the MNA®-SF. Because of the length of the MOWAM service enrollment visits, a second home visit was scheduled within the next four business days to complete the Self-MNA® and other study assessments. Completing the MNA®-SF and Self-MNA® in two separate visits also provided a time lapse between the two instruments to avoid carry-over effects, given that the questions on the two screeners are similar.

During the second home visit, participants were provided with a tape measure and asked to complete the Self-MNA®. Caregivers or family members, if present, were allowed to assist participants with the tool. No instructions on how to complete the tool were provided, in order to best simulate the circumstances of its intended use. After participants finished the assessment, researchers reviewed the tool and recorded on a separate sheet which questions, if any, were left blank or answered incorrectly (e.g., if a client added numbers incorrectly). Researchers then highlighted any blank questions and asked participants to attempt these a second time. In order to assess the overall nutritional risk scores obtained using the two possible anthropometric assessment questions, participants were also asked to complete both options for the sixth question at this time if they had not already done so. After participants completed this second attempt, researchers again recorded any blank or incorrectly answered questions, and then asked participants whether they found any questions difficult and if so, why.

Data Analysis

Because few participants were ultimately able to complete the Self-MNA®, sensitivity and specificity as compared to the MNA-SF® could not be calculated. Data analysis was thus limited to determining the frequency and percentage of subjects who (a) completed each question; (b) correctly followed instructions for each question; and (c) reported difficulty for each question. The frequency and percentage of participant-measured calf circumference scores from the Self-MNA® that agreed with researcher-measured calf circumference scores from the MNA®-SF were also determined.

Results

In total, 55 individuals were enrolled in the study. Six individuals dropped out of the study between enrollment and the second visit, resulting in a final sample size of 49 participants. Reasons for participant dropout included changes in participant health status after enrollment (n=2), inability to contact participants for scheduled visits (n=2), and participants no longer wishing to take part in the research (n=2). The average age of

Table 12. Demographic Characteristics (N=49).

	n	%
Gender		
Male	20	40.8
Female	29	59.2
Age		
65-74	24	49.0
75-84	18	36.7
85-94	6	12.2
95-100	1	2.0
Ethnicity		
White / Caucasian	28	57.1
Black/ African American	15	30.6
Hispanic	6	12.2

participants in the final sample was 75.7 ± 7.3 years, and the majority of participants were female and white/ Caucasian (see Table 12).

Completion rates and rates of self-reported difficulty for each question are displayed in Table 13. The number and percentage of participants who followed instructions correctly (e.g., addition or measurement) are displayed in Table 14.

Out of the 21 participants who recorded a calf-circumference measurement score on the Self-MNA®, 11 (52.4%) recorded scores that agreed with researcher-measured scores from the MNA®-SF, 5 (23.8%) recorded scores that did not agree with researcher scores, and 5 (23.8%) recorded numbers other than “0” or “3” for their scores. Overall, only 30 (61.2%) of the 49 participants completed the tool using an anthropometric assessment question and recorded at least one usable screening score (i.e., a score within the possible scoring range [0-14] of the tool). Of these 30, only 21 (42.8% of the whole sample) recorded screening scores that were accurate based on the information they provided on the form.

Table 13. Completion and Self-Reported Difficulty of the Self-MNA® (*N*=49).

Question ID	Total N for item[a]	n (%)
Question A		
Completed 1st attempt[b]	48	42 (87.5)
Completed 2nd attempt[b]	49	46 (91.8)
Difficulty	47	7 (14.9)
Question B		
Completed 1st attempt	48	44 (91.7)
Completed 2nd attempt	49	46 (93.9)
Difficulty	48	6 (12.5)
Question C		
Completed 1st attempt	48	41 (85.4)
Completed 2nd attempt	49	45 (91.8)
Difficulty	47	7 (14.9)
Question D		
Completed 1st attempt	48	44 (91.7)
Completed 2nd attempt	49	47 (95.9)
Difficulty	47	4 (8.5)
Question E		
Completed 1st attempt	48	42 (87.5)
Completed 2nd attempt	49	45 (91.8)
Difficulty	47	10 (21.3)
Question F1[c]		
Completed 1st attempt	46	25 (54.3)
Completed 2nd attempt	47	29 (61.7)
Difficulty	46	29 (63.0)
Question F2[d]		
Completed 1st attempt	46	14 (30.4)
Completed 2nd attempt	46	22 (47.8)
Difficulty	44	31 (70.5)
Bottom screening score[e]		
Completed 1st attempt	46	14 (40.4)
Completed 2nd attempt	47	20 (42.6)
Difficulty	45	29 (64.4)

