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The relationship between the DETERMINE checklist, social factors, and nutritional risk in rural, community-dwelling, elderly women

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The relationship between the DETERMINE checklist, social factors, and nutritional risk in rural, community-dwelling, elderly women

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TABLE OF CONTENTS

GENERAL INTRODUCTION 1
Dissertation organization 3
REVIEW OF LITERATURE 4
Demographics of aging 4
Health-related characteristics associated with aging 4
Definition of malnutrition 7
Assessment of malnutrition 8
Effects of malnutrition 8
Prevalence of malnutrition in older adults 17
Factors affecting malnutrition in the elderly 19
Indicators of malnutrition 29
Problems with the DETERMINE checklist 43
Purpose of research 46
ANTHROPOMETRIC MEASURES OF RURAL, ELDERLY COMMUNITY-DWELLING WOMEN AND THE ABILITY OF THE DETERMINE CHECKLIST TO PREDICT THESE MEASURES 48
Abstract 48
Introduction 48
Methods 51
Results 53
Discussion 56
References 60
THE ABILITY OF THE DETERMINE CHECKLIST TO PREDICT DIETARY INTAKE OF WHITE, RURAL, ELDERLY, COMMUNITY-DWELLING WOMEN 73
Abstract 73
Introduction 73
Methods 75
Results 77
Discussion 79
Conclusion 83
References 84

ABILITY OF SOCIAL SUPPORT TO PREDICT AT-RISK DIETARY INTAKE AND ANTHROPOMETRIC MEASURES IN WHITE, RURAL, COMMUNITY-DWELLING ELDERLY WOMEN 94
Abstract 94
Introduction 94
Methods 97
Results 99
Discussion 103
Conclusion 105
References 105
GENERAL SUMMARY 114
APPENDIX A: ABBREVIATIONS USED 117
APPENDIX B: DETERMINE YOUR NUTRITIONAL HEALTH CHECKLIST 118
APPENDIX C: LETTER MAILED TO POTENTIAL SUBJECTS 119
APPENDIX D: SCRIPT FOR TELEPHONE CALL TO POTENTIAL SUBJECTS 120
APPENDIX E: QUESTIONNAIRE USED FOR IN-HOME INTERVIEW 121
LITERATURE CITED 134
ACKNOWLEDGEMENTS 155

GENERAL INTRODUCTION

Malnutrition and undernutrition among the elderly are a growing national concern because of the increasing number of elderly and serious health consequences of malnutrition (1, 2). Poor nutrition leads to poorer health status, decreased quality of life, and increased financial costs. Reports of malnutrition and undernutrition in older persons are generally high (3,4). Early detection of increased risk for developing malnutrition as well as frank malnutrition can lessen the consequences associated with this problem. Multiple synergistic factors, broadly classified as physiological changes, economic concerns, and social isolation, contribute to the development of malnutrition (5). Alleviation of the problems associated with increased risk can decrease the probability of developing malnutrition.

In response to this growing problem, the Nutrition Screening Initiative (NSI) has developed three screening tools to assess risk of inadequate nutrition. The DETERMINE Your Nutritional Health checklist is a self-administered ten-item yes-no response survey used to identify individuals with increased risk for developing malnutrition (6). Each item is assigned a risk value so that individuals who score six points or more, out of a total possible score of 21, are identified at high nutritional risk (7). On this basis, an estimated 36-46% of independently living elderly are at nutritional risk due to inadequate dietary intake or poor perceived health (7).

Outcome criteria used to determine the weighted scores for the checklist were nutritional adequacy and perceived health. Overall nutritional adequacy of the diet was estimated by a comparison of estimated intake of five marker nutrients – protein, vitamin A, vitamin C, thiamin and calcium -- to the Recommended Dietary Allowance (RDA). Diets were identified as inadequate at ≤ 75% of RDA (7). For elders the RDA for some nutrients has been set too high, for other nutrients too low (8). Using the protein recommendations as suggested by the RDA may be too low for many of the elderly (9). Moreover, energy requirements are not even mentioned; however, they are closely linked to weight loss and decreasing body mass index (10,11).

Particularly problematic is the use of a single 24-hour recall to determine dietary intake. A 24-hour recall is simple and rapid, however, it depends on the ability of the subjects to recall accurately and does not account for day-to-day variability. Use in a validation study assumes that elderly have a more stable diet than the general population (12). Current health status may affect recall and cause the recall period to be unrepresentative of current intake. Moreover, dietary recall underestimates energy intakes by about 6% (13). Multiple days of dietary recalls or records are required to assess usual individual intake (14).

Rush (15) has criticized the DETERMINE checklist for poor test characteristics, retaining items that were not significantly associated with outcomes of interest, and using outcomes that are neither well-defined pathological states nor have proven treatments. Finally, none of these individuals were checked a second time to determine if changes had occurred. The significance of some indicators and risk factors of poor nutritional status increases when their change or stability over time is known.

Work by Posner et al. (7) is the initial study in which the questions and scoring of the questions were adopted.This is called the validating study in other NSI materials (16); however, Posner et al. are quick to point out that a validating study needs to be done (7). To date, there does not appear to be such a study which shows these questions actually aid in selecting only those with increased risk for malnutrition. Lack of biochemical or anthropometric measures prevents one from demonstrating a link between the checklist question and those who respond positively to each question.

Three attempts have been made to compare the DETERMINE checklist with other nutritional indicators. Using a convenience sample, Melnik et al. (17) found that only one question had a high correlation with nutrient density of the diet. Using a convenience sample that included Elderly Nutrition Program participants, Philipps and Read (18) found that scores on the DETERMINE checklist were not related to body mass index. Using a group of Meals-on-Wheels applicants, Coulston et al. (19) compared the percentage of individuals who were at high nutritional risk using the DETERMINE checklist with those who were identified at risk using biochemical, anthropometric, and dietary measures (19). Unfortunately, there was no comparison of each indicator with the DETERMINE checklist. As can be seen, the ability of the DETERMINE checklist to predict at risk nutritional status is questionable.

A major weakness of the follow-up studies comparing the DETERMINE checklist with other indicators is that subjects have come from convenience, non-random samples. Those most vulnerable to under nutrition and malnutrition may have been overlooked, due to their frailty and social isolation. High risk sub-populations do not attend senior centers, health fairs, or other social or public events because they may not be physically able to participate. Although those who use the elderly nutrition programs are frequently identified to be at risk for developing malnutrition, they may not be the elderly who are at the greatest risk.

The DETERMINE checklist has widespread use (21-27) to screen older adults at risk for poor nutritional status. Moreover use will likely increase because health maintenance organizations (HMO) are now required to screen new Medicare enrollees for health risks (28). However, the questions used on the checklist have not been tested independently and dependently to assure the best combination of questions and appropriate scoring on the basis of current anthropometric measurements and dietary assessment. The primary purpose of this research is to assess the ability of the DETERMINE checklist to predict at-risk nutritional status in a random sample of community-dwelling, older women. A secondary purpose was to determine if any of several social isolation factors would predict increased nutritional risk.

Dissertation organization

This dissertation has been written in the form of three manuscripts intended for publication, preceded by a review of literature and followed by a general summary. Literature cited in the general introduction and the review of literature is listed following the summary.

REVIEW OF LITERATURE

Demographics of aging

Americans over age 65 are one of the fastest growing segments of the population. By 2030 projections suggest that those aged 65 or over will increase to 22% of the population, up from 13.1% in 2000 (29). Today Iowa has already reached these projections with many counties having those aged 65 or more constituting 22% of the population (29). It is important to remember that the elderly are a heterogeneous group: some live a long productive life while others are plagued by chronic disease, disability, and genetic factors that place them at increased risk for poor quality of life. Other attributes that can affect health of the older individual are marital status, social support (family, friends, and organizations), economic resources, place of residence, and the ability to perform activities of daily living (30).

Health-related characteristics associated with aging

Old age is characterized by general universal changes in organs and metabolism that reduce the homeostatic response to physiological, psychological, and other stresses.

Physiological changes

Lean body mass declines with aging (31). Reduced lean mass results in diminished muscle strength, reduced submaximal aerobic power, and loss of organ reserve (32). The loss of muscle corresponds to decreased bone mineral density (33). This loss of lean body mass, combined with decreased physical activity level, results in decreased resting metabolic rate (RMR). (RMR is the amount of energy expended to maintain body tissues when the individual is awake, but not active.) The decline in RMR can either result in an overall diminished nutrient intake because the aging individual consumes less food, or conversely, it can result in obesity because the aging individual continues to consume the same amount of food and energy as when younger. Regulation of nutrient intake is further complicated because older individuals have a decreased ability to regulate intake, especially after overeating or undereating (34, 35). Older individuals have a decreased perception of hunger and feel satiated with less food, resulting in a decrease in total intake (36). Moreover, decreased thirst perception usually results in poor hydration status (37). Changes in the gastrointestinal tract can affect intake and absorption. One physiological change is achlorhydria, which occurs in 30% of individuals over the age of 65 years and is due primarily to parietal cell malfunction (38). Achlorhydria results in decreased digestion and absorption of vitamin B-12, calcium, zinc, and iron (39, 40).

Illness

In addition to natural changes associated with aging, older individuals have many acute illnesses and chronic diseases. Atherosclerosis, chronic obstructive pulmonary disease, and cancer have replaced acute illnesses, such as pneumonia and infections, as major influences on morbidity and quality of life (41). Most older persons have at least one chronic condition and many have multiple conditions. For example, in 1994 half of those over 65 had arthritis, 36% had hypertension, 32% had heart disease, and 10% had diabetes (42).

Use of prescription and over-the-counter medications

As the average life expectancy increases, so does the number of persons receiving long-term drug therapy. Many elderly individuals take multiple medications, with up to 10% of the older population taking five or more medications (43). The elderly use three times as many drugs as younger populations, and account for 25% to 30% of all prescription drug use (43). Many oral medications have side effects, like nausea, vomiting, diarrhea, and/or abdominal discomfort. Many medications cause xerostomia resulting in dysphagia (44). Moreover, many drugs when combined with others lead to potent interactions, including anorexia (45). Adverse drug reactions cause up to 10% of hospitalizations among the elderly and may contribute to cognitive impairment (46). Overuse of prescribed minor tranquilizers and narcotics for physical and mental ill-health may lead to iatrogenic disorders (47).

Yet over-the-counter, self-prescribed medications may pose a larger problem. Over 85% of the community-residing elderly self-medicate with over-the-counter medications and over 5% are taking five or more over-the-counter medications (48). These medications when combined at the discretion of the older person can lead to severe, chronic health problems.

Disability and debilitating conditions associated with "non-fatal" diseases

In 1992, almost 60% of those over 65 reported having at least one disability which limited them in carrying out activities of daily living (42). Added years can leave the older person at risk for developing age-related, non-fatal, and often disabling conditions--dementia, depression, hip fracture, osteoporosis, arthritis, and sensory impairments such as hearing and vision loss. Although these conditions may not affect longevity, they may have a major impact on the quality of life.

Increased medical care utilization and costs

Increased frequency of acute illness and multiple chronic diseases, combined with the use of medications, have resulted in increased health care utilization and costs for the elderly (46). Although those aged 65 and older represented only 12.5% of the population in 1995, this group accounted for 40% of all hospital stays and 49% of all days of care in hospitals in 1995 (49). Moreover, older persons averaged more contacts with doctors in 1995 than did persons under age 65 (11.1 contacts vs. 5 contacts) (49). Not only do current statistics show increased medical costs for the elderly, the presence of risk factors for disease predicts future medical service and hospitalization use (41).

Although economic costs continue to escalate for the elderly, so do human costs for families and the elderly individuals themselves. Health-related quality of life diminishes as a result of chronic diseases and the associated levels of disability. Moreover, the elderly tend to have many co-morbid conditions that diminish quality of life. Although not all disorders affect quality of life equally, most conditions decrease some aspect of quality of life (50). Caregivers described these high human costs by feelings of heavy responsibility, uncertainty about the loved ones' needs, constant worries, restraint in social life, and feeling that the loved ones rely on only their care (51). Disability costs spread throughout the extended family because of diminished family functioning due to more anxious, depressive, and somatic symptoms experienced by the caregiver (52).

In summary, normative aging results in physiological changes that decrease the homeostatic response rate to external and internal environmental changes. This decreased response rate places the elderly individual at increased risk for development of acute and chronic diseases. The homeostatic response rate may further be depressed by malnutrition. What is called normal aging may be a physical response to malnutrition. Protein-energy malnutrition represents one of the classical apathetic presentations of disease in an older person (53).

Malnutrition as a contributor to declining health and well-being

There is very little clinical evidence that significant malnutrition occurs in any normal elderly person as a result of the aging process itself (54). Evidence indicates that good nutrition promotes vitality and independence, whereas poor nutrition can prolong recovery from illness, increase the cost and incidence of institutionalization, and lead to poorer quality of life (55).

Eighty-five percent of the chronic diseases and disabilities experienced by older individuals can be prevented or improved through nutrition interventions (46). Although not often diagnosed, the presence of malnutrition adversely affects the prognosis of geriatric patients admitted to the hospital (56). Not only are patients who are critically ill or have near-terminal diseases at higher risk for malnutrition, but also those who have treatable conditions with good prognosis are at jeopardy for developing protein-energy malnutrition if they are hospitalized for more than two weeks (57). The physical consequences of malnutrition increase the risk of developing pressure sores, decrease cell-mediated immunity, increase surgical mortality rate, and increase infection rate (56). Aggressive nutritional support leading to improved nutritional status has improved the outcome of malnourished older persons by decreasing morbidity and mortality, increasing functional capacities, and enhancing the ability to recover from stresses (58-60).

Multiple synergistic factors, broadly classified as physiological changes, economic concerns, and social isolation, contribute to the development of malnutrition (5). Protein-energy malnutrition can arise from increased protein and energy requirements associated with metabolic responses to severe stress, such as illness, injury, and sepsis. Protein-energy malnutrition can also occur as a result of inadequate intake by an otherwise normal, healthy individual. Reduced dietary intake causing undernutrition often occurs before hospitalization (2). It is this undernutrition coupled with a trigger event that sets the stage for progressive decline (61).

Definition of malnutrition

Nutritional status is influenced by the types and amounts of food ingested and by how that food is digested, metabolized, and stored in the body. Malnutrition is a condition that results from an imbalance of nutrients or energy relative to metabolic and tissue needs. These imbalances result in altered metabolism, impaired function, and losses of body tissue.

There are several facets to malnutrition. *Undernutrition* results from inadequate intake of either macro or micronutrients to meet the individual's needs. *Nutrient deficiency* is a result of inadequate intake or utilization of a nutrient. Low or marginal intake of many nutrients, such as vitamin B12, calcium, zinc, or iron, can lead to subclinical deficiencies and marginal nutritional status (39, 60). *Marginal nutritional status* is a condition in which nutrient stores may be low, but impaired performance, health, or survival may not yet be evident. *Overnutrition* is a result of excessive intake, typically of energy, relative to tissue needs. *Nutritional imbalance* results from insufficient or excessive intakes of one food component relative to another. *Poor nutritional status* includes deficiency, dehydration, under-nutrition, nutritional imbalances, and overnutrition as well as other excesses such as alcohol (62).

Protein-energy malnutrition is a broad term used to describe inadequate protein and energy intake that results in loss of somatic and visceral protein and fat stores. This usually results in decreased micronutrient intake as well. Energy malnutrition (marasmus) results in a wasting of both fat and lean mass, whereas protein malnutrition (kwashiorkor) results in a greater wasting of lean tissue compared to fat mass (63). With loss of lean mass, protein (nitrogen) and potassium concentrations are reduced (63), resulting in peripheral edema (64). An inadequate supply of calories and protein affects organ systems, with rapid turnover of cells and loss of protein, in response to stress (61). In older persons, even minor stresses of relatively short duration can lead to protein-energy malnutrition (61).

Assessment of malnutrition

Virtually all the signs and symptoms of poor nutritional status are nonspecific and may be caused or exacerbated by other medical conditions (64). No single marker can be used to identify protein-energy malnutrition, since single indicators often are affected by numerous non-nutritional factors which can mask protein-energy malnutrition (65). Because no one indicator for protein-energy malnutrition is appropriate, the usefulness of indicators is often measured by their ability to predict nutrition-related complications. Of the measures used to recognize protein-energy malnutrition, changes in body composition compared with standard norms derived from "well-nourished" populations and reported changes in dietary intake are widely used (66). Often a combination of anthropometric, biochemical, and dietary measurements is used to identify individuals with protein-energy malnutrition. Clinically important malnutrition is frequently diagnosed if serum albumin is $\leq$ 3.5 g/dL, total lymphocyte count is $\leq$ 1500 mm^3, total cholesterol $\leq$ 160 mg/dL, and/or body weight has involuntarily decreased more than 15% (59, 67, 68).

Effects of malnutrition

In a classic study, experimental starvation of normal young adult male prisoners was induced over a period of six months. During that time they each lost about 25% of their body weight resulting in a body mass index (BMI) =17.5 (69). These prisoners exhibited several changes in their behavior including increased tiredness, muscle soreness, depression, moodiness, irritability, and apathy. Their ambition, mental alertness, concentration, and self-discipline decreased.

Frequently these same signs of increased tiredness, depression, irritablity, and apathy are present in older adults. Sometimes these feelings are attributed to old age; however, these symptoms may be characteristic of poor nutritional intake.

Morbidity associated with malnutrition in the elderly

Complications associated with malnutrition and undernutrition include increasing resting energy needs, debilitating changes in physiological, physical, and cognitive functioning. As a result, the elderly individual is at increased risk for morbidity and mortality and decreased quality of life.

Physiological changes associated with malnutrition

Sarcopenia or low relative muscle mass is associated with normal aging, resulting in a decrease in RMR (70). Many elderly individuals have a decline in physical activity (71), which may be associated with disease and disability, causing a decrease in energy requirements. In contrast, most micro-nutrient requirements remain the same or increase (8). Since homeostatic regulation is less precise in the elderly, nutrient intake may be less than is necessary to maintain good nutritional status and health.

Increase in RMR

Contrary to decreasing energy requirements associated with normal aging, the RMR increases in those who are malnourished. With increasing age, more calories are needed just to maintain the body cell mass (BCM) of malnourished patients (10). In a study involving 325 individuals, aged 16-91 years, who were receiving total parenteral nutrition, Shizgal et al (10) found that it took longer to restore a depleted BCM in older individuals compared to younger individuals. Moreover, the BCM of malnourished elderly was restored more slowly, even though nutrient intake was similar to the well-nourished elderly. In a similar study, Campillo et al. (72) determined that patients in a convalescent unit who had BMI of <20 had higher resting energy expenditure (28.4 kcal/kg) compared to those who had a BMI >20 (22.1 kcal/kg). This difference was significant for energy expenditure per kg both body weight and fat free mass (72).