[a]sample sizes vary slightly because the assessments detailing when participants completed a question (i.e., during their first or second attempt of the tool) and whether questions were perceived as difficult were added shortly after the study was underway

[b]1st attempt indicates initial exposure to the tool; 2nd attempt refers to attempt after tool was returned with blank questions highlighted

[c]n=2 participants were not eligible to complete question F1; one was a double amputee, and the height of the second was not listed on the tool

[d]n=3 participants were not eligible to complete question F2; one was a double amputee, and the other two did not have access to a tape measure during the visit due to researcher error

[e]sample size for question is smaller due to the participants who were not eligible for anthropometric assessment questions, and could not calculate a final screening score

Table 14. Ability of Participants to Follow Self-MNA® Instructions (*N*=49).

Item	Possible N for item[1]	Followed instructions (%)
Front Page		
Questions A-E		
Added scores for questions A-E correctly	42	36 (85.7)
Back Page		
"CHOOSE ONE of the following two questions – F1 or F2 – to answer"		
Picked only F1 on 1st attempt	47[b]	15 (31.9)
Picked only F2 on 1st attempt	47[b]	4 (8.5)
Picked both F1 and F2 1st attempt	47[b]	11 (23.4)
Left both F1 and F2 blank 1st attempt	47[b]	17 (36.2)
Question F1 (height and weight chart)		
"Usable" screening score from question F1[c]	26	24 (92.3)
"Correct" screening score from question F1[d]	26	17 (65.4)
Question F2 (calf circumference measurement)		
Performed measurement using correct technique	22[e]	9 (40.9)
Performed measurement using proper units (i.e., cm)	24	10 (41.7)
Chose correct score based on measurement	21	12 (57.1)
"Usable" screening score from question F2	18	16 (88.9)
"Correct" screening score from question F2	18	8 (44.4)
Bottom screening score		
Screening scores answered using question F1 vs. F2 matched	14[f]	5 (35.7)
Nutritional risk category answered using question F1 vs. F2 matched	14[f]	7 (50)
"Usable" bottom screening score	20	19 (95)
"Correct" bottom screening score	20	9 (45)

Discussion

The widespread inability of study participants to appropriately complete the Self-MNA® was an unexpected outcome, given that it performed well in prior research (i.e., Huhmann et al., 2013). This finding is likely due to the differences in sample characteristics between this study and the Huhmann et al. (2013) study. Home-delivered meal recipients are known to have more functional limitations, more memory-related diseases, and poorer overall health relative to the general older adult population (Barrett & Schimmel, 2010). These differences could make the Self-MNA® more challenging for this population, although participants were screened for cognitive impairment as part of the research eligibility criteria. Notably, however, Nestlé Nutrition Institute currently recommends the tool for use by any older adult age 65 and above, which should include home-delivered meal recipients.

Based on feedback from the participants and observations made by the researchers, the primary barriers hindering completion of the tool were unclear terminology (e.g., not understanding what “dementia” in question E meant), unclear instructions, and physical limitations (e.g., some participants could not bend over to measure their calf for question F2). At least three participants also explicitly reported reading difficulties with the tool’s small font size. Surprisingly, and in spite of the limited sample size, two participants were unable to complete the tool because specific questions did not apply to them (e.g., one participant was a double amputee, and another was taller than all of the heights given on the height/ weight chart).

Completion rates were especially low and reported difficulty rates especially high for the two anthropometric assessment questions on the back of the form. The inability to complete either of these questions ultimately prevented many participants from obtaining a final screening score. When asked what they found difficult about question F1, participants indicated that they did not understand how to use the height/weight chart provided on the tool. In part, this appears to be a result of many participants failing to read the instructions provided beside the chart prior to attempting to use it. Even upon reading these instructions, however, participants often seemed uncertain about what constituted the “group number” (located at the bottom of the chart) they were instructed to find. Some participants also failed to realize that the weights presented in the chart represented ranges rather than discrete values, and consequently reported that they were unable to find their weight among those provided.

Participants reporting difficulty with question F2 also primarily attributed their difficulty to not understanding instructions. Specifically, participants stated that they were unsure about which portion of their calf to measure, and how to perform this measurement. This uncertainty was reflected in the many instances of participants using an improper measurement technique (e.g., measuring too high or low on the leg, holding the leg up in the air to measure, not rolling down stockings prior to measuring, etc.). Measuring calf circumference using inches in place of centimeters was also frequent, and several participants who did measure in centimeters only did so after writing down their measurement in inches, and then realizing and correcting their mistake when they tried to determine their question F2 score.

Researchers observed that participants often appeared frustrated while attempting to complete this tool. It was not uncommon for participants to verbally reason through the instructions while trying to understand them, and participants frequently asked the researchers for guidance on how to complete the tool. Though the researchers avoided giving guidance to ensure the tool remained completely self-administered, the fact that participants attempted to turn to the researchers for instruction further supports that the instructions on the tool are unclear or insufficient.

Limitations

The small sample size of this study may limit its generalizability. In addition, subjects were not initially asked to assess their ability to use the tool. Rather, this assessment was added while the study was underway in an attempt to capture and quantify unexpected observations. A more systematic and structured method of collecting user feedback would help confirm the results of this study.

Implications

Creating a nutritional risk self-screening tool that uniformly meets the needs of a population as diverse as the elderly continues to pose a major challenge. Given that the Self-MNA® could not be consistently completed by participants of this study, it does not appear to be an effective nutritional risk self-screening tool. More research is needed on how to effectively raise nutritional awareness among older adults to promote appropriate nutritional intervention, and thereby prevent the adverse effects associated with malnutrition.

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APPENDIX SECTION

A. SCREENING TOOLS

B. RESEARCH FORMS

APPENDIX A: SCREENING TOOLS

MNA-SF Form:

Mini Nutritional Assessment
MNA®

Nestlé NutritionInstitute

Last name:		First name:	

Sex:		Age:		Weight, kg:		Height, cm:		Date:	

Complete the screen by filling in the boxes with the appropriate numbers. Total the numbers for the final screening score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe decrease in food intake
1 = moderate decrease in food intake
2 = no decrease in food intake ☐

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss ☐

C Mobility
0 = bed or chair bound
1 = able to get out of bed / chair but does not go out
2 = goes out ☐

D Has suffered psychological stress or acute disease in the past 3 months?
0 = yes 2 = no ☐

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems ☐

F1 Body Mass Index (BMI) (weight in kg) / (height in m^2) ☐
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater ☐

IF BMI IS NOT AVAILABLE, REPLACE QUESTION F1 WITH QUESTION F2.
DO NOT ANSWER QUESTION F2 IF QUESTION F1 IS ALREADY COMPLETED.

F2 Calf circumference (CC) in cm
0 = CC less than 31
3 = CC 31 or greater ☐

Screening score
(max. 14 points) ☐☐

12-14 points:	☐	Normal nutritional status
8-11 points:	☐	At risk of malnutrition
0-7 points:	☐	Malnourished

Save
Print
Reset

Ref. Vellas B, Villars H, Abellan G, et al. *Overview of the MNA® - Its History and Challenges.* J Nutr Health Aging 2006;10:456-465.
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For more information: www.mna-elderly.com

NSI Form:

Provider/Center: ______________________

Client Name: ______________________

Client ID: ______________________

Date: ______________________

The Warning Signs of poor nutritional health are often overlooked. Use this checklist to find out if you are at nutritional risk.

DETERMINE YOUR NUTRITIONAL HEALTH

Read the statements below. Circle the number in the yes column for those that apply to you. Add the circled numbers to get your total nutritional risk score.