In addition to requiring more energy just to maintain current weight, Dormenval and associates (73) determined that malnourished elderly made more masticatory movements before swallowing than well-nourished individuals. This in itself could lead to a decreased food intake.

Metabolic disturbances

Total body water declines with age, from nearly 80% of total body weight as an infant to 60% as an older adult (74). Older adults report less thirst and more xerostomia than younger individuals (75). This is especially true for the malnourished elderly. Salivary flow rates are decreased in the malnourished which leads to difficulty swallowing in general and swallowing food in particular (73). Dysphagia leads to reduced dietary intake and increased risk of aspiration (76). To minimize difficulties associated with swallowing, many individuals choose an alternative food or reduce total dietary intake. In healthy older individuals, taste and food enjoyment remain relatively unaffected, although smell is diminished (77). In contrast, medically compromised individuals experience both taste and smell diminution, leading to poor dietary intake (77).

Malnourished individuals have altered hormone responses to ingestion of food. Berthelemy et al. (78) reported that malnourished elderly individuals had 2.5 times more postprandial cholecystokinin secretion than did well-nourished elderly individuals. This is particularly significant since cholecystokinin is a gastro-intestinal peptide that inhibits food intake by delaying gastric emptying.

Increased numbers of cataracts

Epidemiological evidence points to an increased prevalence of cataracts associated with poor dietary intake. Poor riboflavin intake was the first vitamin related to cataract formation (79). In a case controlled study of 1380 older individuals, dietary intake of vitamins C, E, and carotene were shown to have a protective effect against cataracts (80). In an extension of this work, Leske et al. (81) found that regular users of multivitamins had a 33% reduced risk of nuclear opacification, and those with high serum vitamin E levels reduced risk by approximately half. Moreover, long-term consumers of vitamin C supplements had 84% reduced prevalence of moderate lens opacities (82).

Not only did supplements alter the risk for developing cataracts, so did consumption of certain foods. Intake of meat, cheese, certain fruits, and vegetables like tomatoes, broccoli, citrus fruits, and melon, decreased the risk of developing cataracts while high intake of butter, total fat, and salt increased the risk for cataract development (83).

Compromised immunity

In an elderly population that did not have conditions that would alter immune response, Gianni et al. (84) demonstrated that malnourished individuals had altered immunological response parameters (IL-6, TNF αIL-10, CD-4, CD-8, and CD-16). This decreased immune response resulted in an increased rate of infection, which further compromised nutritional status (85). Infections are associated with serious nutritional problems, such as poor intake of solid foods, reduced absorption, increased catabolic losses, and internal diversion of nutrients to combat the infection. Usual dietary intake is inadequate to repair the catabolic effects of repeated infections, which can require up to 50% above normal maintenance (86). A vicious cycle then develops between malnutrition and infection. Recovering from a catabolic setback accompanied by infection requires significant increases in energy and protein to repair tissue and return to nitrogen equilibrium (74). Each recurrent infection tends to reduce energy and protein stores causing the patient to be more susceptible to subsequent infections (2,86).

Increased number of infections

Many studies show an increased likelihood of developing an infection due to compromised immunity caused by malnutrition. Sullivan et al. (87) found that serum albumin concentration at admission and the amount of weight loss in the previous year were independent predictors of infections and complications that would likely occur during hospitalization. Naber et al. (88) reported that the relative risk for an elderly malnourished individual to develop a severe complication and infectious complication was 3.5 and 4.3 respectively. Stroke patients with hypoalbuminemia had greater risk of infectious complications (89). Risk of infection continues for the malnourished after dismissal from acute care. The prevalence of infectious episodes in the following nine months after hospitalization was 5 times higher in the malnourished (90). Supplementation can reverse or at least minimize this increased risk. In a controlled trial, infection rates and level of morbidity were decreased in a nursing home population who were given highly fortified food supplements (91).

Increased lengths of stay in acute / skilled care facilities

Malnourished individuals are more likely to be hospitalized than well-nourished individuals. Mowe et al. (2) reported that reduced dietary intake was common for those who were hospitalized. Once hospitalized, the malnourished stayed longer, simply because they took longer to improve, especially those recovering from stroke (89, 92). In elderly medical patients, the malnourished were hospitalized from one and a half to more than three times longer than elderly well-nourished patients (90,93-95). At the time of dismissal from the hospital, fewer malnourished individuals were dismissed to the same level of care from which they were admitted (95), or were not dismissed to home (96).

Increased number of readmissions

Over the short-term, elderly malnourished individuals are readmitted at the same rate as elderly well-nourished individuals (95). However, at three months after discharge the readmission rate is 26% higher for the malnourished individuals (97). At one year, the readmission rate for the malnourished is almost half whereas only one-thrid of the well-nourished are readmitted (93). Perhaps the best documented indicator at discharge to predict readmission to acute care is a combination of serum albumin concentration at discharge, subscapular skinfold, and serum gamma globulin concentration (98).

Increased drug toxicity

Serum albumin concentrations are frequently low in the malnourished. This makes these individuals particularly vulnerable to adverse reactions associated with protein-bound drugs (99). Body weight may change substantially over time in the malnourished elderly, placing them at increased risk for overdose. Since malnourished individuals have a higher rate of infection, they are also prescribed more antibiotics, leading to the potential of drug-drug interaction. In older women, total number of drugs, psychotropic drugs and drugs liable to cause postural hypotension are associated with increased risk of falls (100). Furthermore, commonly prescribed antibiotics can induce weight loss by suppressing appetite (101). Some medications are more effective when combined with food; therefore, the effectiveness of some of these medications may be limited in those who have a limited food intake, i.e. the malnourished.

Poor/delayed wound healing due to delayed collagen synthesis

Due to the long term nature of malnutrition, there is a consistent positive relationship between poor nutritional status and poor wound healing. Poor wound healing in general is caused by delayed collagen synthesis, fibroblastic proliferation, and neovascularization (102). Different nutrients are needed at each step in the healing process. Adequate intake of protein, either as complete protein or as amino acids, vitamin A, vitamin C, and zinc are necessary to promote wound healing (103, 104). Often these are limited in the diet of the malnourished; however, aggressive nutritional support has improved wound healing for malnourished individuals who required amputation (105, 106). Malnourished individuals who are immobile are more likely to have skin breakdown resulting in ulceration. In a study of nursing home residents, only the severely malnourished developed pressure sores, and the degree of malnutrition paralleled the severity of the pressure sore (107).

Muscle weakness

Malnutrition affects lean tissues first (108). Muscle loss, with or without accompanying fat loss, results in loss of strength, endurance, and ability to walk (109). Loss of muscle power decreases respiratory function leading to decreasing vital capacity (110). Moreover cardiac contractility and reserves also diminish (69). In addition to muscle weakness, the malnourished individual's skeletal muscles are more easily fatigued (111), decreasing mobility and work capacity.

Functional impairment and disability

Malnutrition leads to loss of lean muscle tissue, resulting in muscle weakness. Another contributing factor to the loss of lean mass is the lack of physical activity (32). Vellas et al. (112)

reported that those who fell most frequently had lower BMI, calf and arm circumference, and mid arm muscle area (indicating malnutrition) than those who did not fall. It is this muscle weakness that alters the walking gait (113). An altered walking gait increases the risk of falling (114). Furthermore, if a malnourished individual had a fall, they frequently expressed a fear of falling again and had restricted mobility (115). Falls resulting in fracture can occur either because of fear of falling or because of an altered gait due to reduced muscle mass (116). Falls may also be due to inappropriate use of medications (100).

Some measures of malnutrition are also associated with increasing prevalence of fractures. Increasing weight loss is associated with an increasing relative risk for non-spine and fragility fractures (117). Langlois et al. (118) reported that a 10% weight loss increased the relative risk for hip fracture to 2.9. After hip fractures, the malnourished are more likely to die, have more complications, and become more dependent (119).

Ability to perform activities of daily living (self-care functions) can be hampered by lack of muscle strength and mobility. Equally important to maintaining independence is the ability to perform interactive daily living skills. As malnutrition becomes more severe, functional ability for these activities decreases (120).

Results from two long-term study populations—the Framingham Heart Study and the Cardiovascular Health Study—reported that high body fat predicted physical disability (121, 122). Moreover, both studies reported that low skeletal muscle mass, measured either by bioelectrical impedance or dual energy x-ray absorptiometry, was not associated with self-reported physical disability. This is in contrast to reports from National Health and Nutrition Examination Survey I (NHANES I) which showed the individuals with low BMI (123), both low and high BMI (124), and those who had lost weight (125) all had increased relative risk of disability. Using NHANES I Epidemiologic Follow-up Study data, Hubert et al. (126) reported that high BMI at age 40, low energy intake, low serum albumin, and low activity level were predictive of physical disability ten years in the future.

Nutritional deficiencies in older persons have been associated with cognitive deficits. Goodwin et al. (127) reported that community-residing older adults with low dietary intakes of protein, vitamin C, thiamin, riboflavin, folate, niacin, and vitamin B-6, had lower average scores than their better-nourished peers on tests of verbal memory and nonverbal abstract reasoning. Significant associations were also noted between blood concentrations of certain nutrients (vitamin C, riboflavin, and vitamin B-12) and cognitive performance. In a similar study, Perrig et al. (128)

found high plasma levels of vitamin C and β-carotene to be correlated with better memory performance. This lead to the suggestion that lower levels of both vitamin C and β-carotene may decrease cognitive function. Goodwin et al. (127) and La Rue et al. (129) found that higher abstraction performance was associated with higher biochemical and dietary levels of thiamin, riboflavin, niacin, and folate. Perhaps more intriguing is the association of dietary protein intake with increased memory score and the association of serum albumin with memory, visuospatial, and abstraction scores. Spring et al. (130) also suggested the importance of consuming sufficient protein with high carbohydrate meals to minimize loss of attention and alertness. Ortega et al. (131) reported higher cognitive function with higher total energy intakes, especially carbohydrates (131). A symptom of vitamin B-12 deficiency is dementia (132). Malnutrition caused by metabolic disorders, drug toxicity, and hypothyroidism can frequently lead to confusion and dementia (63). Dehydration is another cause of confusion in the elderly (133).

In a classic study on malnutrition, Keys et al. (69) characterized the malnourished as being depressed and apathetic (69). These characteristics are prevalent among the malnourished elderly. Anxiety, confusion, irritability, lethargy, and social withdrawal are symptoms of depression that can be magnified by malnutrition (64). Apathy and negative attitude can result from poor nutritional intake and can contribute to depression. Once depression is present, loss of self-worth, indecisiveness, and other cognitive loss may exacerbate poor nutritional status (134). As general malnutrition becomes more severe, the likelihood of developing delirium can nearly quadruple (135).

Mortality associated with malnutrition

Malnutrition is a lethal disease in old age. Low body weight or other low anthropometric measures and weight loss are highly predictive of increased mortality.

Epidemiological studies

Epidemiological studies demonstrated a correlation between low BMI and increased relative risk for death in older individuals. One of the most recent studies is of 324,135 individuals who participated in the 12 year American Cancer Society's Cancer Prevention Study (136). Women $\geq$ 85 years old whose BMI was <19 had an increased relative risk of 1.7 for death from any cause and relative risk of 1.6 for death from cardiovascular disease. Women aged 65-84 with BMI <19 also had an increased relative risk of 1.2 for death from any cause. Reports from the Longitudinal Study of Aging showed that the hazards ratio increased for decreasing BMI (hazards ratio=2.3 for BMI <18; hazards ratio $=1.6$ for BMI ≥ 18 - <20) (137).

Studies using the first NHANES I Epidemiologic Follow-Up Study found similar relative risks. Davis and colleagues (138) found that women aged 65-74 (n=1748) with a BMI <22 had a relative risk of 1.5 compared to those with BMI of 22-30. This was after race, education, income, employment, living arrangement, dietary quality, and chronic diseases were controlled for. In a study (n=1,661) of the same population, Tayback and colleagues (123) reported much higher death rates associated with BMI <22 and > 32 for white women over age 65. Relative risk for women whose BMI was <22 was 1.3 after adjustment for smoking, elevated blood pressure, and poverty (123).

Using the same NHANES I Epidemiologic Follow-Up Study, Pamuk and colleagues (139) investigated the relationship of weight loss to survival. Weight loss of ≥ 15% of maximum lifetime BMI had a relative risk of 2.0 compared to those who lost ≤ 5%. Those who were the heaviest appeared to have the greatest relative risk for weight loss. In a parallel study which excluded those who had died in the first eight years after baseline, Pamuk et al. (140) reported that individuals with a maximum lifetime BMI > 26 and who had a weight loss > 15% had relative risk of 2.0. For those who had a weight loss of 5-15%, the relative risk dropped to only 1.2. These results are similar to Losonczy et al. (141) who reported that low BMI did not increase relative risk; however, for women who lost 10% of their middle-age body weight relative risk increased to 1.62.

Acute care

In the acute care setting, mortality rate of malnourished individuals is always higher than well-nourished individuals. Mortality in hospitalized malnourished elderly was one and a half to two times higher than in well-nourished hospitalized elderly (142, 143).

This high mortality rate continues if the malnourished are discharged from the hospital. Cederholm et al. (90) in a nine month follow-up reported a 26% increase in mortality in the malnourished based on low anthropometric measures, particularly triceps skinfold (TSF). McMurtry and Rosenthal (96) determined mortality rate was 29% at the end of one year and an additional 41% at the end of two years for a total mortality of 70%. In another study (144) at the eighteen month follow-up, the mortality rate increased 42% for those with low BMI, TSF and mid arm circumference (MAC). Muhlethaler et al. (142) reported an increased relative risk for mortality within four and a half years to be 1.6 for low body weight and 1.8 for low muscle arm area. In a four year prospective study involving veterans, Wallace et al. (145) reported that a weight loss of only 4% per year increased the relative risk of mortality to 2.43.

Biochemical measures to predict mortality

Serum albumin concentration in the hospital was a strong and independent predictor of mortality at 3 months after acute stroke (89, 96), as well as for other hospitalized malnourished elderly (146). Burns and Jensen (93) showed a mortality rate of 12% for those with a serum albumin concentration of < 3.0 g/dL, accounting for 25% of the deaths. Only 8% of those surviving had a serum albumin concentration of < 3.0 g/dL. In a similar study involving 15,511 patients, in-patient mortality was 14% among the patients with serum albumin concentration ≤ 3.4 g/dL compared to only 4% among patients with serum albumin > 3.4 g/dL (147).

Costs associated with malnutrition

Costs to a malnourished individual are high—both economically and psychologically. Costs to family members who care for these individuals may also be high. The most obvious costs to the individual are the extra dollars spent for healthcare. Length of hospital stay is increased (88,90,92-95, 148, 149), and costs for daily care increase due to the number of complications and infections (88,90, 94, 95). True dollar costs related to malnutrition are often hidden in hospital charges because hospitals do not specifically track severity of illness associated with malnutrition (150). This makes it very difficult to assess actual dollar costs associated with malnutrition, although estimated increases in cost of caring for the hospitalized malnourished range from 35%-75% (59). But dollar costs do not end with hospital dismissal. Malnourished individuals are more frequently dismissed to the nursing home (95), which increases the costs to the individual.

Not all of the high costs associated with malnutrition are necessarily increases in acute care. Sometimes a single event like a fall can increase costs. For example, in 1996, costs associated with an injurious fall totaled almost $20,000 (151). Similar high costs are associated with depression—a complication associated with malnutrition. In the United States, annual costs for depression are $43.7 billion with $7.5 billion attributed to mortality associated with depression (152).

Although dollar costs are high for the malnourished elderly, so are the human costs. Pain and suffering associated with malnutrition cannot be measured; neither can the social isolation felt by the individuals who experience repeated hospitalizations or nursing home stays. Quality of life studies showed that homebound elderly—some of those most likely to be malnourished—have low quality of life (50). Moreover, a recent study showed that those who were hospitalized due to infection had increased feelings of anxiety, depression, and lowered feelings of self-esteem and sense of control (153). Malnutrition can lead to changes in functional status resulting in loss of independence and reduced quality of life.

The direct financial costs of malnutrition to the older person's family members have not been reported; however, malnourished individuals require significantly more caregiver's time than those with good nutritional status (154). Not only is more time necessary, but caring for those who have dementia takes its toll on the caregivers who report poorer health, activity limitation, and increased use of health care services for self (155). On the other hand, Pruchno and Potashnik (156) reported that spousal caregivers are less likely to seek care for themselves, leading to higher levels of morbidity for caregivers (157). Such morbidity is most strongly associated with extensive daily care-giving assistance, not just caregiving per se (158). About 50% of those who care for an elderly person with a disability reported mental or physical strain associated with caregiving (159). This mental strain may diminish family function (52).

Health care costs to society increase due to the high use of services by the malnourished. Each complication and infection increases the cost born by society (154). Medicare costs as well as rising insurance premiums reflect the costs associated with malnutrition. For example the cost to Medicare for a principle diagnosis of dehydration is $446 million annually (37). Medicare costs associated with hip fractures were $8.7 billion in 1988 (119).

Perhaps Torres-Gill (160) summed it up best, "Malnutrition costs. It costs older people by exacerbating disease, by increasing disability, by decreasing their resistance to infection, and by extending their hospital stays. It costs caregivers by increasing worry and caregiving demands. The entire country pays health care costs related to this increase in complication rates, increasing hospital stays and increasing mortality rates. Malnutrition costs people and dollars." (p. 8)

On the other hand, adequate nutrition fosters continued independent living in the community, avoids premature placement in the nursing home, helps to avoid using health care, reduces hospitalization and rehospitalization, promotes health or delays onset of disease, and aids in recovery from illness (160). Success in controlling health care costs is directly related to preventing adverse outcomes of hospitalization. There is a need to target patients truly "at risk".

Prevalence of malnutrition in older adults

Hospital-dwelling

Even though health care professionals have been aware of the importance of nutrition for years, malnutrition is still very prevalent in hospitalized patients. Depending on the defining measurements, malnutrition is present in 13-61% of those admitted into acute care (92, 94, 96,149, 161-163). In a report analyzing eight studies, Gallagher-Allred et al. identified 40-55% of 1347 individuals who were malnourished with 12% classified as severely malnourished (59). Comparison is difficult because markers and standards vary across studies.

Cut-off points to describe malnutrition using BMI range downward from 22 (96, 163, 164). Other investigators have used population norms of 90% of ideal body weight (IBW) (162), 85% of IBW (93), 85% of usual weight (165) or 75% of IBW (95). Weight loss of 15% or 10 pounds within 6 months have been used as indicators for malnutrition. If the cut-off point for describing malnourished individuals was BMI ≤ 22, then 54% were malnourished (163). If the cut-off BMI was decreased to 20, then 31% were malnourished (93). In a study that identified 75% of IBW and serum albumin concentration ≤ 3.0 g/dL as malnutrition, almost a third were classified as malnourished (95).