	YES
I have an illness or condition that made me change the kind and/or amount of food I eat.	2
I eat fewer than two meals a day.	3
I eat few fruits or vegetables, or milk products.	2
I have three or more drinks of beer, liquor or wine almost every day.	2
I have tooth or mouth problems that make it hard for me to eat.	2
I don't always have enough money to buy the food I need.	4
I eat alone most of the time.	1
I take three or more different prescribed or over-the-counter drugs a day.	1
Without wanting to, I have lost or gained ten pounds in the last six month.	2
I am not always physically able to shop, cook and/or feed myself.	2
TOTAL	

Nutritional Health Score

0 – 2	Good
3 – 5	Moderate Nutritional Risk
6 or More	High Nutritional Risk

Refer to the Determine Your Nutritional Health Handout to learn more about the warning signs of poor nutritional health.

The Nutrition Screening Initiative • 1010 Wisconsin Avenue, NW • Suite 800 • Washington, DC 20007

The Nutrition Screening Initiative is funded in part by a grant from Ross Products Division of Abbott Laboratories, Inc.
Form #NRA1.0
Edition Date: 9/15/2004

Self-MNA Form:

Nestlé NutritionInstitute

Self-MNA®

Mini Nutritional Assessment

For Adults 65 years of Age and Older

Last name: First name:

Date: Age:

Complete the screen by filling in the boxes with the appropriate numbers. Total the numbers for the final screening score.

Screening		
A Has your food intake declined over the past 3 months? [ENTER ONE NUMBER] *Please enter the most appropriate number (0, 1, or 2) in the box to the right.*	0 = severe decrease in food intake 1 = moderate decrease in food intake 2 = no decrease in food intake	
B How much weight have you lost in the past 3 months? [ENTER ONE NUMBER] *Please enter the most appropriate number (0, 1, 2 or 3) in the box to the right.*	0 = weight loss greater than 7 pounds 1 = do not know the amount of weight lost 2 = weight loss between 2 and 7 pounds 3 = no weight loss or weight loss less than 2 pounds	
C How would you describe your current mobility? [ENTER ONE NUMBER] *Please enter the most appropriate number (0, 1, or 2) in the box to the right.*	0 = unable to get out of a bed, a chair, or a wheelchair without the assistance of another person 1 = able to get out of bed or a chair, but unable to go out of my home 2 = able to leave my home	
D Have you been stressed or severely ill in the past 3 months? [ENTER ONE NUMBER] *Please enter the most appropriate number (0 or 2) in the box to the right.*	0 = yes 2 = no	
E Are you currently experiencing dementia and/or prolonged severe sadness? [ENTER ONE NUMBER] *Please enter the most appropriate number (0, 1, or 2) in the box to the right.*	0 = yes, severe dementia and/or prolonged severe sadness 1 = yes, mild dementia, but no prolonged severe sadness 2 = neither dementia nor prolonged severe sadness	
Please total all of the numbers you entered in the boxes for questions A-E and write the numbers here:		

Self-MNA Form – continued:

Now, please CHOOSE ONE of the following two questions – F1 or F2 – to answer.

Question F1

Height (feet & inches)	Body Weight (pounds)			
4'10"	Less than 91	91 – 99	100 – 109	110 or more
4'11"	Less than 94	94 – 103	104 – 113	114 or more
5'0"	Less than 97	97 – 106	107 – 117	118 or more
5'1"	Less than 100	100 – 110	111 – 121	122 or more
5'2"	Less than 104	104 – 114	115 – 125	126 or more
5'3"	Less than 107	107 – 117	118 – 129	130 or more
5'4"	Less than 110	110 – 121	122 – 133	134 or more
5'5"	Less than 114	114 – 125	126 – 137	138 or more
5'6"	Less than 118	118 – 129	130 – 141	142 or more
5'7"	Less than 121	121 – 133	134 – 145	146 or more
5'8"	Less than 125	125 – 137	138 – 150	151 or more
5'9"	Less than 128	128 – 141	142 – 154	155 or more
5'10"	Less than 132	132 – 145	146 – 159	160 or more
5'11"	Less than 136	136 – 149	150 – 164	165 or more
6'0"	Less than 140	140 – 153	154 – 168	169 or more
6'1"	Less than 144	144 – 158	159 – 173	174 or more
6'2"	Less than 148	148 – 162	163 – 178	179 or more
6'3"	Less than 152	152 – 167	168 – 183	184 or more
6'4"	Less than 156	156 –171	172 – 188	189 or more
Group	0	1	2	3

Please refer to the chart on the left and follow these instructions:

1. Find your height on the left-hand column of the chart.
2. Go across that row and circle the range that your weight falls into.
3. Look to the bottom of the chart to find out what group number (0, 1, 2, or 3) your circled weight range falls into.