Rates of occurrence also vary with diagnosis and medical location. General internal medicine reported around 60% of the patients malnourished (93, 95). Stroke rehabilitation units have similar high rates of malnutrition based on the presence of at least two of six possible anthropometric measures and serum measures (92). Griner et al. reported 43% of elderly individuals admitted into the intensive care unit were malnourished (94).

Institutional dwelling

Reports of protein-energy malnutrition in institutionalized elderly vary tremendously— from 10% to as high as 85% (74, 86). Large variations are due to the type of patient and the facility as well as differences in criteria for identifying malnutrition. Among Veteran's Administration nursing homes, prevalence of protein-energy malnutrition ranged from 2-20% using anthropometric measures and 5-58% using biochemical markers (166).

Community dwelling

Most studies involving community-dwelling elderly reported a prevalence of protein-energy malnutrition considerably lower than those for hospitalized or institutionalized older adults. In a large (n=5373) study to screen new enrollees of a health care system, 10% of the women were identified as malnourished by BMI <22, but only 3.4% by BMI <20 (167). Only 4% were malnourished according to biochemical markers 167). Similar percentages have been reported by others (1, 68, 168). As expected, those who are more frail and homebound show a high prevalence of malnutrition. In a small study (n=49) of rural, frail, homebound elderly, Ritchie et al. (4) reported that 19% had serum albumin ≤ 3.5 g/dL and a similar percentage had a BMI <24. In another study, approximately 30% of apparently healthy seniors have subclinical malnutrition, which can also pose a health threat (120). The lowest prevalence of malnutrition reported to date appears to be in NHANES I where only 1.2% were found to have serum albumin ≤ 3.5 g/dL (169). However, NHANES I was conducted in 1971-1975; results collected more than 20 years ago may not be relevant for today due to changing cohorts and lifestyles.

Unfortunately, despite reported prevalence rates which indicate that protein-energy malnutrition may have reached endemic proportions in the older American population, this condition often remains under-diagnosed, reflecting poor nutritional screening (99). Early detection of increased risk for developing malnutrition as well as frank malnutrition could lessen the consequences and costs associated with this problem. Improved function and health are central outcomes of nutritional interventions.

Factors affecting malnutrition in the elderly

Nutrition risk is the existence of a condition that may result in poor nutritional status or malnutrition. Although many older adults are at increased risk for developing protein-energy malnutrition due to chronic disease states, dementia, and advanced age, many do not develop malnutrition.

Multiple synergistic factors precede malnutrition, yet it is difficult to decipher which factor or combination of factors— illness, isolation, poverty, or depression— causes malnutrition. Many of the changes commonly associated with aging— and described above— have the potential to lead to malnutrition.

Chronic disease and acute illness

Chronic diseases and their treatments can lead to increased nutritional risk. In general the number of diseases an individual has is a strong predictor of nutritional risk (170). Many elderly have diseases that alter appetite, produce malabsorption, and/or increase metabolism (171-173).. Depending on the disease process, the nutritional deficiency may not be reversible.

Eating problems are common among stroke patients. They may fail to eat because of dysphagia, depression, or difficulty in performing the tasks of eating (174).

Gastrointestinal problems such as nausea and vomiting can impair appetite. Frongillo et al. (175) reported that nausea and diarrhea were characteristics associated with an older adult's not eating for one or more days. Chronic constipation may signal inappropriate nutrient or food intake but constipation is often diagnosed inappropriately. Excessive and unnecessary laxative use can lead to malabsorption. Diarrhea can also lead to malabsorption (64).

Acute illness, such as pneumonia or urinary tract infection, can cause both loss of appetite and increased metabolic rate. Weight loss can result. Chronic infection from *Helicobacter pylori* may also reduce dietary intake (176). Recovering from an acute infection requires a significant nutritional effort to repair tissues and return to nitrogen equilibrium. An older patient may not consume enough calories to replete or even maintain energy and tissue stores. The inability to recover may potentiate additional infections with each new infection leaving the individual in progressively poorer nutritional health (86).

Multiple medications

The elderly use three times as many drugs as younger populations, and account for 25% to 30% of all prescription drug use (67). Thompson and Morris (68) found that drugs were the cause of weight loss in 9% of ambulatory elderly. Moreover, drug reactions caused up to 10% of the hospitalizations in the elderly (177). Overmedication can place the elderly individual at increased risk for poor nutritional status (178).

Drugs can affect nutritient intake and diminish appetite by causing nausea, vomiting, and abdominal discomfort (45, 179), by altering taste and smell (180), and by depression or other cognitive impairment (45, 177).

Over-the-counter drugs (OTC) may also have potent effects on nutritional status. Over 87% of community-residing elderly use at least one over-the-counter medication (48). The most prevalent use of OTC was analgesics (used by 66%), followed by vitamin and mineral supplements (38%), and regular laxative use (10%) (48). In a longitudinal study of 2529 older adults, laxative use was independently associated with hypoalbuminemia (odds ratio 3.17) with increasing risk of hypoalbuminemia with increasing length of laxative use (181). Aspirin and non-steroidal anti-inflammatory drugs increase the likelihood of blood loss which may result in anemia (182).

Oral health problems

Food and fluid intake is strongly influenced by oral health status. In healthy elderly, chewing efficiency and swallowing are only slightly diminished whereas in medically compromised elderly, these processes are diminished (77). Sullivan et al. (183) reported that collective oral problems such as poor oral hygiene, xerostomia, inability to chew, dental caries, and periodontal disease contributed to weight loss. Ritchie et al. (4) reported that difficulty chewing was a predictor of low BMI. In an epidemiological study, poor dental status was correlated with poorer micronutrient intake and higher mortality in elderly women (184).

Tooth loss, even with replacement dentures, has been associated with reduced protein intake (185). Posner et al. (186) reported a strong relationship between dental disease and poor dietary intake of vitamin A, thiamin, and calcium, and a somewhat weaker relationship between dental disease and low protein intake. Moreover, difficulty swallowing was one of the characteristics associated with older adult's failure to eat for one or more days. (175)

Alcohol abuse

In adults over age 64, about 56% of the males and 31% of the females consume some alcohol, with 9% of the males and 2% of the females consuming at least 1 oz. of alcohol daily (187). Estimates indicate that 5-15% of those over age 65 are alcoholics (188). Older adults are more vulnerable to the effects of ethanol. Physiological changes in volume distribution make older people more susceptible to acute alcohol toxicity than younger individuals. With increasing age, the quantity needed for intoxication is less. Organ sensitivity to alcohol, especially the liver and pancreas, is increased (189). Alcohol-induced nausea and vomiting interfere with appetite and ingestion of food. Diarrhea may develop when the individual does eat (190). Alcohol's interaction with medications and/or disease conditions may alter nutrient utilization in the body.

Cognitive impairment

Not only does malnutrition lead to cognitive impairment, cognitive impairment increases the risk of malnutrition. Confusion and memory loss make it hard to remember what, when, and if one has eaten. Increased activity due to restlessness or anxiety increases energy requirement.

Dementia is a chronic loss of intellectual or cognitive function of sufficient severity to interfere with social or occupational function (191). Dementia occurs in 5% of persons over age 65 increasing to 25-40% in those aged 85 and older (188). Moreover, 40% of elderly individuals with unexplained weight loss have dementia (53). Reduced food intake among demented individuals is more prevalent among those who also suffer from depression (192). In dementia, poor food intake may be due to indifference about eating, memory loss, or impaired judgment (101). To compound the problem of inadequate intake, energy requirements may increase 600-1600 kcal if the demented individuals walk, pace, or wander (193).

Disordered attitudes toward food and body image occur in some elderly. Tardive anorexia is anorexia nervosa that presents late in life. Abnormal responses to body image and eating attitudes such as preferring the stomach to be empty, avoiding eating when hungry, and engaging in dieting behavior are common among those 70 years and older (194). In this study (n=183), approximately 60% of undernourished participants acknowledged practicing self-control with food and 9-26% had inappropriate eating attitudes. Buckler et al (195) found that dietary restriction was associated with malnutrition. Moreover, cholesterol phobia has been identified as a cause of weight loss in elderly individuals (68).

Depression

Depression is an affective disorder denoted by a dysphoric mood and the loss of ability to enjoy usual activities such as eating (191). Approximately 3-6% of community-dwelling elderly are clinically depressed (188) with many more who do not fall under the definition of clinically depressed. In older people with depression, about 90% lose weight compared to only 60% of younger persons with depression (53).

Changing dietary requirements

Normal aging precipitates a decrease in the older individual's energy requirement because of a decrease in lean muscle mass (31). Protein needs based on body weight appear to increase with age. In a longitudinal study, elderly individuals who had protein intakes of ≥ 1.2 g/kg body weight had fewer health problems than those with an intake of ≤ 0.8 g/kg body weight (196).

Requirements for other nutrients are also altered in older adults. Current recommended levels may not be adequate to minimize the risk of developing chronic diseases. Calcium and vitamin D recommendations are higher for older adults to minimize bone mineral loss (197, 198), and decrease the risk of hip fracture (199, 200). Many older adults may have subclinical deficiency of riboflavin, folate, vitamin B-12, or vitamin B-6 even though dietary intake is at recommended levels (201-203). The recommended level of folate may not be sufficient to reduce homocysteine levels (204). Some investigators believe vitamin E recommendations should be increased to reduce the risk of lipid peroxidation and enhance immune response (205). Not all nutrient needs are increased with age. For example vitamin A appears to be conserved at higher levels in older adults (206).

Sensory impairment

Taste threshold sensitivity declines with age (207), as does smell threshold sensitivity (208). In a study comparing 246 recently hospitalized, with 103 home-dwelling elderly, Mowe and Bohmer (55) found reduced taste acuity contributed to weight loss and low body weight. Decline in smell sensitivity has a greater impact on dietary intake than does decline in taste acuity (209).

Poor appetite

Poor appetite is a predictor of poor dietary intake (210). Some reduced appetite and reduced intake is expected as part of normal aging (35, 36). Reduced appetite may be secondary to isolation, low interest in self-care, suspicious thoughts and feelings, generalized weakness, apathy, loss of self-esteem, or poor physical well-being (101), as well as specific diseases (211). McIntosh et al. (212) found that financial stress negatively affected appetite.

Reduced physical capability

As with cognitive function, reduced physical capability is a risk factor for developing malnutrition as well as a result of malnutrition. It is difficult to determine which came first—the physical disability or malnutrition. Whatever the cause of physical disability (i.e. an accident, chronic disease like arthritis, or poor rehabilitation after a stroke or fracture), inability to accomplish basic activities of daily living or instrumental activities of daily living places an individual at increased risk for poor nutritional status (213). For example, an individual may be so impaired that meal preparation becomes a formidable task.

Other studies have found that functional status is a predictor of malnutrition or conditions that increase the risk for malnutrition (214-216). Using NHANES I Epidemiologic Follow-up Study data, Galanos et al. (124) found that functional disability was strongly correlated with BMI $< 15^{th}$ percentile. Those with extremely low BMI ($< 5^{th}$ percentile) had the highest relative risk for having functional impairment (124). In a cross-sectional report of elderly health maintenance organization applicants, Jansen et al. (167) found that poor appetite and eating problems were independent predictors of functional limitations. Change in functional status, independent of actual functional status, was also an independent predictor of adverse outcomes including morbidity, hospitalization, and mortality (217).

Payette et al. (210) reported that in a group of 145 community-dwelling frail elderly, arthritis was associated with very low energy and protein. Not being able to shop for one's self was an important indicator for hospitalized malnourished older adults vs. a random sample of older adults who were not hospitalized (55).

Any impairment in food procurement or preparation process places the individual at increased risk for poor nutritional status. Frongillo et al. (175) reported that poor mobility was one of the characteristics associated with elderly person's not eating for one or more days

Individuals who have difficult in performing any basic activities of daily living—such as bathing, dressing, toileting, continence, feeding, or mobility—are often referred to as "frail" (178). These frail individuals are at particularly high risk for malnutrition because they are partially or totally dependent on others for performing essential activities to preserve health and independence (218). The frail are sick and hospitalized more frequently making it less likely that intake will be adequate (58). Furthermore, they are often released from the hospital with poorer functional status than when they entered, exacerbating already high risk (5, 219).

Individuals needing help with instrumental activities of daily living such as managing transportation for shopping, using the telephone, handling finances, taking medications, and preparing meals are also at risk for poor nutritional status. Even if a person has transportation and is able to shop, the individual must also have enough strength to carry the grocery sacks into the home.

Poverty/ Economic concerns

Level of income has a direct impact on nutrition. Overall, approximately 26% of the elderly are below 150% of the poverty level (220), with women more affected than men by finances. First, a higher proportion of women are below the poverty level (15%) compared to men (7%) (221). Second, more poor women than poor men have inadequate diets (222).

Individuals with a recent decrease in income, those who have unreliable sources of income, or those who rely on economic assistance programs are at highest risk. Indirect indicators such as the percentage of population in poverty or the number of individuals receiving food stamps have been used to estimate food insecurity. Approximately 9% of older adults receive public assistance income, 10% receive food stamps, and 14% are on Medicaid (220). These percentages may not be reliable indicators of food insecurity, however, because many elderly individuals may not be aware, have access to, or be willing to take advantage of such economic assistance programs. Others feel that food stamps are not worth the trouble for $10 per month (223). Nevertheless, Frongillo et al. (175) reported that receiving food stamps and Medicaid have been associated with older adults going without food for one or more days.

Food insecurity exists whenever the availability of nutritionally adequate, safe foods or the ability to acquire personally acceptable foods in socially accepted ways is limited or uncertain (224). Maxwell (225) reported that those with food insufficiency conserved their money and/or food by eating foods less preferred, limiting portion size, borrowing food or money to buy food, skipping meals, or skipping eating for whole days. Frongillo et al. (175) reported that receiving food from a food pantry was one of the characteristics associated with older adults not eating for one or more days. Often individuals who require therapeutic diets may be unable to afford the appropriate dietary modifications (226).

Reports of food insufficiency vary from 2-16% depending on the population. Using data from the Continuing Survey of Food Intake of Individuals, Rose and Oliveria (227) found that about 2.7% of the elderly aged 65 and older were food insufficient. Based on consuming ≤ 50% of the RDA and assessed by a 24-hour recall, diets of elderly individuals with food insufficiency were significantly lower in energy, calcium, vitamins A, E, B-6, folate, riboflavin, niacin, and zinc than those with sufficient food (227). Burt (3) noted that approximately 8-16% of older people experience food insecurity in a six month period.

Actual poverty verses real poverty

The major risk factors for food insecurity are household resources and the portion of those resources that must be spent on non-food expenditures, such as housing, health care emergencies, taxes, and discretionary income. Individuals with low incomes have limited access to food and fewer food choices, particularly when other needs, such as medication, utility bills, or rent, are perceived as more pressing. Even older adults who are not poor may live on a fixed income. As expenses increase, these older adults may opt to reduce their food intake, thereby placing themselves at increased risk for poor nutritional status.

Income level and adequacy of income to meet the basic needs are issues. In a small qualitative study (n=41), Wolfe et al. (223) concluded that in addition to limited incomes, poor health and physical disabilities, high medical bills and medicine costs, unexpected expenses such as house repairs and medical emergencies are factors that contribute to food insecurity. This finding is consistant with Roe (228), who found that food insecurity was associated with physical immobility and lack of in-home assistance as well as poverty.

A relative form of poverty occurs when an older person on a fixed income is prescribed a very expensive drug or the utility bill is very high due to cold weather. The older person may decrease food intake to purchase medication or pay the utility bill.

The impact of economic limitations can be reduced by the use of public and private food programs, having savings, the availability of children or other family members, and through various food management strategies which are a product of long lives and rich life experiences (223). Elders draw on their survival of previous hardships as a coping strategy for present problems (221). Nevertheless, a study by Stitt et al. (229) reported that older people know what they should eat, and because of past experiences know how to budget their money, yet they simply don't have enough money to buy the food they need.

On the other hand, food expenditures may not always accurately reflect food availability. Not all individuals who spend less than the United States Department of Agriculture's suggested amount of $30 per week per individual (46) are food insecure. For example, some individuals grow or have access to home-grown foods, commodities, home-delivered meals, or other food sources, all of which reduce food insecurity.

The availability of family members was extremely important in preventing or lessening food insecurity (223). Moreover, availability of neighbors also decreased the anxiety associated with food insecurity due to transportation and other physical disabilities. Unfortunately, those with low economic resources tended to have smaller social support networks (212).

Reduced social contact

The protective effect of social networks has been documented. Mortality rates were highest for those receiving low levels of social support (230). The protective effect of social support increases as women age and have more social network contacts and neighborhood integration (231).

McIntosh et al. (212) found that both financial well-being and extensive friendship networks were important in producing adequate diets. Companionship appeared to buffer against the negative effects of poor appetite. In another study Tonner and Morris (232) found that elderly individuals with support from family, friends, and neighbors had higher dietary adequacy in general, and higher intakes of vitamin A, thiamin, niacin, folate, iron, and dietary fiber. Keller et al. (233) found that men and women with higher levels of social support had a higher diet score, which was based on the number of portions consumed each day from the food groups. Moreover, men but not women, with higher levels of social support had higher mean adequacy ratios, calculated as nutrient density of nine dietary components.

Social isolation

Although unrelated to age, the number of social contacts was the most important independent predictor of the degree of loneliness ($r=-.35$) and increased loneliness negatively impacted energy, protein, and phosphorous intake (234). In contrast, individuals who were more socially active reported less loneliness and increased dietary intake (234).

Living arrangements

Depending on the end points, not living with a spouse may not be detrimental. First, living alone doesn't necessarily increase mortality. Older women who live alone were not at increased risk for mortality, but a change in living arrangements from living alone to living with others or from living with a spouse to living with others increased the risk of mortality (235). For men, survival time was not associated with living arrangements (235).

Using data from the 1987-1988 Nationwide Food Consumption Survey, Gerrior et al. (236) reported there were no significant differences in dietary intakes between women who lived alone and those who lived in multi-person households. On the other hand, men who lived alone consumed lower levels of carotene, vitamin E, and fiber than men who lived with others. Men and women aged 75 or over who lived alone had significantly lower protein intake, calcium, and zinc than those who lived with others. Analyzing data from the 1977-78 Nationwide Food Consumption Survey, Davis et al. (237) reported similar results in that men who lived alone had a higher risk of poor dietary quality than those who lived with a spouse, but for women, dietary adequacy was not decreased by living alone. Living alone accounted for fewer calories, but not necessarily poorer food choices (237). In a smaller study (n=268), Ryan and Bower (238) also found no difference in dietary intake between men and women over age 55 living alone or with others; however, very few (11%) had adequate nutritional intake on the basis of a 24-hour recall.

McIntosh et al. (212) reported that although marital status had no effect on dietary intake, mealtime companionship and help with cooking increased energy, protein, and micronutrient intake. Additionally companionship acted as a buffer against poor appetite by increasing dietary intake in those with a poor appetite. Those who live alone eat less, especially older men, compared to those who eat with others (222). De Castro et al. (239) concluded that having other people present was the strongest determinant of meal size, regardless of time of the eating occasion (meal or snack), where it was eaten, or whether alcohol was ingested with the meal.