Write the Group Number (0, 1, 2, or 3) here: ☐

Write sum of questions A-E (from page 1) ☐

Lastly, calculate the sum of these 2 numbers. This is your SCREENING SCORE: ☐

Question F2

DO NOT ANSWER QUESTION F2 IF QUESTION F1 IS ALREADY COMPLETED.

Measure the circumference of your LEFT calf by following the instructions below:

1. Loop a tape measure all the way around your calf to measure its size.
2. Record the measurement in cm: ____________
   - If less than 31cm, enter "0" in the box to the right.
   - If 31cm or greater, enter "3" in the box to the right.

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☐

Write the sum of questions A-E (from page 1) here: ☐☐

Lastly, calculate the sum of these 2 numbers.
This is your SCREENING SCORE: ☐☐

Screening Score (14 points maximum)

12–14 points: Normal nutritional status
8–11 points: At risk of malnutrition
0–7 points: Malnourished

Copy your SCREENING SCORE: ☐☐

If you score between 0-11, please take this form to a healthcare professional for consultation.

APPENDIX B: RESEARCH FORMS

Research Consent Form:

IRB #2013E3835

Consent Form to Participate in Research

Title: The Impact of Participation in Meals on Wheels and More (MOWAM) in Austin, TX, on Dietary Intake and Nutrition Status

Principal Investigator and Contact Information:

Texas State University – School of Family & Consumer Sciences

- Dr. BJ Friedman, RD, Professor
  Phone: 512-245-8342 Email: bf04@txstate.edu
- Dr. Sylvia Crixell, RD, Professor
  Phone: 512-245-2155 Email: sh07@txstate.edu
- Britta Moore, Human Nutrition program Graduate Student
  Phone: 210-872-2681 Email: b_m74@txstate.edu

Information
We are inviting you to participate in a research project for Meals and Wheels and More (MOWAM) in Austin. This form gives you information about the research project. Please read this form and ask questions about anything you do not understand before you decide if you want to participate. You will get a copy of this form to keep.

Why are we doing this research study?

The reason for this study is to learn if the foods you eat and the meals you receive from MOWAM affect your nutritional health.

Why are we asking you to help in this research project?
We are asking you because your "Initial Assessment" for MOWAM is almost complete and you are at least 65 years of age.

Your participation in this study is <u>voluntary</u> – that means you are volunteering to help, and can stop at any time. Participation in this study will not affect your current participation or future services from MOWAM.

How many people will be involved?
There will be between 100 and 150 clients of MOWAM in Austin, TX taking part in this study.

What will happen if you help us in this research study?

1. <u>Today</u>, now that you have almost completed the "Initial Assessment" for Meals and Wheels and More (MOWAM), we will ask you to complete 2 questionnaires and to schedule another visit to complete 2 more questionnaires.

Page 1 MOWAM Consent Form

Research Consent Form – continued:

IRB #2013E3835

- The 2 questionnaires we would like you to complete today are both nutrition questionnaires. MOWAM always gives these questionnaires during their "Initial Assessment," but if you decide to help us in this research study, we will ask you the questions instead of your caseworker. Together, they will take about 10 minutes.
- We would like to visit you within the next 4 weekdays to complete the remaining 2 questionnaires. The first one is about your nutrition and health. You will complete this questionnaire by yourself. It will take about 2-3 minutes. The other is a questionnaire about how often you eat certain foods and what supplements you use (we will ask about up to 134 different foods and 20 supplements). It should take 45 to 60 minutes.

2. In approximately 3 months, we will call to schedule another home visit. During the visit, we will ask you to complete the same four questionnaires described above. Altogether, this second visit will take about 60 to 75 minutes.

What are the possible risks?