Reduced dietary intake by those living alone or not having a mealtime companion may be associated with meal skipping. Using the 1977-78 Nationwide Food Consumption Survey, Davis et al. (240) reported that compared to persons living with a spouse, persons living alone were more likely to skip meals in general and specifically to skip breakfast. This breakfast skipping pattern declined with age. In a study of elderly nutrition program participants, Frongillo et al. (175) reported that living alone was one of the characteristics associated with elderly person's not eating for one or more days. This was especially true for home-delivered meal participants.

Despite previous reports of adequate dietary intake, Ranieri et al. (216) found that living alone was associated with poorer nutritional status measured by TSF, serum protein levels, and measures of immunologic function.

Social support loss and bereavement

The elder who has lost a spouse or caregiver to ill-health or death may be at particularly high risk for developing protein-energy malnutrition. Not only is social support gone, so is instrumental support. Rosenbloom and Whittington (241) concluded that energy intake and total diet quality dropped within two years of the death of a spouse. The widows were more likely to report a poor appetite, decreased enjoyment of meals, and weight loss compared to those who were married (241).

Although spousal death negatively impacted diet, other losses can lead to depression and anorexia as well, for example death of a child (242). Death of a sibling or confidant leads to a shrinking social support system and can result in an extended grieving process. This loss is more detrimental if it occurs after the death of a spouse (243). Death of a pet can result in a reaction parallel to that following human bereavement (244). Even moving from the long term family home into an apartment can result in long-lasting grief.

Sensory impairment

Sensory impairment decreases a person's ability to interact with others and the environment to obtain necessities, such as food or medical care. Vision and hearing losses are functional losses that interfere with food procurement, preparation, and consumption (178).

Loss of hearing alters ability to function by decreasing activity and increasing depressive symptoms (245). Yet, good hearing was negatively associated with diet quality (233). A possible explanation may be that seniors who are quite deaf receive more formal and informal supports that promote adequate diets. The increased social supports may be due to cognitive dysfunction, since hearing loss contributes to cognitive dysfunction (246).

Vision loss affects multiple domains of function. Poor vision increases the likelihood of falls (247) and hampers driving. Inability to see may cause older adults to be reluctant to leave their homes to do grocery shopping or eat with others (210). These combine to foster isolation and reduce dietary intake in community-dwelling elderly. Keller et al. (233) reported that adequate vision was significantly associated with increased dietary adequacy and overall energy intake.

In summary, many factors influence the risk of developing a poor nutritional status. Not all factors which increase risk can be eliminated. Nevertheless, it is important to identify those who may be at increased risk. Frequently, older adults are unaware that they may be at increased risk for poor nutrition. By becoming aware of a potential preventable problem, older adults can be on guard to maintain adequate dietary intake. By minimizing nutritional risk, older adults may be able to maintain a higher quality of life and healthy active lifestyle and reduce medical costs. Identifying those with increased risk is best done by a multifaceted, comprehensive assessment including anthropometric, biochemical, clinical, and dietary assessments.

Indicators of malnutrition

It is important to take practical action against nutritional risks at an early stage, to prevent or delay the downward spriral to negative energy balance, complications, ill-health and finally death (248). For this reason it is important to identify those with increased risk for developing malnutrition. Currently there are no recognized standards to identify malnourished individuals because the cut-off points for anthropometric and biochemical measures that demark malnutrition vary among investigators.

Anthropometric measures

As of today, nationally representative reference populations are only available for individuals up to age 74 (249). Expanded reference populations are expected soon from NHANES III. Until then, we must use studies that have reported various anthropometric measures with limited numbers of individuals ≥ 75 years. Characteristics of these older adults vary according to the samples reported. Some report measures in institutionalized subjects (250, 251) while others report measures in elderly nutrition program participants (252, 253), or in very healthy volunteers (254, 255).

In place of standardized reference populations, minimal criteria for comparison samples are: 1) population should be well-nourished, 2) each age/sex group of the sample should contain at least 200 individuals, 3) the sample should be cross-sectional, 4) sampling procedures should be defined and reproducible, 5) measuring procedures should be optimal, 6) measurements should include all variables to be used in nutritional evaluation, and 7) raw data and smoothing procedures should be available (256). Most of these criteria are not met in current reports of anthropometric data.

Consistency of methods among studies varies. For example, some studies report left arm measures (251, 255) while others report right arm measures (249, 257, 258). Still others report non-dominant arm (253, 259). The World Health Organization (260) states that the right arm should be used in measuring arm circumference. Particularly confusing is the *Anthropometric Standardization Reference Manual* (261) which states one should use the right arm to measure TSF, yet demonstrates finding the location of the mid-arm point by using the left arm. Moreover, Gibson (262) presents tables of percentiles for TSF and mid upper arm circumference by Frisancho (263) who uses the right arm. Yet in a section on common errors (page 159), Gibson (262) refers to the wrong arm as the right.

Despite all the confusion with reference populations, anthropometry remains a significant component of assessment of an elderly person's nutritional status. Anthropometric characteristics of individuals and populations are simple, strong predictors of future ill health, functional impairment, and mortality, and may be modified by disease. As such, anthropometry provides non-invasive, indirect information about subcutaneous fat stores, muscle mass, and changes in body size. The use of anthropometry in protein-energy malnutrition is based on the assumption that the size of muscle in both well-nourished and malnourished bears a constant relationship to muscle composition. Recent short-term semi-starvation produces no detectable changes in muscle mass, protein, or total energy content, while chronic semi-starvation causes muscles to atrophy and results in a different composition of the body (264). Body weight (muscle and fat), TSF, MAC, and calf circumference are reduced during long-term semistarvation, although serum albumin and visceral protein shown as immune function are preserved (264). Adipose tissue is a measure of the body's energy reserve; whereas skeletal muscle is a measure of the body's protein reserve. When these body stores become depleted, normal body functions may become progressively and severely compromised (265). Since the loss of muscle and fat can be insidious, frequent anthropometric measures and monitoring over time may provide the primary clues that intervention is warranted.

Height and weight

Height and weight measured periodically are simple, inexpensive, safe, practical indicators of body composition and changes in it. Using height and weight measures is effective in monitoring changes within an individual, provided the measures are taken, recorded, and plotted accurately. These measures can be compared to reference populations or to previous measures of the individual to assess body composition or increasing nutritional risk.

A well-known change that occurs with aging is a decrease in stature (266, 267). Several explanations for this observation have been proposed: A shortening of the spinal column resulting from a narrowing of the vertebral discs, a shrinkage of the vertebrae themselves, or symptoms of osteoporotic changes resulting in curvature of the spine or even bowing of the legs (268). Most of these decreases occur in the spine, yet length of long bones remains stable with aging (266). Therefore, it is possible to use arm length (269), arm span (270), or knee height (271) as a surrogate to calculate stature when stature could not otherwise be obtained. Roubenoff and Wilson (272) suggested that in older aldults particularly, knee height was better correlated to fat free mass than standing height. Based on data from NHANES III, gender-specific and ethnic-specific formulas have been developed to calculate current stature using age and knee height (273).

Body weight is a global measure and may reflect various alterations in body composition at different ages. Poor nutritional status develops insidiously with signs that are nonspecific. Therefore measures taken every four-to-six months may pick up important trends. A single body weight may be of little value; however, serial measures can identify changes. Fluctuations are likely to occur, but the trend over time is important.

To assess a single measure of weight in Americans, standard reference values of ideal body weight were derived from data published by actuaries of the Metropolitan Life Insurance Company (274). For these reference standards, concern was with mortality risk rather than nutritional risk. However, this standard was not age-specific. To correct these limitations, age-specific (up to 74 years) and body size standard reference models were established using data from NHANES I and II (263). Significant deviations either above or below standardized norms suggest increased risk for protein-energy malnutrition. These are usually set at ≤ 10^{th} percentile and ≥ 95^{th} percentile.

Height to weight indices were developed to assess weight in relationship to height. BMI [weight (kilograms)/height (meters^2)] is accepted as a better estimate of body fatness/leanness and health risk than body weight alone (275). While determination of BMI yields valuable information, several limitations still exist. For the muscular individual, BMI tends to overestimate body fatness. BMI provides no information about body fat distribution or bone mineral loss. In the elderly this can be especially problematic, since there is a redistribution of fat from the limbs to the trunk (276). BMI by itself is not a sensitive indicator of protein-energy malnutrition, because it does not distinguish between depletion of fat or muscle (164). Low BMI will include some individuals who normally weigh less than is usual for their height, but are not malnourished.

Inadequate protein and/or energy intake can result in progressive wasting of fat and muscle tissues to the point where there is delayed wound healing, decreased immune function, and even increased mortality. Those who are over 70 years of age show an increased hazards ratio of 2.3 for a BMI <18 and 1.6 for a BMI of 18-20 (137). This may indicate that a BMI of 18 may be too low for health. Epidemiological studies have shown that mortality risks increase with a BMI <22 (123). Low BMI is an important predictor for mortality when combined with renal failure (277) or chronic obstructive pulmonary diseases (278). BMI cut-off points used to describe malnutrition have ranged downward from 22 (96, 163, 164).

On the other hand, increased fatness can lead to increased risk of morbidity and mortality as well. *The Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults* (279) defined overweight as a BMI of 25-29.9, obesity as a BMI from 30-39.9, and extreme obesity as a BMI ≥ 40. But for those aged 70 and over, the significance of being moderately overweight is still not clear. In an epidemiological study of individuals over 70 years of age, the lowest mortality was at a BMI of 31.7 for women, and 28.8 for men (137). In the Buffalo Health Study—an age-adjusted study—BMI was not related to all-cause mortality in women (280). In yet another age-adjusted study, the lowest rate of mortality for women was found in a BMI range of 23.7-25.8 (281).

Mortality may not be the appropriate end-point to measure when looking at obesity, but rather increased risk of disability and chronic disease. Adipose tissue accumulation on the trunk vs. peripherally on the limbs is associated with increased levels of chronic disease like coronary heart disease, type II diabetes mellitus, hypertension, and dyslipidemia (282). Both obesity and thinness appear to carry risk for mortality, but in the elderly, thinness carries a greater risk than overweight (283).

Weight change. Weight change, especially involuntary weight loss, also poses risk. Recent unintentional weight loss alone and in combination with percent usual body weight (current weight / usual body weight x 100%) are important, sensitive indicators of malnutrition (85). For immediate risk, voluntary weight loss is not as critical as involuntary loss, because voluntary weight loss is usually regained, but involuntary weight loss is usually sustained (284). Unintentional weight loss is a dynamic measure of nutritional status (164). An annual weight loss of greater than 4% of body weight appears to be clinically important as an independent predictor of increased mortality (145). For older persons lesser degrees of weight loss may be of clinical significance. A 10% loss of body weight over 10 years is associated with increased mortality and functional decline (285). In an earlier study, Pamuk et al. (139) found that women who lost more than 15% of maximum BMI had twice the mortality risk as those who lost ≤ 5%. Weight loss is particularly critical for those who have a low body weight initially. Vellas and associates (112) report that as the percentage of usual weight decreases, decreased muscle mass occurs resulting in weakness and increased risk for falls and disability. Weight loss of 10% or more past age 50 is associated with almost three times increased risk of hip fracture (118). Pamuk et al. (140) reported that relative risk was 2.3 for those who lost weight if baseline BMI was 26 to<29 and 1.4 if baseline BMI was ≥ 29.

If height, weight, and weight change are the only indicators relied upon, underestimation of nutritional risk could occur, especially in the elderly. For example, edema, hypertrophy of cancerous condition, or preexisting obesity could mask the actual severity of muscle or fat loss (265). Therefore, more detailed characterization of body composition may be warranted.

Skinfold thickness

Subcutaneous fat stores seen in TSF play an insignificant role in daily body metabolism, but depletion of this compartment can reflect chronic inadequate intake or nutrient deprivation. Measurement of TSF provides an estimate of body fat stores, and is a particularly good indicator of malnutrition among elderly women (286, 287). Nevertheless, loss of muscle does not necessarily mean a loss of subcutaneous fat layers (288).

TSF is easy to measure and cost effective yet there are limitations in the elderly. Changes in the elasticity, hydration, and compressibility of subcutaneous adipose and connective tissues can alter the relationship of skinfold thickness measurements to other measures of body composition (289). The physical response to undernutrition is variable in older adults, which makes evaluation difficult. Difficulties arise when using one or two sites for diagnosis of malnutrition because body composition can vary widely (66); therefore, several skinfold sites should be measured to minimize intra-individual fat distribution differences (99). As an alternative to skinfolds, circumferences can be measured for body fat estimations (265).

Circumferences

MAC provides an index of total body energy stores and muscle mass compartments of the arm. Although MAC can be used as an independent measure of muscle protein stores (164), it is often combined with TSF. From these measures mid-arm muscle area (MAMA) can be calculated: $[MAC-(\pi \times TSF)]^2 / 4\pi$ (262). Keys et al. (69) reported that MAMA is the most sensitive index of malnutrition in a young population; however, these same characteristics seem to hold for the older adults. MAMA is usually depressed during chronic protein depletion, but is not significantly altered by dehydration, heart failure, ascites, or bulky tumor masses (290). Exercise minimizes the degree of atrophy in the arm, since MAMA remains unchanged in elderly who are physically active; whereas among those who are less active these muscles decrease (288).

Calf circumference is the most useful predictor of somatic protein stores and the most sensitive measure of muscle mass in the elderly, because calf circumference is independent of problems associated with BMI or changes in abdominal girth associated with aging (260). Calf circumference indicates the changes in fat-free mass that occur with aging and with decreased activity (291). If physical activity is maintained calf circumference remains relatively unchanged in an elderly individual (288). Calf circumference is particularly important because it is associated with general muscle strength, gait, and balance which are associated with the risk of falls and injury (112).

Biochemical measures

In older individuals, biochemical indicators may be the first sign of poor nutritional status (133). Just as anthropometric measures are useful for assessing long term nutritional status, biochemical measures are more sensitive and show recent changes in nutritional status (46). Usually, biochemical measures are done in a health care setting.

Serum albumin

Just as calf circumference assesses somatic protein stores, serum albumin assesses visceral protein status. Early studies concluded that serum albumin was the best indicator of prolonged protein shortage and negative changes in protein status (286). More recent studies continue to show that low serum albumin (3.5 g/dL) is a strong predictor of mortality (96), extended hospital stay, and readmission to the hospital or admission to a nursing home (57,87, 98). In those who have a catastrophic event, e.g. a stroke, serum albumin is an important predictor of the degree of disability (89).

Serum albumin concentrations respond slowly to protein restriction and low concentrations may be a reflection more of illness than of nutrient intake (164). Hypoalbuminemia may be the result of a nutrition-related decrease in protein synthesis; however, hypoalbuminemia is not specific to only malnutrition. Hypoalbuminemia may be present due to overhydration and many disease processes including inflamation, or medication (164, 292). Due to these numerous confounding factors, the extent to which serum albumin reflects protein stores and nutritional status is unclear (99). Therefore, this measurement is best utilized to identify high risk persons most likely to benefit from additional nutritional evaluation and intervention (99).

Total lymphocyte count

Low lymphocyte count coupled with low serum albumin is characteristic of protein-energy malnutrition (67), although not always. Low dietary intake of zinc, selenium, and vitamin B-6 all depress immune response (293).

Serum cholesterol levels

Low cholesterol levels ($<$ 160 mg/dL) have been associated with poor health outcomes (294, 295). In a study of 104 nursing home residents, primarily females, over age 60 with relatively good health, Frisoni (296) showed that older adults with total cholesterol below 130 mg/dL had an eight fold greater risk of dying over an 18 month period. Harris et al. (297) reported a J-shaped relation between serum cholesterol and mortality in elderly women. Low levels of serum cholesterol may be due to low levels of carrier proteins common with malnutrition. Therefore, those with low cholesterol levels may be considered at risk for malnutrition.

Clinical measures

The medical history can identify specific nutritional risks. Diseases, their treatments, prescription and over-the-counter medications can all increase nutritional risk. Symptoms that decrease dietary intake include anorexia, early satiety, nausea, dysphagia, and a change in bowel habits. Each of these symptoms has a cumulative effect in the amount of risk it contributes to developing malnutrition (134).

Physical examination may occasionally reveal subtle and non-specific signs suggestive of malnutrition. A general appearance of subcutaneous fat loss, muscle wasting, dehydration, and/or fluid retention may be indicative of protein-energy malnutrition. Abnormalities in the nails, bruising, skin color and turgor, spongy bleeding gums, tooth loss, tongue texture, angular stomatitis and cheilosis are all indicators of possible malnutrition (46). Functional status or changes in functional status may suggest malnutrition.

Mental and cognitive conditions such as anxiety, memory deficits, and depression may have a direct impact on the individual's ability to eat, purchase, and prepare food. In a regression analysis that assessed nutritional risk in 240 cognitively-intact adults in their 60's, 80's and 100's, poor mental health status was a strong predictor of nutritional risk (170).

Socio-demographic measures

The amount of social support available from family, neighbors, church members, and others can improve nutritional status (212, 223, 239), particularly if the functional assessment indicates that the person is frail and his cognitive and mental status are poor. Low income is one of the sociodemographic predictors of low dietary intake (298). Reuben et al. (169) reported that low income was an independent predictor of serum albumin in community-dwelling older adults. Keller et al. (233) reported that low income was predictive of low dietary variety and specific nutrient intake.

Dietary measures

Another way to assess nutritional risk is by examining current dietary intake and eating patterns. Accurate assessment of dietary intake is difficult and each field method of assessment has advantages and limitations.

Multiple day food records

In a 10-year longitudinal study that assessed changing nutritional status of 304 healthy elderly, Vellas et al. (196) collected dietary information yearly by 3-day food records. Women who were above or below recommended energy levels at baseline were more likely to be sick or die within the next ten years. Those with higher protein levels (>1.2 g/kg body weight) were more likely to have fewer health problems than those with lower intakes.

This method provides quantitatively accurate information concerning food consumed during the recording period. This particular method avoids memory error which is likely to occur if cognitive impairment is present. However, this method has a few weaknesses: 1) the respondent must be literate and motivated to complete the record, 2) the foods consumed during the recording period may not reflect usual foods consumed, and 3) coding of the records (which may not be consistently recorded) can lead to high personnel costs (13). Even though this method is considered the "gold standard" for community studies, energy intake as recorded in 7 days of food records was significantly lower than total energy expenditure as measured by doubly labeled water for both young and elderly women (299).

24-hour recall

Using a 24-hour recall for dietary assessment, Ritchie et al (4) found in a small sample (n=49 of primarily black elders) that over half did not consume 75% of estimated energy needs and over one-third did not consume 75% of estimated protein needs. These individuals were likely malnourished for some length of time because about a third were underweight (<24 BMI) and about 20% had depressed serum albumin (≤3.5 g/dL).

There are many advantages to this method of assessment: it is simple, quick, and useful if the individual may not complete and return dietary records. In this method, dietary intake is not consciously altered as it may be if the individual has to write down everything he has eaten. However, a 24-hour recall relies on a person's memory, and many elderly persons have memory impairments, which lead to inaccurate intake estimates (13). Moreover, individual diets vary day to day. The previous day may not be representative of usual intake. When compared to observed intake, individuals with higher mean intakes tended to underestimate amounts of food consumed on the 24-hour recall. On the other hand, those who had low mean intakes tended to overestimate dietary intake (13). Finally, Sawaya et al. (299) found no relationship between reported 24-hour dietary intake and TEE as measured by doubly labeled water.

Semi-quantitative food frequency questionnaire (SQFFQ)

Using a food frequency questionnaire with almost 50,000 Canadians, Keller et al. (233) reported poor dietary intake was predictive of low BMI, while more diet variety and higher nutrient intake was associated with better perceived health, better functional status, and better vision.

SQFFQ provides information regarding dietary patterns instead of food consumption on one or more days. A SQFFQ is usually self-administered making it easy to use for the interviewer and the individual. This method appears to give the best estimate of usual dietary intake. Using doubly labeled water to estimate of total energy expenditure in older women, Sawaya et al. (299) found that the SQFFQ gave mean energy intakes that were closer to measured total energy expenditure than did 7-day weighed food records.

Diet history

Diet history can help to identify low dietary intake in older adults in the months preceeding hospitalization. When compared to non-hospitalized elderly, those who were hospitalized were more likely to have lower energy intake, vitamin A, niacin, calciferol, and iron intake (2). More than twice as many hospitalized as unhospitalized elderly women followed a prescribed diet which restricted dietary intake.

This method of assessment provides more complete dietary information than the other methods. It combines a person's usual intake assessed through a SQFFQ with additional details about the characteristics of the food. Food habits are characterized by asking questions regarding size, frequency, timing, and location of meals. This helps to identify risk factors—regularly skipping meals, lack of variety from all of the food groups, and eating < 1 hot meal per day—that might be present (300). Food preferences according to taste or ethnic or religious background can also be identified as can use of dietary supplements, being on a special diet, and consumption of unusual amounts of alcohol, sweets, or fried foods. The major strength of using a diet history is its assessment of usual meal patterns and details of food intakes rather than intakes that cover a short period of time. Since meals are characterized, nutrient interactions may be observed. By focusing on a meal, some repondents find it easier to report how many servings are consumed. In contrast, respondents who 'graze' find this method very difficult to complete.

Most of the methods of dietary assessment can be time consuming, place a high burden on the respondent, and require professional administration. In order to minimize these problems, the Nutrition Screening Initiative (NSI) was developed to screen older adults for risk of developing malnutrition.

Nutrition Screening Initiative

In response to the preventive health objectives of Healthy People 2000 (301), the NSI was formed to promote nutritional screening in health and medical care screenings (302). The NSI, funded in part through a grant from Ross Laboratories, is a multidisciplinary project of the American Dietetic Association, the American Academy of Family Physicians, and the National Council on the Aging plus 30 other key nutrition, medicine and aging organizations (303). Composed of leading experts in nutrition and geriatrics, the Technical Review Committee reported a consensus of the risk factors (178) and indicators (134) of poor nutritional status in older adults. It then developed a program and materials to help health professionals screen the health of older Americans and provide consistent nutritional care throughout America's health care system (46). Three levels of screening tools were developed: The DETERMINE Your Nutritional Health Checklist, Level I Screen, and Level II Screen (6).

DETERMINE Your Nutritional Health checklist, Level I Screen and Level II Screen

The NSI utilizes a three-tiered approach initiated by self-screening, conducted by the individual or primary caregivers. The DETERMINE Your Nutritional Health Checklist is one page with a simple 10-item checklist. Written at the fourth to sixth grade reading level (304), these 10 statements assist individuals in recognizing aspects of their lifestyle that may place them at nutritional risk. The DETERMINE Your Nutritional Health checklist name comes from:

D isease

E ating poorly

T oothless/ mouth pain

E conomic hardship

M ultiple medications

I nvoluntary weight loss

N eeds assistance in self-care

E lder years above age 80

The resulting score from the DETERMINE checklist may warrant further assessment with the Level I Screen or Level II Screen.

Level I Screen. Level I Screen is a primary risk assessment tool for use in community settings (305). In areas where the number of health professionals is limited, these tools assist health care providers by identifying individuals who should be referred to a physician, social worker, or dietitian. Questions in the Level I Screen seek to expose risk in four areas: body weight and height, eating habits, living environment, and functional status.

Level II Screen. Level II Screen, usually administered by a health care provider, includes in-depth investigation of anthropometrics, laboratory analysis, a physical examination, and interview (6). The information gained is sufficient to diagnose malnutrition and target the individual for intervention.

Scoring of DETERMINE Your Nutritional Health checklist. The DETERMINE checklist (Appendix A) consists of 10 statements, each describing a risk factor for malnutrition. Each statement is assigned points ranging from one to four. The respondents are to circle the point/s if they agree with the statement. The points are summed for a total. A score of 0-2 identifies individuals who are at low nutritional risk. A score of 3-5 identifies those at moderate risk. Those who score ≥ 6 have a high nutritional risk.

Studies using DETERMINE Your Nutritional Health checklist

Although the DETERMINE checklist was developed as a self-administered screening and awareness tool, the checklist has had widespread use in a variety of settings. As seen in Table 1, many investigators have reported the results of the DETERMINE checklist screening, frequently citing questions that have high frequency of positive responses.

Many Elderly Nutrition Programs, medical clinics, and, more recently, HMOs have used the DETERMINE checklist as a screening tool. Many studies have reported large percentages of older adults at high and moderate risk for developing malnutrition (Table 1). Initially most states screened Elderly Nutrition Program participants, (20, 21, 26, 27, 306). Others chose to focus on home-delivered meal participants (22). Still others focused on populations that would be less likely to be at nutritional risk—attendees of fairs (24, 25). The DETERMINE checklist has been used in the clinical setting (307) and as a screening tool for Medicare applicants for HMOs (23). The latter study reports the highest percentage of those at high nutritional risk—50% of 16,000.

A review of literature revealed a dearth of comparisons between nutritional indicators and the DETERMINE checklist. Table 2 contains the studies that have compared the DETERMINE checklist with other nutritional indicators. The initial study conducted by Posner et al. (7) assigned the weights and cut-off points for nutrition risk. Only one study has compared the results of the DETERMINE checklist with anthropometric, biochemical and dietary measures (196). Only two studies have reported a comparison between dietary intake and the DETERMINE checklist (17, 18).

Table 1: The DETERMINE Your Nutritional Health Screening results in various states using many different populations.

Date, Study	Location, sample, source	N	% High risk	% Moderate risk
1993 Clawson, Howell[306]	Iowa. ENP participants	10,485	32	42
1995 Vailas, Nitzke[27]	All Wisconsin. ENP* participants	21,000	27	32
1995 Benedict et al.[20]	All Nevada ENP participants	2,044	25	30
1995 Ryan, Bundrick[308]	1 county in South Carolina ENP + Self-selected convenience sample	402	31	26
1995 Herndon[22]	NW Indiana. HDM** participants	245	33	39
1995 Reiter et al.[307]	Wisconsin. Family medical clinic	69	28	39
1995 Spangler, Eigenbrod[24]	Indiana State Fair, Indiana Black Expo. Self-selected convenience sample	283	19	34
1995 Garofalo, Hynak-Hankinson[21]	All New Jersey. Self-selected, convenience sample (includes ENP)	8,760	30	33
1996 Rood et al.[26]	All Utah. 29 CM*** sites	838	15	28
1996 Stouder, Spangler[25]	NE Indiana, HF#, CM, HDM participants	HF-848	4	21
		CM-531	20	31
		HDM-534	44	35
1996 Kerekes, Thornton[23]	Medicare HMO enrollees	16,000	>50	NA
1997 Sahyoun et al.[309]	Boston, MA. Nutrition Status Survey Follow-up women	381	27	45

* ENP = Elderly Nutrition Program

** HDM = Home-delivered meal participants

*** CM = Congregate meal participants

HF = Health Fair Attendees

Table 2. Studies that compare the DETERMINE checklist with other nutritional measures.

Date, Study	Location, sample source	N	Other nutritional indicator
1993 Posner et al.[7]	New England. Medicare recipients	749	24-hour recall
1994 Melnik et al.[17]	Albany, NY. Senior center, Convenience sample	49	Food frequency
1996 Coulston et al.[19]	California. HDM applicants	230	Anthropometric, biochemical, 24-hour recall
1997 Phillips, Read[18]	Nevada. ENP, Senior centers Convenience sample	90	SQFFQ

In what is called the validation study (16), Posner et al. (7) collected data from a random sample of participants of the New England Elders Dental Study conducted in 1990. Using a stratified random sample of Medicare participants, the New England Elders Dental Study measured height, weight, and took a 24-hour recall. On the basis of this single 24-hour recall available for 449 individuals, inadequate intake was defined as consuming any 3 of 5 nutrients—protein, thiamin, vitamin A, vitamin C, and calcium—at <75% of RDA. Approximately 20% of the sample had inadequate intake according to this definition. Using inadequate intake and perceived health status as predictor variables, a set of weights "was assigned to the items [on the checklist] to reflect each item's relative importance as an independent predictor of nutritional risk"(p.974, 7). One would expect that the relationship between each question on the DETERMINE checklist and predictor variables—inadequate intake and perceived health—would be strong. Yet only 3 questions—eating fewer than 2 meals per day, eating few fruits, vegetables or milk products, and not having enough money—were significantly related to inadequate intake. Only two questions—having an illness that changed dietary behaviors and taking ≥ 3 medications per day—were significant predictors of poorer perceived health status. Moreover, the DETERMINE checklist identified only 46% of those with poor perceived health and 36% of those with inadequate intake. The authors of this study recommended that the DETERMINE checklist be independently validated.

Soon afterward, Melnik et al. (17) compared each question on the DETERMINE checklist with dietary intake calculated from a 60-item food frequency questionnaire. Only three questions—having an illness (r=.11), eating few fruits, vegetables, or dairy products (r=.16) or eating alone (r=-.34)—showed correlations ≥ ±.10 with mean adequacy ratio. Mean adequacy ratio is based on adequacy compared to the RDAs of nine nutrients—protein, iron, calcium, phosphorus, vitamin A, vitamin C, thiamin, riboflavin, and niacin. Unfortunately, this study did not report the correlation between each dietary indicator and total DETERMINE checklist scores or nutritional risk categories of the DETERMINE checklist.

In a more recent study, Phillips and Read (18) compared subjects' BMI with scores on the DETERMINE checklist and a calculated nutritional inadequacy score based a SQFFQ. To assess nutritional risk, these researchers developed a nutritional inadequacy score based on 2/3 of the RDA for nine nutrients, plus excessive amounts of cholesterol (range 0-5). Phillips and Read (18) found that DETERMINE checklist scores were not related to BMI; however, their nutritional inadequacy scores were related to BMI. Approximately 20% were found at high risk using the DETERMINE checklist, whereas only 9% were identified as at high risk by having a nutritional inadequacy score ≥ 3.

A comprehensive study compared those who were at nutritional risk based on anthropometric, biochemical, or dietary indicators with those who scored at-risk on the DETERMINE checklist (19). Meals-on-Wheels applicants (n=230) aged 60-90 years who were free from terminal illness were assessed. Any applicant was judged at nutritional risk if BMI was<24, if TSF or MAC was $< 10^{th}$ percentile, if energy intake was < 1.5 times the basal energy expenditure (BEE), if serum albumin was ≤ 3.5 g/dL, or if serum cholesterol was <4.14 mmol/L. Under these criteria, 74% of the applicants were judged at nutritional risk compared to 83% who were identified at high nutritional risk by the DETERMINE checklist. The report did not mention if those who were judged at nutritional risk by the DETERMINE checklist were the same as those judged at nutritional risk via other indicators. The mean BMI of those judged at nutritional risk was above 22, which is above the at-risk cut-off point suggested by NSI. Although activity level of these Meals-on-Wheel applicants was not reported, it would seem reasonable to assume that activity level was sedentary; therefore BEE x 1.5 would likely result in a positive energy balance and weight gain. Moreover, for the results that are reported, it is impossible to tell which indicator contributed the largest percentage of individuals deemed at nutritional risk. It is therefore difficult to tell if these high cut-off points for at nutritional risk indicators resulted in an excessive number at nutritional risk (74%). Mean biochemical measures—serum albumin and cholesterol—in those identified at-risk are above at-risk cut-off points. This seems to indicate that factors other than biochemical measures identify those who are at nutritional risk.

As can be seen with the few studies that compare the DETERMINE checklist questions with other measures of nutritional assessment, the effectiveness of the DETERMINE checklist to identify those with nutritional risk is questionable.

Problems with the DETERMINE checklist

There are two main types of nutritional risk: the first is long-standing, against which early-warning signs and early preventative action are needed. The second type of nutritional risk may be sudden, following medical or social stress. It remains unclear which type of nutritional risk the DETERMINE checklist is screening, if either. Presumably, the checklist is screening for the long-standing, slowly developing nutritional risk.

Ideally, screening tools should be easily applied, cost-effective, and reasonably sensitive and specific (99). The DETERMINE checklist is easy but may not be particularly effective. In the initial study (Posner et al., 1993) the DETERMINE checklist had very low sensitivity because almost two-thirds (64%) of those with poor nutrient intake and over half (54%) of those with poor perceived health were missed. The poor sensitivity may be due to the fact that half of the questions which remained on the final version of the DETERMINE checklist had no significant relationship to either poorer perceived health or inadequate intake.

The DETERMINE checklist focuses on nutritional status, functional status and a variety of physical and mental illnesses which may compromise nutritional function (99). The attempt to screen for numerous factors simultaneously may compromise efficiency, as this tool has been shown to have a relatively low specificity with a low predictive value (7). Self-referrals are encouraged by use of this tool and include a significant number of false positives. This constitutes a drain on available health resources. Identifying a large number of individuals who may be at high risk may be in the best interest of the major funding source for NSI—Ross Laboratories, a company which makes food supplements and, as such, has a clear financial interest in the success of this program. Moreover, NSI is managed by a public relations firm from Washington DC and two of the major sponsoring organizations have a major stake in who will provide care to the elderly and what services are reimbursable (310). Perhaps because of its development by consensus and widespread support of geriatric professionals, the DETERMINE checklist has not gone through the careful and systematic evaluation that usually occurs prior to the introduction of other therapeutic or preventative strategies.

Furthermore, there are some definite problems with the checklist questions. Negative phrasing and awkward phrasing leads to confusion in the elderly (311). Even though the developers of the checklist took great care to create a series of statements usable with individuals with a low literacy level (284), the questions may still confuse many elderly individuals. For example, does having an illness that leads to dietary changes include those changes that were implemented over ten years ago? Moreover, not all dietary changes are illness induced, so are these changes included? Eating fewer than two meals may not occur frequently, yet how big is a meal? If left up to an older individual's discretion, especially if the screen is self-administered, many older persons would not be identified at-risk when in fact they are.

Another problem with the current DETERMINE checklist is that one item asks more than one question. Fruits and vegetables are not similar to dairy products. Therefore each of these items should be addressed in separate questions. Moreover, how many is "few"? Individuals often view what they currently eat as about right. "Few" should be quantified to reduce confusion. Both of these changes appear to have been successfully implemented in Wisconsin (312). Although the NSI suggested that the DETERMINE checklist and Screen I and II can be modified to meet individual screening needs; this problem is likely widespread. It would seem more appropriate to make changes and conduct a validation study nationally instead of expecting each local area to commit resources to what might be duplicate efforts.

Although the DETERMINE checklist has been widely accepted as a screen for nutritional risk, validation of the scoring method has not been done. Frequently the study completed by Posner et al. (7), which developed the scoring system for the checklist, is also identified as the validation study (21, 309). Materials distributed by NSI indicate that the DETERMINE checklist is a "validated, reliable measure of potential nutritional risk" (16 p.16). However, Posner et al. (7) are quick to point out that this is not a validation study and such a study should be conducted.

Problems with methodology

In the study which calculated weights and cut-offs (7), a single 24-hour recall taken approximately one year earlier was used to assess dietary adequacy. For older individuals, a single 24-hour recall may not be the best method to assess dietary intake. A 24-hour recall is simple and rapid; however, it depends on the ability of the subjects to recall accurately and does not account for day-to-day variability. Current health status may affect recall and cause the recall period to be unrepresentative of current intake. Dietary recall underestimates energy intakes by about 6% (13). Furthermore, data from a single 24-hour recall should not be used to estimate the proportion of the population that has adequate or inadequate diets (313). Estimates of nutrient intake from a single 24-hour recall increase variations because there is variation in usual intake between people, but also from day to day for each person (68). Instead, a semi-quantitative food frequency questionnaire is more effective to assess current dietary intake (299).

If the DETERMINE checklist is to assess current nutritional risk, dietary intake should be measured at the same time. It is these kinds of difficulties that resulted in elimination of about a quarter of the survey population who said they had modified their diet within the nine months between the 24-hour recall and the DETERMINE checklist. These individuals would have been the most likely to have an illness, yet were not included in the analysis (15).

Finally the DETERMINE checklist is supposed to identify those with increased nutritional risk. As such, a longitudinal study should have been conducted to assess the ability of the DETERMINE checklist to predict increased at-risk nutritional indicators.

The study conducted by Posner et al. (7) only used dietary information to assess predictability of the DETERMINE checklist to identify nutritional risk. No biochemical or anthropometric measures were taken to identify nutritional risk. To date, no other studies have completed such comparisons to validate the DETERMINE checklist.

Less than 75% of RDA of the selected nutrients may not be an appropriate standard to identify risk. The current RDA for protein may be the very minimum that an older adult should consume (9). An amount < 75% of the RDA for protein would then severely jeopardize the older adult's health causing that person to be at a very increased risk for infection and loss of muscle mass (314). This is also true for calcium. Intake of < 75% of the RDA would jeopardize bone mineral density to such a degree that an individual would be at increased risk for osteoporosis and susceptibility to fractures and increased disability (112). However an intake < 75% of the RDA for vitamin A may not be critical for the health of older adults because even with intakes <75% of the RDA serum retinol levels remain high (8). Therefore, perhaps other nutrients may have been more appropriate to identify inadequate intake. Finally, although the relationship between self-rated health and survival has been established, no such relationship has been established between self-rated health and being at-risk for poor nutritional status (315).