- This study involves minimal risks, because we will only be asking you questions about your health and what foods you eat and how often you eat them. Your answers will not affect your participation in MOWAM. If you begin to feel too tired at any point while we are asking you questions, you can request that we schedule another visit to finish.

What are the possible benefits to you or to other people?

- The knowledge gained from this study will help MOWAM learn about how well the program works and make improvements.
- Would you like us to tell you about the results of this study after it is done? __Yes. __No.
- If yes, should we ___email, ___mail or ___call you?
- If at any time you decide you would like access to the final results of the study, please contact one of the investigators listed above.

Will you receive compensation for your participation in this study?

Participants will not receive any money or gifts for participating in this study.

Will the researchers get anything from your help in this study?

The researchers will benefit from the study because they will learn more about how MOWAM helps participants. They may also publish the results of the study in a journal article or present the results to others interested in MOWAM.

How will we protect your privacy and your records?

- All information collected as part of this study will be kept confidential.
- All paper records from this research study will be kept in a secure locked filing cabinet at the Texas State University Community Nutrition lab. They will be shredded in June of 2018.
- Electronic records will be kept on a secure, password-protected computer at the Texas State University Community Nutrition lab.
- All records (paper and electronic) will use a participant number in place of your name so that information cannot be matched to you. Only the graduate student and the principle investigators listed above will have access to the key linking your name and ID.

Page 1 MOWAM Consent Form

Research Consent Form – continued:

IRB #2013E3835

- Only the graduate student and the principle investigators listed above will be able to study the diet and health information collected in this research project.
- If the results of this research study are published or presented at MOWAM or at a meeting, we will not identify any person who participated in the study.

What is the funding source for this project?

This project has no funding source. Its goal is to learn more about MOWAM.

If you have any questions about this study

- You can ask any questions about this study by contacting Texas State Professors (Dr. BJ Friedman and Dr. Sylvia Crixell), or Britta Moore, the graduate student coordinating the project. Contact information is at the top of this form. You can also contact the Director of Nutrition Services at MOWAM (Ms. Seanna Marceaux [(512) 628-8105-smarceaux@mealsonwheelsandmore.org] with any questions.

What if you don't want to continue in the study?

- If you decide to help in this study, it is on a volunteer basis.
- You have the right to refuse to be in this study or to choose not to answer any questions(s) for any reason.
- You can stop at any time after giving your consent. This decision will not affect your current or future status with Meals on Wheels and More or Texas State University in any way.

Required statement of IRB approval:

- This project IRB#2013E3835 was approved by the Texas State IRB on November 10, 2013. Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB chair, Dr. Jon Lasser (512-245-3413 - lasser@txstate.edu) and to Becky Northcut, Director, Research Integrity & Compliance (512-245-2314 - bnorthcut@txstate.edu).

If you're willing to volunteer for this research, please sign on the next page.

We will give you a copy of this consent form to keep.

Statement of Consent:

I have read the above information and clearly understand my role as a participant in the study. I have asked questions and have received answers. I, ________________________, consent to participate in the study.

Signature: ____ Date: ___________________

Signature of Investigator: ________________________________ Date: ___________________

Page 1 MOWAM Consent Form

Research Consent Form – continued:

IRB #2013E3835

Demographic Summary

Address: ____

____

Phone: _(__________)___________-____________________

Age: __________

Sex (circle): male female

Ethnicity (check): _______ White/ Caucasian
_______ Hispanic
_______ Black/ African American
_______ Asian
_______ American Indian
_______ other

Height: _______ ft _______in (convert to m/ cm [cm*2.54]: ___________cm = ___________m)

Weight: __________ lb (convert to kg [lb/2.2]: __________kg)

Page 1 MOWAM Consent Form

Reminder Sheet for Baseline Part 2 Visits:

<u>Thank you for participating in our study!</u>

This is a reminder that we have scheduled our next visit for:

Day:

Date:

Time:

Please call **Britta Moore** at **210-872-2681** if you need to reschedule this visit. You may also call **Seanna Marceaux** at **512-628-8150**

Self-MNA Feedback Matrix Form:

Self-MNA feedback matrix Client ID:________________ Date:___________

Question	Completed 1st time, without assistance? ✓=yes (even if not correct), highlight=no.	Completed after handing Self-MNA back with highlights? ✓=yes, highlight=no.	Did the client say this question was difficult or have a hard time completing it? ✓=yes, highlight=no.	Was question answered correctly? (added correctly, etc.)
Page 1				
A				
B				
C				
D				
E				
Sum A-E				
Page 2	Did client choose F1 or F2 the 1st time? (circle) F1 F2 both neither			
F1- group				
F1- sum A-E				
F1- screening score				
F2- group				
F2- sum A-E				
F2- screening score				
F2- CC measurement				
	Was CC measurement done correctly? (circle) yes no Number recorded: (circle units) ________ cm or in			
Bottom-screening score				

Other notes:

Follow-up Client History Form:

Follow-up client history

In the last 3 (or 5) months, have you experienced any of the following? (yes or no; check all that apply)

___ hospitalization for any reason

___ diagnosis of a new illness

___ new prescriptions

___ begun to receive home-care services (i.e., help with cleaning or personal care)

___ major fall

___ decline in health

___ improvement in health

___ more than 5 lb weight loss

___ more than 5 lb weight gain

___ loss of a loved one

___ anything that you consider a "life-changing event" (*automatically check if client answers yes to previous item)*

What other MOWAM have you used or do you currently use? (check all that apply)

___ H.O.P.E (volunteer delivers an extra bag of groceries)

___ Mike's Place (weekly activities at the main Meals location for client's with dementia)

___ P.A.L.S. (pet and pet food services)

___ Veterans Services (for military veterans)

___ Handy Wheels (assistance with minor safety-related home repairs— shower bar installation, etc.)

___ Groceries to Go (volunteer grocery shops for or with client)

___ Country Wheels (7 frozen meals delivered weekly to clients in country)]

___ Second meals (additional meals delivered to clients)

___ Congregate Meals (meals at senior activity center)

___ Home Repair (for more serious home repair)

IF CLIENT CANNOT BE CONTACTED:

___ No longer receiving HDM services from MOWAM

Reason, if know:

___ Deceased

___ Other (describe):

Meal Satisfaction Survey Form:

Survey: The Impact of Participation in Meals on Wheels and More in Austin, TX on Dietary Intake and Health Status

"Mr./Mrs.__ we are contacting you today to ask you a few questions about how Meals on Wheels is going to help us improve our services. Your answers will not affect the services Meals on Wheels and More provides to you. May I ask you a few questions?"

Q1A. Do you like the MOW meals? a. Yes (always) [go to Q2] b. Yes (usually) [go to Q2] c. Sometimes [go to Q1B] d. No (usually not [go to Q1B] e. Never [go to Q1B]	Q1B. What don't you like about the meals? a. I'm not used to this kind of food b. The foods don't taste good to me c. The foods don't 'agree' with me d. Too many vegetables e. Other________________

2. Which of the following is true about how many of the meals you eat from MOWAM?
   a. I eat every meal delivered.
   b. I almost always eat the meals.
   c. I eat the meals about half the time.
   d. I usually don't eat the meals.
   e. I never eat the meals

3. When you eat a meal, how much of each meal do you 'usually' eat?
   a. Whole meal
   b. Almost all of it (About ¾)
   c. About ½
   d. Less than half (About ¼)
   e. Not very much, if any

4. Considering your overall diet, how much are you eating now compared to before you started your meal service?
   a. More
   b. Less
   c. About the same

5. If you are eating less food now that you are receiving Meals on Wheels and More, is it because you:
   a. Don't like the food
   b. Have been ill
   c. Don't have much of an appetite
   d. Are trying to eat less (to lose weight)
   e. Have less food in your house now than before
   f. Are sharing the meals with another person
   g. Other________________

6. Where did you get food before Meals on Wheels and More began delivering meals to you? (Check all that apply)
   a. Food I made or bought
   b. Food friends or family brought to me
   c. Fast food
   d. I often skipped meals
   e. Other________________

7. How is the other food (besides MOW meals) in your home provided?
   a. Food I buy
   b. Food friends or family bring to me
   c. Fast food
   d. I often skip meals
   e. Other________________

8. How much money do you spend on food now compared to before you began receiving meals from MOWAM?
   a. More
   b. Less
   c. About the same