The Technical Review Committee maintains that the Checklist is not a definitive diagnostic tool. Despite the checklist's proven inability to identify those with poor nutrient intake (7, 17-19), this tool continues to be used to screen older adults. It is likely that use will increase dramatically because new federal guidelines, which took effect July 27, 1998, require health plans with Medicare risk contracts to assess the health of all new enrollees within 90 days of enrollment (28).

Unfortunately, many managed care providers are turning to the DETERMINE checklist to assess nutritional risk.

Purpose of research

Most previous studies have used special populations (19) or convenience samples (17, 18) to compare the results of the DETERMINE checklist with nutritional indicators. Details concerning the nutritional status of the elderly who do not use the ENP appear to be non-existent. Although several studies have tried to reach the non-users of the elderly nutrition program through senior centers, churches, grocery stores, newspapers and physician offices (21, 308), yet none of the previous studies have actively sought out an entire area, relying instead on a self-selected convenience sample. Moreover, many elders who are likely to be at increased nutritional risk may not be mobile or well enough to participate in activities outside the home.

The purpose of this research was to examine the ability of the DETERMINE checklist to identify rural, elderly, community-dwelling women who are at nutritional risk. To overcome the biased samples of earlier studies, we used a stratified random sample of 250 Iowa women aged 65 or more. These women were selected from counties which have high risk profiles for the elderly: 1) at least 16% of those 65 and older are in poverty, 2) at least 50% of those 65 or older do not have a high school diploma, 3) at least 65% of those 65 or older live in rural areas, 4) at least 10% of the population are 75 or older, 5) at least 40% of those 75 or older live alone, and 6) the county has three or fewer senior nutrition program sites. We collected data at two time points -- baseline and six months later. By using a longitudinal study, a test of the ability of the DETERMINE checklist to predict nutritional risk in six months can be made. Moreover, by using a random sample with interviews within the home, those who are at increased nutritional risk may be more likely to be identified. The instrument consisted of a SQFFQ, anthropometric measures, questions concerning social isolation, socio-demographic variables and two screening tools from NSI—the DETERMINE checklist and Level I Screen. Use of multiple measured anthropometric indicators will minimize error from self-reported measures and permit assessment of differences in fat distribution. Use of a SQFFQ will minimize error due to intraindividual day-to-day variation in dietary intake, while estimating usual usual intake. The reported research will minimize the sampling and methodology errors of previous research.

The hypotheses tested by this research were:

A. Using the DETERMINE checklist, women aged 65 and over who score at high (6 points or more) or moderate (3-5 points) risk have significantly lower anthropometric measurements than those who are at low risk.

B. Using the DETERMINE checklist, women aged 65 and over who score at high (6 points or more) or moderate (3-5 points) risk have significantly lower energy, protein, vitamin A, vitamin C, folate, calcium, iron, fiber and fruit and vegetable intake than those who are at low risk.

C. Older women who have less social support have significantly lower protein and energy intake and significantly lower anthropometric measures.

D. Total energy and protein intakes are directly related to anthropometric measures in the elderly.

ANTHROPOMETRIC MEASURES OF RURAL, ELDERLY, COMMUNITY-DWELLING WOMEN AND THE ABILITY OF THE DETERMINE CHECKLIST TO PREDICT THESE MEASURES

A paper submitted to *The Journal of Nutrition for the Elderly*

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Abstract

Using a stratified random sample of 249 older rural community-dwelling women, this study evaluated the predictability of the DETERMINE checklist to identify those with at-risk anthropometric measures. A modified DETERMINE checklist found 7% and 42% of the sample to be at high and moderate nutrition risk, respectively. For those 85 and older, having an illness, a ten pound weight change, or a nutritional risk score ≥ 6 identified those who more were likely to have at-risk anthropometric measures. Young-old (65-74 years) individuals were likely to be identified at-risk by large anthropometric measures, whereas those who were oldest-old (≥ 85 years) were more likely to be identified at-risk by small anthropometric measures.

Key words: DETERMINE checklist, aged, anthropometric measures, BMI, elderly women

Introduction

Americans over age 65 are a fast growing segment of the population with those 85 and older the fastest growing group (U.S. Bureau of the Census, 1995). By the year 2000 national projections suggest that the elderly will number some 35 million and will constitute 13.1% of the population (U.S. Bureau of the Census, 1995). These numbers are projected to continue to increase as the babyboomers become an "elderboom". By 2030 projections suggest that at least 22% of the population will be over age 65 (U.S. Bureau of the Census, 1995). It is important to remember that the elderly are a heterogeneous group: some live a long productive lifestyle while others are plagued by chronic disease, disability, and heredity factors that place them at increased health risk.

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Health risks are behaviors and attributes which can jeopardize one's well-being and lead to a poor quality of life. One of the health risks for those over 70 is a body mass index (BMI) of <22 (Campbell et al., 1991; Tayback, 1990; Davis et al., 1994; Stevens et al., 1998; Klein et al., 1997; Allison et al., 1997; Diehr, 1998). Health risks increase even more dramatically with a BMI of <20 as evidenced by increased mortality, more frequent hospital admissions for longer stays, leading to higher health care costs (Burns and Jensen, 1995). Galanos and colleagues (1994) identified both low (<18.9) and high (>34.7) BMI as risk indicators for functional impairment. Vellas and associates (1992a) have identified those who are likely to fall with decreasing BMI. Increased potential for hip fracture also occurs with decreased BMI (Greenspan et al., 1994), resulting in increased health care costs, hospitalization and increased institutionalization (Gumby and Morley, 1994; Chima et al., 1997).

High BMI as well as low BMI can pose health risks. Either overweight or underweight is an indicator for malnutrition (Dwyer et al., 1994). Allison et al. (1997) reports that mortality for women increases when BMI is ≥ 35, whereas others suggest increased mortality at a BMI of ≥ 32 (Tayback et al., 1990; Stevens, et al., 1998 Diehr et al., 1998).

Although one of the easiest measures to calculate, BMI alone is not a sensitive indicator of health risk, because it does not distinguish between fat or muscle mass (McWhirter and Pennington, 1994). Measurement of triceps skinfold (TSF) provides an estimate of body fat stores (Vellas et al., 1992b). Kohrt and associates (1992) reported that skinfolds are greater in those who are sedentary, resulting in risk for increased mortality (Davis et al., 1994). When energy stores are reduced, TSF provides a particularly good indicator of malnutrition among older women (Mitchell and Lipschitz, 1982; Friedmann et al., 1997). Ham (1994) identifies those below the 10^{th} percentile of TSF as more likely to change from independence to dependence in activities of daily living. Cedarholm et al. (1995) reports that TSF values help to predict who will have more hospital days, more frequent infections, and increased hospital mortality rates. In addition to TSF, mid arm circumference (MAC) also identifies those at risk for hospital mortality (Constans et al., 1992; Frisoni et al., 1994), or increased length of hospital stay (Finestone et al., 1996). MAC reflects both protein and fat reserves whereas TSF only reflects fat reserves (Chumlea et al., 1986). To determine protein reserves, calf circumference may be a better indicator. Calf circumference is the most sensitive measure of muscle mass in the elderly (WHO, 1995), which indicates the changes in fat-free mass that occur with aging and with decreased activity (Baumgartner et al., 1995). Vellas et al. (1992a) suggest that low calf circumference is a predictor of increased risk for falls. Moreover, muscle loss with or without fat loss results in loss of strength and endurance (Verdey, 1995).

Perhaps one of the biggest difficulties in identifying those with increased risk is that there are no anthropometric reference standards for those who are aged 75 and older. Standards for those younger than 75 have been developed using a national multi-stage stratified random sample (Frisancho, 1990). Chumlea and colleagues (1985b, 1986) have reported recumbent measures for institutionalized individuals. Numerous other studies have reported mean measures of BMI in convenience samples (Baumgartner et al., 1995; Chumlea and Baumgartner, 1989b; Prothro and Rosenbloom, 1995; Silver, 1993). Kubena and associates (1991) reported percentiles for BMI from a convenience sample; however, there are only two age groupings.

Only Burns and colleagues (1986) reported mean MAC; other reports from convenience samples use a larger age range which make comparisons difficult (Falciglia et al., 1988; Kubena et al., 1991). Several studies report mean TSF measures (Czajika-Narins et al., 1991; Kubena et al., 1991; Prothro and Rosenbloom, 1995; Burns et al., 1986). Only Falciglia et al. (1988) reported percentiles for the older ages; however, age ranges were large again making comparisons difficult. To date, no other percentile measurements of calf circumference for older women have been published.

Although anthropometric measures are important indicators of health risk, it may not be feasible to collect anthropometric information from community dwelling older adults; therefore, it is important to be able to identify those who are at risk without actual measures. For example, many do not visit a physician regularly, or if they do, anthropometric measures are not recorded. Moreover, many of those who may be at risk are frail and homebound making it difficult to collect anthropometric measures. The DETERMINE checklist was developed by the Nutrition Screening Initiative (NSI) as a screening and educational tool to identify those who are at risk of developing malnutrition (White et al., 1992). Although a few studies have correlated some anthropometric measures to scores on the DETERMINE checklist (Klein et al., 1997; Friedmann et al., 1997; Jensen, 1996), none have looked at the DETERMINE questions individually and collectively as they relate to anthropometric measures.

The purposes of this paper are 1) to report selected anthropometric measures of five cohorts of community-dwelling women aged 65 and over and 2) to ascertain the ability of the DETERMINE checklist to predict anthropometric measures associated with health risk in elderly women.

Methods

Sample

Using a longitudinal design, data were collected in a stratified random sample at two time points—baseline and six months later. This report discusses baseline results only. The population for sampling was community-dwelling older women in counties with high risk profiles for the elderly: 1) at least 16% of those 65 and older were in poverty, 2) at least 50% of those 65 or older did not have a high school diploma, 3) at least 65% of those 65 or older lived in rural areas, 4) at least 10% of the population were 75 or older, 5) at least 40% of those 75 or older lived alone, and 6) this identified county had three or fewer senior nutrition program sites.

Eight counties met these criteria. Four counties were randomly selected to form the sampling population. Using the white pages of the telephone book and driver's license applications, a market survey company drew the sample of 1,000 women to our specifications: 1) three equally distributed age groups of women 65-74, 75-84 and 85 or older, 2) lived in the identified counties, 3) and lived in a single family dwelling or small apartment building. Those who did not have a phone or had an unlisted number were excluded from the samples.

Four hundred ninety eight women were sent introductory letters and subsequently contacted by telephone asking for an in-home interview. Of these contacts 181 refused to participate and 68 were not eligible due to death or move to a less independent living arrangement, leaving a total sample size of 249 (57.9% response rate). The mean age difference between participants [76.8 ± 7.19 (range 65-94)] and those refusing to participate [76.3 ± 7.21 (range 65-95)] was not statistically significant. This study was approved by the Institutional Review Committee on Use of Human Subjects in Research.

Data collection

A trained interviewer who is a registered dietitian conducted the in-home interviews. The data collection instruments and methods were pilot tested with five volunteers over age 75, who had similar levels of education and income as the study population. The instrument was revised and then retested with eight female volunteers who were over age 70.

The survey consisted of a modified DETERMINE checklist and anthropometric measures. The NSI developed a checklist consisting of 10 statements, each describing a risk indicator for malnutrition (Dwyer, 1991). Each statement is assigned points ranging from one to four. The respondents circle the points if they agree with the statement. A score of 0-2 identifies individuals who are at low nutritional risk. A score of 3-5 identifies those at moderate nutritional risk, whereas those who score ≥6 have a high nutritional risk. The survey DETERMINE checklist was modified in the following ways: A question format is used rather than a statement format, the second person is substituted for first person, and both "yes" and "no" response options are available. For example, "I eat few fruits or vegetables, or milk products" was changed to "Do you eat few fruits or vegetables or milk products?" The maximum score remained 21 for the modified DETERMINE checklist.

Knee height, weight, TSF, MAC, and calf circumference were measured. Anthropometric measurements were collected using the techniques described in Lohman's *Anthropometric Standardization Reference Manual* (Lohman et al., 1988). Left knee height was measured using a sliding caliper (Ross Labs) by having the subject sit so that the knee and ankle were at 90° angles. Weight was measured on a portable beam balance scale (Detecto) with each participant wearing only light clothing (no shoes). TSF was measured three times on the left arm at a point between the acromion and the olecranon over the triceps muscle with a Lange skinfold caliper. MAC was measured three times at midpoint of the left upper arm with a plastic insertion tape (Ross Labs). While the subject was seated, calf circumference was measured three times at the fullest part of the left calf. A mean was calcuated for TSF, MAC, and calf circumference. Repeated measures were not significantly different from each other.

Data analysis

The mean of two knee height measures was used to calculate height (Chumlea et al., 1998). BMI was calculated by dividing the individual's weight in kilograms by their height in meters squared. BMI, MAC, TSF, and calf circumference were used in analysis as continuous measures as well as discrete measures. Nutrition risk level was established for each participant using selected anthropometric risk cut-off points. Each of the checklist's ten questions and nutrition risk scores established by NSI as risk cut-off points were evaluated on their predictability of an at-risk anthropometric measure.

Statistical analysis

Using SAS, descriptive statistics consisting of means, standard deviation, percentages and frequencies were used to describe the population (SAS Institute, 1997). Chi-square was used to determine odds ratios for each question, total risk score, risk score ≥6 and risk score ≥ 3 and at-risk levels for BMI, MAC, TSF and calf circumference respectively. In addition to odds ratios for the overall sample, odds ratios were determined for each of three age cohorts: 65-74, 75-84 and ≥ 85 years. Linear regression was used to determine significance between means of those who answered "yes" and those who answered "no" to each question, total risk score, risk score ≥6 and risk score ≥ 3 and BMI, MAC, TSF and calf circumference.

Results

Demographic variables are presented in Table 1. This group of women was well-educated with one-third having some post secondary education. The lowest mean level of education was in the youngest group and the highest mean was in the oldest group. In those aged 85+, 42% had post-secondary education. Approximately 22% of the women had household income ≤ $9,000. Mean household income overall was <$25,000. The percentage of women with household income of ≤ $9,000 increased from 7.3% in those aged 65-69 compared to 42.6% in the oldest group. Approximately 47% of all the women were married. This percentage progressively decreased from 83% in the 65-69 aged group to just 12% in the group aged 85+. Almost half of the women lived alone. The percentage progressively increased from 12% in the youngest group to 85% in the oldest group.

Anthropometric measures

Age-specific percentile distributions for BMI, MAC, TSF and calf circumference are presented in Table 2. The mean measures of BMI, TSF, MAC and calf circumference showed differences that are apparently related to aging: the measures decrease with age. The mean BMI of the overall group was 28.41 (±5.35). The mean BMI steadily decreased from 29.66 (±5.54) in the youngest age group to 27.03 (±5.06) in the oldest age group. The mean BMI of the oldest group of women was 8.9% less than the youngest group.

The overall mean MAC was 31.85 (±4.66) cm. The mean MAC steadily decreased from 34.15 (±4.16) cm in the youngest age group to 29.65 (±4.61) cm in the oldest age group. The overall mean TSF was 28.64 mm (±10.23). The mean TSF progressively decreased from 33.51 (± 9.28) mm in the youngest group to 24.04 (±10.41) mm in the oldest group. The mean calf circumference was 37.34 (±4.19) cm with mean ranges from 38.96 (±4.78) cm in the youngest group to 35.94 (±4.28) cm in the oldest group. TSF and MAC measures consistently dropped over the age groups at 5^{th} percentile, but this was not true for measures in the 95^{th} percentile. At higher percentiles, age did not appear to be the determining factor in identifying upper limits.

DETERMINE checklist

In this random sample of community dwelling elderly women, 7% were identified as being at high risk for developing malnutrition. An additional 42% were identified as being at moderate risk for developing malnutrition. The numbers (and percentages) of "yes" responses to each DETERMINE checklist question and risk scores are found in Table 3. The overall mean risk score was 2.6, ranging from 1.8 in the youngest group to 3.1 in the oldest group. In the youngest group of women, 29% were at moderate risk, with 2% at high risk. In the women aged 70-74, 50% were at moderate nutritional risk with an additional 3% at high nutritional risk, with scores ranging up to 10.0. For the women aged 75-79, scores ranged up to 11.0 with 40% at moderate nutritional risk and 12% at high nutritional risk. Scores for those aged 80-84 ranged up to 4.0, with 51% at moderate nutritional risk. Scores for the oldest group of women ranged up to 7.0, with 38% at moderate nutritional risk, with 17% at high nutritional risk.

Three questions answered "yes" most frequently by the respondents were having an illness, eating alone and taking multiple medications. Having an illness resulting in dietary changes was reported by 37% of the women, with almost one-third of that number in the 70-74 age group. Over half (56%) reported using multiple medications. Almost half (49%) reported eating alone most of the time. Only 14% of the youngest group of women reported eating alone, but these percentages increased over five fold to 82% of those aged 85 and older. Six of the ten questions had less than a 10% "yes" response rate as seen in Table 3. Three questions had only one or two "yes" responses.

Comparison of DETERMINE checklist questions to at-risk anthropometric measures overall

The odds ratios and 95% confidence intervals (CI) associated with each question and nutrition risk score are presented in Table 4. In the overall sample, having an illness or condition that changed dietary intake significantly increased the odds of having an at-risk MAC (<26.0) by 2.75 (95% CI=1.21-6.25). It also increased the odds of having at-risk TSF [either low (<15.5 mm) or high (>41.3 mm) TSF] by 1.88 (1.01-3.51). Women who were eating few fruits, vegetables or milk products had 4.27 (95% CI=1.42-12.78) increased risk for either underweight or obesity. Eating alone resulted in a risk of 1.33, 1.37, 1.16 and 2.25 for at-risk BMI, MAC, TSF and calf circumference, respectively. Eating alone approaches significance only in CC (p=0.068). Multiple medications resulted in an odds ratio of 1.02, 1.18, 0.89 and 1.33 for at-risk BMI, MAC, TSF, and calf circumference, respectively. A ten pound weight gain or loss had odds ratios of 1.56, 2.08 and 3.08 for at-risk BMI, TSF, and calf circumference respectively. Weight change only identified at-risk calf circumference. Inability to shop, cook and feed oneself had an odds ratio of 0.81, 3.04, 1.19 and 2.30 for at-risk BMI, MAC, TSF and calf circumference respectively. Inability to shop, cook or feed onesself was only significant in identifying those with an at-risk MAC.

Total DETERMINE checklist scores of 3-5, indicative of moderate nutritional risk, had odds ratios of 1.31, 3.65, 1.71 and 2.21 for at-risk BMI, MAC, TSF and calf circumference, respectively. The only anthropometric at-risk measure that had increased likelihood of occurring was MAC. Odds ratios for total DETERMINE checklist scores of ≥ 6 were only able to be calculated for at-risk MAC and calf circumference, which were 4.06 and 1.18 respectively. Once again a score of ≥ 6 only identified those with an at-risk MAC.

Comparison of DETERMINE checklist questions to at-risk anthropometric measures within three age cohorts

Having an illness identified those with at-risk TSF only in the cohort aged 65-74 (OR=2.66, p=0.046). A ten pound weight change only identified those aged 85+ with an at-risk MAC (OR=5.50, CI 1.17-25.91). Eating alone, multiple medications, and inability to shop, cook or feed yourself did not reach significance for any age cohort or anthropometric measure. Moreover, neither a score of ≥ 6 nor ≥ 3 was able to identify any at-risk anthropometric measure.

Comparison of DETERMINE checklist questions to continous anthropometric measures

Using continuous anthropometric measures (not categorizing individuals into at-risk or not at-risk) may be more appropriate to identify their relationship to the DETERMINE checklist questions. Overall, only one question --eating alone--revealed a significant difference in the means for MAC (eat alone=32.5 cm, not eat alone=31.16 cm) and TSF (eat alone=30.6 mm, not eat alone=26.6 mm) between those who eat alone and those who do not eat alone. However, neither those who ate alone nor those who did not eat alone had an MAC or TSF that would identify them at nutritional risk.

More anthropometric differences between those who answered "yes" and those who answered "no" were apparent in each of the three age cohorts. For those 65-74, the only question that showed a difference between the responses was eating alone. TSF was significantly lower in those who ate alone; however, the mean TSF of those who ate alone (mean TSF=28.0) was not at-risk. A nutrition risk score of ≥ 6 for those aged 65-74 identified those with significantly different mean BMIs. The mean BMI for those who had a total risk score ≥ 6 was 35.36 which placed them at-risk, whereas those who had a score of 0-5 had a mean BMI of 29.1. Calf circumference means were also significantly different in this age group, however, both means were above 32.3 cm.

For those aged 75-84, no questions identified those who are at nutritional risk based on anthropometric measures. Moreover, mean scores (either total score, risk score ≥ 6, or risk score ≥ 3) were not significantly different between those who responded "yes" and those who responded "no".

For those aged ≥ 85, two questions--illness and weight change--showed a difference in "yes" and "no" respondents. Those who reported an illness had significantly lower BMI (24.0 vs. 26.7) and MAC (30.4 cm vs. 26.1 cm) than those who did not. However, none of these measures denote an at-risk status. Those who reported a weight change of ≥ 10 pounds had significantly lower mean BMI (22.6 vs. 27.9), mean TSF (14.8 mm vs. 25.9 mm), and mean calf circumference (26.6 cm vs 32.6 cm). Once again the mean BMI, TSF and calf circumference of those who responded "yes" did not reach at-risk status. Those who had a total risk score ≥ 6 had a mean MAC of 26.1 cm which was significantly different (p=0.015) from those who had a risk score of 0-5 (MAC=30.4), but once again not indicating at-risk status. Differences between the mean BMI (27.7 vs. 24.0) approached significance (p=0.068) for women aged 85+; however, neither mean reached at-risk status.

Discussion

This study extends the findings of past investigations by reporting calf circumference in ambulatory community dwelling elderly women. Moreover, this is the first report of a random sample of apparently healthy community-dwelling older women. This study includes sufficient numbers of women ≥ 85 years to determine body composition into the ninth decade. Often older individuals are lumped together into a single group, which hides changes that occur with aging (Kubena et al., 1991; Burns et al., 1986). In past research, if five-year divisions are made, insufficient numbers were available for reliable measures (Chumlea et al., 1989a; Czajka-Narins et al., 1991; Silvers et al., 1993; Prothro and Rosenbloom, 1995).

Examination of age distributions of the mean BMI, TSF, MAC and calf circumference showed a trend toward decreasing measures. These trends continued in percentile distributions, especially for TSF and MAC measures. Upper percentile distribution trends were not as consistent with age as the lower percentile distribution, especially for calf circumference. BMI percentile distributions were inconsistent among age groups at even the mid range percentile distribution, suggesting that fat and protein stores vary inconsistently among age groups. This may be due to the heterogeneous nature of the older adult population, especially obvious in a small random sample.

Mean BMI and percentile distributions are consistently higher than have been reported in previous studies (Czajka-Narins et al., 1991; Baumgartner et al., 1995; Kubena et al., 1991; Chumlea et al., 1989a; Silvers et al., 1993; Prothro and Rosenbloom, 1995). Two previous studies targeted populations already identified as at-risk nutritionally (Czajka-Narins et al., 1991; Prothro and Rosenbloom, 1995). Still others targeted an urban population (Kubena et al., 1991) or populations that were more health conscious (Silvers et al., 1993; Baumgartner et al., 1995). Moreover, most of the data in these studies were collected over a decade ago (Czajka-Narins et al., 1991; Baumgartner et al., 1995; Kubena et al., 1991; Silvers et al., 1993; Prothro and Rosenbloom, 1995). Over the past ten years, BMI has increased in the U.S. population (Flegal et al., 1998). It would seem reasonable to assume that mean BMI is also increasing in the elderly as well. This has been shown in yearly measures in a healthy elderly population in New Mexico which showed a trend for both increasing BMI and MAC (Vellas et al., 1992b). In a more recent study in a similar rural population (Jensen et al., 1997), BMI measures calculated from self-reported height and weight measures were very similar to those found in the current study in which height and weight were measured.

Physical aspects of measuring stature can be difficult and inaccurate at times due to excessive curvature of the spine, particularly kyphosis, in the elderly than among younger persons. Chumlea, Roche, and Steinbaugh (1985a) suggested that knee height provided a reliable substitute for stature. Knee height changed only slightly with age, and therefore provided a clearer picture of adult stature before degenerative changes have occurred (Roubenoff and Wilson, 1993). Gender and ethnic specific equations developed from nationally representative data allowed predicted stature values using knee height and age to be acceptable surrogates in nutritional indexes (Chumlea et al., 1998).

Mean and lower percentile distribution of MAC and TSF in our population were consistently higher than in previous studies (Frisancho, 1990; Kubena et al., 1991; Falciglia et al., 1988). Mean calf circumference were also larger compared to previous studies (Chumlea et al., 1985b; Baumgartner et al., 1995); however, these studies used the recumbent method to measure the calf.

DETERMINE checklist

Information concerning the population and the percentage of subjects at moderate or high risk in previous studies is shown in Table 5. Using the DETERMINE Checklist risk score as an indicator, half of the participants scored at low nutritional risk. The current results are similar to those from convenience samples reported by Phillips and Read (1997) and Spangler and Eigenbrod (1995) and for congregate meal (CM) participants reported by Stouder and Spangler (1996). In statewide screenings of elderly nutrition program (ENP) participants, Vailis and Nitzke (1995) and

Benedict et al. (1995) found slightly fewer at low nutritional risk (41%, 45% respectively); however, Rood et al. (1996) found slightly more (57%). In the first study, which derived a set of weights for the individual checklist items, the percentage of those who were identified at low nutritional risk was much lower (37%); however, the participants were all over age 70 and 35% over age 80 (Posner et al., 1993).

In the current study, almost 42% were at moderate risk. This is a much higher percentage than most studies (Posner et al., 1993; Vailis and Nitzke, 1995; Benedict et al., 1995; Rood et al., 1996; Weddle et al., 1997; Phillips and Read, 1997). The high percentage of moderate risk in the current study can be explained by the low percentage of those with high nutritional risk—only 7.2%. The percentage of those at high nutritional risk was reported lower (4.7%) only in a study conducted at a health fair for seniors (Stouder and Spangler, 1996). Among CM participants, Rood et al. (1996) found 15% identified at high nutritional risk, with a slightly larger percentage reported by Stouder and Spangler (1996) and Philips and Read (1997).

At least one-third of the participants identified three areas that increase nutritional risk: having an illness that resulted in a dietary change, eating alone, and taking multiple medications. These same high-risk areas were identified by others (Benedict et al., 1995; Rood et al., 1996; Ryan and Bundrick, 1995; Spangler and Eigenbrod, 1995; Stouder and Spangler, 1996; Vailas and Nitzke, 1995; Vailas et al., 1998). Compared to the current study, a larger percentage of ENP participants experienced problems with each of the individual questions on the checklist, except changing dietary habits due to illness (Vailas et al., 1998).

Less than 5% of the current study's participants identified four areas of risk: (1) eating fewer than 2 meals per day, (2) eating few fruits, vegetables or dairy products, (3) consuming ≥ 3 alcoholic beverages per day, and (4) not having enough money to buy food. In previous studies (Sahyoun et al., 1997; Ryan and Bundrick, 1995; Spangler and Eigenbrod, 1995), eating fewer than 2 meals per day was an identifier in < 10% of the respondents. This percentage was much lower (2%) in more recent reports (Vailas et al., 1998). In the current study 5% of the respondents reported low intake of fruits, vegetables, or dairy products, which corresponds to 10% reported by Ryan and Bundrick (1995). Moreover, studies which report a high percentage of individuals eating few fruits, vegetables or dairy products have either quantified the desired serving amounts (Vailas et al., 1998), or administered the questionnaires by trained interviewers who may have interpreted the question for the respondents. In Midwest studies, Vailas et al. (1998) and Spangler and Engenbrod (1995) reported similar low percentages of high alcohol consumption. This is in contrast to east coast studies which reported much higher alcohol consumption (Ryan and Bundrick, 1995; Sahyoun et al., 1997). Previous studies also report < 10% of the individuals who do not have enough money to buy food (Vailas et al., 1998, Spangler and Eingenbrod, 1995; Garofalo and Hynak-Hankinson, 1995). In contrast, < 1% of the current study reported such difficulties.

Fewer "yes" responses to the individual questions may be due to some difficulties in using the DETERMINE Checklist. Negative phrasing leads to confusion. Changing the statement in first person to a question in the second person did not alleviate awkward wording. Even though the developers of the checklist took great care to create a series of statements usable with individuals with a low literacy level (NSI Technical Review Committee, 1995), the questions still confused many elderly participants. For example, does having an illness that leads to dietary changes include those that occurred over ten years ago? Moreover, not all dietary changes are illness induced, so are these included? In response to the question concerning consumption of few fruits, or vegetables or dairy products, participants said, "I eat a lot of ...., and a few ..... so the answer is no." Changing the response to this question alone would probably have increased the number of women identified as having high nutritional risk. Only two individuals reported eating fewer than 2 meals per day; however, many questioned "How big is a meal?" If left up to the older individual's discretion, especially if the screen is self-administered, many older persons would not be identified at-risk when in fact they are.

Another problem with the current DETERMINE checklist is that one item asks more than one question. Fruits and vegetables are not similar to dairy products. Therefore each of these items should be addressed in separate questions. Moreover, how many is "few"? Individuals often view what they currently eat as about right. "Few" should be quantified to reduce confusion. Both of these changes appear to have been successfully implemented in Wisconsin (Vailas et al., 1998). Although the NSI suggested that the DETERMINE checklist and Screen I and II can be modified to meet individual screening needs, this problem is likely widespread. Why not modify the checklist and screens at the national level? It would seem more appropriate to make changes nationally instead of at the local level.

In the current study, several other questions may not have identified those who could be at risk. For example, only one individual reported "not having enough money to buy the food you need". However, 55 individuals (22%) reported household incomes below $9,000. Even though many participants reported growing gardens, preserving food and practicing prudent spending, many that were likely to be at-risk were not identified. Moreover, the question involving inability to shop, cook and feed yourself did not identify those who did not have adequate transportation available. Questions about using alcohol or eating alone may not be effective at identifying risk. Perhaps a change, particularly a loss in one's social network, may identify risk better than eating alone.

Although the DETERMINE checklist has been widely accepted as a screen for nutritional risk, validation of the scoring method has not been done. Frequently the study completed by Posner et al. (1993), which developed the scoring system for the checklist, is also identified as the validation study (Sahyoun et al., 1997; Garofalo and Hynak-Hankinson, 1995). Moreover, materials distributed by NSI indicate that the DETERMINE checklist is a "validated, reliable measure of potential nutritional risk" (NSI, 1996 p.16). However, Posner et al. (1993) is quick to point out that this is not a validation study and such a study should be conducted.

The current findings have limitations common to other cross-sectional studies, which are limited to one point in time, and therefore can not provide insight to dynamic relationships. A built-in bias may result in selective survivorship; that is, death of either larger or smaller individuals. Only longitudinal studies can eliminate this bias. The current study used a cohort of randomly selected, rural, community-dwelling, older white women who were well-educated and had a higher income than the census norm for the area. As a result, the current findings may not be generalizable to all older women. Moreover, some participation bias may have occurred, resulting in fewer older individuals who may be at higher nutritional risk, even though those who chose not to participate were not older than participants.

In summary, this study can provide useful norms for ambulatory white elderly women. Identifying individuals who have nutritional vulnerability is important to reduce health risk. Findings from this study indicate little relationship between each of the DETERMINE checklist questions, nutritional risk scores, and selected anthropometric measures in general. Young-old individuals were likely to be identified at-risk by large anthropometric measures, whereas those who were oldest-old were more likely to be identified at-risk by small anthropometric measures.

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Table 1: Frequency of selected demographic characteristics of Iowa women 65 years of age and older: overall and stratified by age.

Variable	overall	65-69 years	70-74 years	75-79 years	80-84 years	85+ years
Number of Participants	249	42	66	57	37	47
Household Income < $9,000	54	3	8	12	11	20
Education						
Grade school or less	31	4	5	8	6	7
Some high school	23	6	6	2	4	5
High school diploma/GED	113	21	33	28	16	15
Some college	54	7	12	14	6	16
Bachelor's degree +	28	4	10	5	5	4
Live alone	124	5	23	30	26	40

Table 2: Anthropometric measures of rural community-dwelling, older women by age categories: Means, standard deviations and selected percentiles.

Anthropometric measure	Overall	65-69 years	70-74 years	75-79 years	80-84 years	85+ years
Mean BMI	28.41± 5.35	29.66± 5.54	28.96± 5.03	28.70± 5.95	27.30± 4.74	27.03± 5.06
5th percentile	20.22	23.09	23.51	19.54	20.0	19.2
10th percentile	21.72	23.51	23.17	20.98	20.95	20.23
25th percentile	24.30	26.79	25.05	23.83	23.64	23.88
50th percentile	28.19	29.23	28.94	29.37	26.03	26.51
75th percentile	31.49	32.01	32.09	31.97	30.31	29.63
90th percentile	34.71	34.69	34.58	37.01	32.83	32.73
95th percentile	37.54	40.95	36.45	38.62	34.62	34.57
Mean mid arm circumference (cm)	31.85± 4.66	34.15± 4.16	32.57± 4.14	32.19± 5.07	30.24± 3.95	29.65± 4.61
5th percentile	24.71	27.87	26.47	24.76	24.73	22.23
10th percentile	26.00	29.33	27.43	25.27	25.03	23.70
25th percentile	28.41	31.73	29.23	28.13	27.33	26.40
50th percentile	31.82	33.97	33.00	32.03	29.92	29.27
75th percentile	34.82	36.67	35.00	35.23	32.93	32.20
90th percentile	37.40	38.87	38.10	37.53	35.73	35.10
95th percentile	39.03	39.57	38.73	38.97	37.63	48.47

Table 2 continued.

Anthropometric measure	overall	65-69 years	70-74 years	75-79 years	80-84 years	85+ years
Mean triceps skinfold (mm)	28.64± 10.23	33.51± 9.28	30.29± 9.62	28.97± 9.94	25.55± 9.66	24.04± 10.41
5th percentile	11.52	19.33	13.33	12.33	9.00	8.67
10th percentile	15.54	22.33	16.33	16.00	11.67	10.67
25th percentile	21.20	29.00	23.67	20.33	18.90	16.33
50th percentile	28.92	32.33	28.67	28.67	24.30	22.00
75th percentile	35.32	37.00	36.67	35.67	31.67	32.13
90th percentile	41.23	46.33	42.00	40.33	39.00	38.67
95th percentile	45.69	49.33	46.55	44.33	39.67	41.67
Mean calf circumference (cm)	37.34± 4.19	38.96± 4.78	38.03± 3.81	37.27± 3.75	36.18± 3.93	35.94± 4.28
5th percentile	30.71	28.33	32.30	31.50	30.63	28.50
10th percentile	32.30	33.71	33.41	32.70	31.33	29.87
25th percentile	34.32	36.73	34.93	34.58	33.40	32.83
50th percentile	37.38	38.83	37.97	36.50	35.20	36.31
75th percentile	39.70	40.80	40.30	39.17	38.23	38.53
90th percentile	42.63	43.23	42.33	42.63	40.53	40.27
95th percentile	44.18	45.73	43.97	44.00	43.47	44.23

Table 3: Frequency and percentages of "yes" responses, from rural, community-dwelling, older women overall and by age categories, to each DETERMINE checklist question and in each nutrition risk category based on total score.

DETERMINE checklist question and corresponding points	Overall	65-69 years	70-74 years	75-79 years	80-84 years	85+ years
Do you have an illness or condition that made you change the kind and/or amount of food you eat? 2 points	94 (37%)	15 (36%)	31 (42%)	22 (39%)	14 (38%)	12 (26)
Do you eat fewer than 2 meals per day? 3 points	2 (<1%)	1	1	0	0	0
Do you eat few fruits or vegetables or milk products? 2 points	12 (5%)	3 (7%)	3 (6%)	5 (9%)	0	1 (2%)
Do you have 3 or more drinks of beer, liquor, or wine almost every day? 2 points	1 (<1%)	0	1	0	0	0
Do you have tooth or mouth problems that it hard for you to eat? 2 points	24 (10%)	4 (10%)	5 (8%)	7 (12%)	0	8 (17%)
Do you always have enough money to buy the food you need? (Coded inversely) 4 points	1 (<1%)	0	0	1 (2%)	0	0
Do you eat alone most of the time? 1 point	122 (49%)	6 (14%)	23 (35%)	29 (44%)	25 (67%)	39 (82%)
Do you take 3 or more prescribed or over the counter drugs a day? 1 point	140 (56%)	17 (41%)	38 (58%)	33 (57%)	27 (73%)	25 (53%)
Without wanting to have you lost or gained 10 pounds in the last 6 months? 2 points	28 (11%)	3 (7%)	8 (12%)	6 (11%)	3 (8%)	8 (17%)
Are you always physically able to shop, cook and/or feed yourself? (Coded inversely) 2 points	22 (9%)	0	3 (5%)	5 (9%)	2 (5%)	12 (26%)
Total with DETERMINE score at low risk (0-2 points)	126 (51%)	29 (69%)	31 (47%)	27 (47%)	18 (49%)	21 (45%)
Total with DETERMINE score at moderate risk (3-5 points)	105 (42%)	12 (29%)	33 (50%)	23 (40%)	19 (51%)	18 (38%)
Total with DETERMINE score at high risk (≥ 6 points)	18 (7%)	1 (2%)	2 (3%)	7 (12%)	0	8 (17%)

Table 4: The odds ratio and 95% confidence interval for each DETERMINE checklist question and nutrition risk score and the likelihood of having either low or low and high anthropometric measures that may result in a person being at nutritional risk. Measures that include a larger percentage of adipose tissue have both low and high at-risk cut-off points.

DETERMINE Checklist question or score	BMI <22 and > 34.7	MAC cm <26.0	TSF mm <15.5 and > 41.3	Calf cm <32.3
Do you have an illness or condition that made you change the kind and/or amount of food you eat?	1.00 0.53-1.87	2.75* 1.21-6.26	1.88* 1.01-3.51	1.45 0.62-3.37
Do you eat fewer than 2 meals per day?	❖	❖	❖	❖
Do you eat few fruits or vegetables or milk products?	4.27* 1.42-12.78	❖	❖	❖
Do you have 3 or more drinks of beer, liquor, or wine almost every day?	❖	❖	❖	❖
Do you have tooth or mouth problems that it hard for you to eat?	0.71 0.24-2.19	❖	❖	❖
Do you always have enough money to buy the food you need? (Coded inversely)	❖	❖	❖	❖
Do you eat alone most of the time?	1.33 -0.73-2.46	1.37 0.60-3.14	1.16 0.62-2.16	2.25 0.94-5.37
Do you take 3 or more prescribed or over the counter drugs a day?	1.02 0.55-1.88	1.18 0.51-2.76	0.89 0.48-1.67	1.33 0.56-3.17
Without wanting to have you lost or gained 10 pounds in the last 6 months?	1.56 0.65-3.78	❖	2.08 0.89-4.87	3.08* 1.15-8.22
Are you always physically able to shop, cook and/or feed yourself? (Coded inversely)	0.81 0.26-2.50	3.04* 1.06-8.74	1.19 0.42-3.40	2.30 0.73-7.27
Mean total DETERMINE nutrition risk score >6	❖	4.06** 1.41-11.69	❖	1.18 0.26-5.52
Mean total DETERMINE nutrition risk score ≥3	1.31 0.71-2.41	3.65** 1.48-9.05	1.71 0.91-3.12	2.21 0.93-5.28

❖Cell has count < 5. * Significant at <0.05 level ** Significant at <0.01 level

Table 5: Location and results of previous studies using the DETERMINE checklist.

Date, Study	Location, sample, source and age respondents	N	% High risk	% Moderate risk
1993 Posner et al.	New England. Medicare recipients	1,071	24	38
1995 Vailas, Nitzke	All Wisconsin. ENP* participants	21,000	27	32
1995 Benedict et al.	All Nevada ENP participants	2,044	25	30
1995 Ryan, Bundrick	1 county in South Carolina ENP and self-selected convenience sample 60 years +	402	31	26
1995 Spangler, Eigenbrod	Indiana State Fair, Indiana Black Expo. Self-selected convenience sample Women 60 years +	283	19	34
1995 Garofalo, Hynak-Hankinson	All New Jersey. Self-selected, convenience sample 55 years +	8,760	30	33
1996 Rood et al.	All Utah. 29 CM** sites	838	15	28
1996 Stouder, Spangler	NE Indiana, HF***, CM, HDM# participants	HF-848	4	21
		CM-531	20	31
		HDM-534	44	35
1997 Sahyoun et al.	Boston, MA. Nutrition Status Survey Follow-up women	381	27	45
1997 Phillips, Read	Nevada, Convenience sample	90	20	31
1997 Weddle et al.	Dade County, FL. CM participants	288	31	37
1998 Current study	Iowa, random sample, rural women	249	7	42

* ENP = Elderly Nutrition Program

** CM = Congregate meal participants

*** HF = Health Fair Attendees

HDM = Home-delivered meal participants

THE ABILITY OF THE DETERMINE CHECKLIST TO PREDICT DIETARY INTAKE OF WHITE, RURAL, ELDERLY COMMUNITY-DWELLING WOMEN

A paper accepted by *The Journal of Nutrition for the Elderly*

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Abstract

Using a stratified random sample of 249 older, rural, community-dwelling women, this study evaluated the ability of the DETERMINE checklist to identify those with at-risk dietary intakes. A modified DETERMINE checklist found 7% and 42% of the sample to be at high and moderate nutrition risk respectively. Dietary analysis of the semi-quantitative food frequency found 93% of the women to be at-risk for at least one of nine key nutrients. Over one-third were at-risk for four or more nutrients. Stepwise logistic regression revealed that only three questions from the DETERMINE checklist were predictive of at-risk nutrient intake. Neither total DETERMINE checklist score, nor a score of ≥3 nor ≥ 6 was predictive of at-risk nutrient intake.

Key words: DETERMINE checklist, aged, food frequency, dietary intake, elderly women

Introduction

The elderly are a heterogeneous group: some live a long productive life style while others are plagued by chronic disease, disability, and heredity factors that place them at increased health risk. Health risks can be minimized by adequate nutrition since nutrition significantly influences physical health, independence, and well-being, particularly for older individuals (Dwyer, 1991). Older individuals with inadequate energy, vitamin and mineral intake are more likely to develop acute illness and chronic disease (Mowe et al., 1994; Naber et al., 1997). Optimal nutrient intake improves existing health problems; minimizes complications associated with acute and chronic conditions; improves wound healing, functional capacity, cognitive thinking and quality of life; and

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extends years of healthy living (Vailas et al., 1998; Ortega et al., 1997; Vellas et al., 1997; Roebothan and Chandra, 1994; Rosenberg et al., 1992).

Health professionals have identified at least 25% of home-dwelling and up to 62% of the hospitalized elderly as malnourished (Hart, 1993; Gallagher-Allred et al., 1996; Naber et al., 1997). In addition, once in a malnourished state, elderly individuals require more calories to maintain body mass and are repleted more slowly than are younger individuals (Shizgal et al., 1992).

Because dietary intake is an important indicator of health risk, it is important to be able to identify those who are at risk without actual measures because it may not be feasible to collect extensive information from community-dwelling older adults. For example, many do not visit a physician regularly, or if they do, questions about dietary intake are not discussed or recorded. Moreover, many of those who may be at risk are frail and homebound making it difficult to assess dietary intake.

In response to these challenges the Nutrition Screening Initiative was formed to create tools to screen older individuals for nutritional risk. Seven risk factors associated with poor nutritional and health status were identified and major and minor indicators were suggested to detect individuals at risk (White, 1991). The DETERMINE Your Nutritional Health Checklist, a ten question self-administered checklist, was developed to identify those who were at increased nutritional risk and may need in-depth assessment and follow-up (White et al., 1992). A weighted scoring system for the checklist (Posner et al., 1993) permits it to be used as a screening tool. Since then, numerous studies have reported large numbers of elderly at nutritional risk based on the use of this simple questionnaire (Phillips & Read, 1997, Sayhoun et al., 1997, Spangler & Eigenbrod, 1996, Coulston, 1996; Herndon, 1995).

Although often cited as the validation study, Posner et al. (1993) called for an independent validation of the checklist because the population used to develop the scoring system was the same as the validation sample. Another problem was that dietary intake was determined by a single 24-hour dietary recall taken nine months earlier. A single 24-hour dietary recall may over estimate nutritional risk because the recall day may not be representative of usual intake or the elderly individual may not adequately recall the food and beverages consumed the previous day. In the study, perceived health and 75% of the recommended dietary allowance (RDA) (Food and Nutrition Board, 1989) for five selected nutrients were used as the indicators for malnutrition. These indicators may not be appropriate. While some nutrient intakes below the current RDAs, such as protein, may seriously jeopardize the health of the elderly individual (Campbell et al., 1994), others such as vitamin A may not be a serious threat at all (Russel and Suter, 1993).

Several studies have compared the effectiveness of the DETERMINE checklist with other screening tools (Phillips and Read, 1997; Sayhoun et al., 1997), yet none have analyzed the ability of the DETERMINE checklist to identify at-risk nutritional intake. Our study was undertaken to evaluate the ability of the ten DETERMINE checklist questions, individually and collectively, to identify at-risk dietary intake of community-dwelling, rural elderly women.

Methods

Sample

This study was approved by the Institutional Review Committee on Use of Human Subjects in Research. We collected data in a stratified random sample at two time points -- baseline and six months later. This paper presents baseline results only. The population for sampling was community-dwelling older women in counties with high risk profiles for the elderly: 1) at least 16% of those 65 and older were in poverty, 2) at least 50% of those 65 or older did not have a high school diploma, 3) at least 65% of those 65 or older lived in rural areas, 4) at least 10% of the population were 75 or older, 5) at least 40% of those 75 or older lived alone, and 6) the county had three or fewer senior nutrition program sites.

Eight counties met these criteria. Four counties were randomly selected to form the sampling population. Using the white pages of the telephone book and driver's license applications, a market survey company drew the sample of 1,000 women to our specifications: three equally distributed age groups of women 65-74, 75-84 and 85 years or older who lived in the identified counties, and who lived in a single family dwelling or small apartment building. Those who did not have a phone or had an unlisted number were excluded from the sample.

Four hundred ninety eight women were sent introductory letters and subsequently contacted by telephone asking for an in-home interview. Of these contacts 181 refused to participate and 68 were not eligible, leaving a total sample size of 249 (57.9% response rate). The mean age difference between participants [76.8 ± 7.19 (range 65-94)] and those refusing to participate [76.3 ± 7.21 (range 65-95)] was not statistically significant. Seven participants were eliminated from dietary analysis because excessively high energy or protein intakes suggested their data was unreliable.

Data collection

A trained interviewer who is a registered dietitian conducted the in-home interviews. The data collection instruments and methods were pilot tested with five volunteers over age 75, who had similar levels of education and income as the study population. The instrument was revised and then retested with eight female volunteers who were over age 70. The survey consisted of a modified DETERMINE checklist, semi quantitative food frequency questionnaire (Block et al., 1986) and categorical demographic questions. The DETERMINE checklist consists of 10 statements, each describing a risk indicator for malnutrition (Dwyer, 1991). Each statement is assigned points ranging from one to four. The respondents circle the points if they agree with the statement. A score of 0-2 identifies individuals who are at low nutritional risk, 3-5 those at moderate nutritional risk, and ≥6 those at high nutritional risk. For this study, the DETERMINE checklist was modified in the following ways: A question format was used rather than a statement format, the second person was substituted for first person, and both "yes" and "no" response options were available. For example, "I eat few fruits or vegetables, or milk products" was changed to "Do you eat few fruits or vegetables or milk products?" The maximum score remained 21 for the modified DETERMINE checklist.

Dietary intake was estimated with a 116-item semi-quantitative food frequency questionnaire (SQFFQ) designed by Block and associates (Block et al., 1986) and used by the National Cancer Institute (NCI, 1989). Respondents categorized intake according to portion size (small, medium and large) and frequency of consumption. The results of the SQFFQ provide valid information on dietary intake over an extended period of time when compared to biochemical indicators and food records (Block et al., 1992). This instrument was validated in middle-aged and older women (Mares-Perlman et al., 1993).

Data analysis

Nutrient analysis was performed using the National Cancer Institute DIETANAL computer program. (NCI, 1989). Nutritional intake was assessed by absolute intake and at-risk/not at-risk intake. Subjects were classified at nutritional risk for poor energy intake if energy intake was less than 75% of need. Need was calculated as body weight in kilograms X 24 hours X 1.2. Risk for low protein intake was identified as 75% of protein needs which was calculated as one gram of protein per kilogram of body weight. Nutritional risk for other selected nutrients—vitamin A, vitamin C, folate, calcium and iron—was 75% of the RDA (Food and Nutrition Board, 1989) or Dietary Reference Intakes (DRI) (Yates et al., 1998). Weekly fruit and vegetable intake of < 75% of 35 servings identified nutritional risk. Fiber intake of 20 g identified recommended amount with high nutritional risk at < 15 g. For an overall measure of nutritional adequacy for each individual, the number of at-risk nutrients were summed (range 0-9) to form the total nutrient risk score (TNR).

Statistical analysis

Descriptive statistics consisting of means, standard deviations, percentages and frequencies were calculated using the Statistical Analysis System (SAS Institute, 1997). Stepwise linear regression models were used to assess the ability of each DETERMINE checklist question to identify at-risk nutritional intake.

Results

Demographic variables are presented in Table 1. This group of women was well-educated with one-third having some post secondary education. In those aged 85 and older, 43% had post-secondary education. Approximately 22% of the women had household income ≤ $9,000. Mean household income overall was <$25,000. The percentage of women with household income of ≤ $9,000 increased from 10.6% in those aged 65-74 compared to 41.3% in the oldest group. Almost half of the women lived alone. The percentage of women living alone progressively increased from 26% in the youngest group to 85% in the oldest group.

Insert Table 1.

DETERMINE checklist

In this random sample of community-dwelling elderly women, 7% were identified as being at high risk for developing malnutrition. An additional 41% were identified as being at moderate risk for developing malnutrition. The numbers (and percentages) of "yes" responses to each DETERMINE checklist question and risk scores are found in Table 2. The overall mean risk score was 2.5, ranging from 2.2 in the youngest group to 3.1 in the oldest group. The mean scores between the youngest and oldest group of women are significantly different ($p<0.01$). In the youngest group of women, 40% were at moderate risk, with 3% at high risk with scores ranging up to 10. For the women aged 75-84, scores ranged up to 11 with 45% at moderate nutritional risk and 26% at high nutritional risk. Scores for the oldest group of women ranged up to 7, with 37% at moderate nutritional risk, and 17% at high nutritional risk.

Insert Table 2.

Three questions answered "yes" most frequently by the respondents were having an illness, eating alone and taking multiple medications. Having an illness resulting in dietary changes was reported by 38% of the women, but the percentage dropped with increasing age. Over half (57%)

reported using multiple medications. Almost half (49%) reported eating alone most of the time. Only 27% of the youngest group of women reported eating alone, but these percentages increased over three fold to 82% of those aged 85 and older. Six of the ten questions had less than a 10% "yes" response rate as seen in Table 2. Three questions had only one or two "yes" responses.

Dietary intake

Dietary intake is summarized in Table 3. Overall mean intake of protein, energy, vitamin A, vitamin C, iron, and weekly number of servings of fruits and vegetables met recommended levels, whereas mean intake of folate, calcium and fiber were below recommended levels. Mean total and saturated fat intakes, 31.8% and 11.5% of total energy respectively, are above recommendations. Across the three age groups, the only significant difference in intake was iron ($p < 0.04$), which was lower in the oldest group compared to the younger two groups. Although not significant, the middle group, aged 75-84, consistently had higher mean intakes of most nutrients—energy, protein, folate, iron, fiber, and fruit and vegetable servings.

Insert Table 3.

Figure 1 shows the percentages overall and between age groups for intakes of nutrients which are below 75% of the recommended level. The percentage of women not meeting 75% of calculated energy needs decreases across the three age groups, from 60% to 40%. The percentage of the oldest women with inadequate protein intake is 2.5 times higher than in the youngest women. The percentage of the oldest women with inadequate iron intake is 17% compared to only 11% for the young-old women.

Insert Figure 1.

Reported intakes for vitamin A, vitamin C, folate, fruit and vegetable servings and fiber are all relatively stable across the three age groups. A larger percentage of those 65-74 have an inadequate energy, fiber, and calcium intake compared to the other age groups. For those in the oldest age group, a larger percentage consume inadequate amounts of folate, vitamin C, and protein. The group aged 75-84 had the highest percentage of low fruit and vegetable intake.

The cumulative effects of consuming nutrients at less than recommended amounts increases the risk for malnutrition. The percentage of women who have multiple nutrient risks, TNR score, is shown in Figure 2. Overall, 13% of the women had less than recommended intakes for five or more nutrients. At these high risk levels, the percentages were stable across each age group. The overall TNR score mean was 2.83 ± 1.63 with no significant difference across the age groups.

Insert Figure 2.

Relationship between DETERMINE checklist and dietary intake

Stepwise linear regression revealed few relationships between dietary intake of < 75% of recommended amounts and the DETERMINE checklist questions. Only three questions showed any statistically significant relationship: fruit, vegetable, or dairy consumption; eating alone; and weight change. Consuming few fruits, vegetables or dairy products identified at-risk vitamin A intake [$p<0.04$, Odds Ratio (OR)=0.16], vitamin C intake ($p<0.001$, OR=0.05), energy intake ($p<0.001$, OR=0.15), and number of fruit and vegetable servings ($p<0.001$, OR=0.10) and TNR score ($p<0.001$, OR=0.15). Eating alone identified at-risk protein intake ($p<0.03$, OR=0.33), and in contrast, an increased calcium intake ($p<0.05$, OR=1.74). Weight change identified at-risk energy intake ($p<0.02$, OR=0.34) and folate intake ($p<0.03$, OR=0.24). Neither the overall DETERMINE checklist score, nor a score ≥3 nor ≥ 6 was predictive of at-risk intake or TNR score. Inclusion into the model of other factors like age, education, income and living alone did little to improve the ability of the DETERMINE checklist questions or risk scores to predict at-risk dietary intake.

Discussion

Assessment of usual dietary intake is central to the study of eating behaviors and their relationship to health risks. Several methods to assess usual intake are available: 24-hour recall, estimated and weighed food records and food frequency questionnaires (FFQ). Each of these methods has limitations. Although weighed food records are recognized as the 'gold standard' (Block et al., 1990), cost and respondent burden are very high, making them unsuitable for studies involving large numbers of people. Similar problems exist for estimated food records as well. A single 24-hour recall can be unreliable because individuals, especially elderly individuals do not remember what food items they eat and do not estimate portion size correctly (Ervin et al., 1998). Estimation of usual intake would necessitate multiple randomized 24-hour recalls throughout the year, adding to cost and respondent burden. A simple FFQ is limited in its ability to describe absolute dietary intake of individuals; however, comparing usual portion, either small or large to a medium portion helps to increase precision of the instrument compared to dietary records (Block et al., 1986). Without this choice the researcher assumes a portion size which may not be accurate (Tylavsky and Sharp, 1995).

Although far from exact nutrient calculations, the SQFFQ was previously shown to give mean energy intakes that were closer to total energy expenditure than did 7-day weighed food records (Sawaya et al., 1996). Two studies have validated this SQFFQ in older women (Mares-Perlman et al., 1993; Block et al., 1990). Potential sources of error are the individual's ability to report usual frequency of consumption and portion size; the adequacy of the food list; the nutrient database; and the quantification calculations.

Our results suggest that age is not a determining factor in nutrient intake. Mean macro and micro nutrient intake across the three age groups remained consistent for most nutrients. Only mean vitamin A, iron and the percent of saturated fat from total kilocalories decreased as age increased. Mean calcium intake and percent of fat from total kilocalories increased as age increased. Over 2/3 of women reported eating ≥ 5 servings of fruit and vegetable daily. Although this appears to be an overestimation of intake, the Third Report on Nutrition Monitoring in the United States (1995) reported the average intake of fruits and vegetables in all Americans is about four servings. Trends reported in the United States Department of Agriculture's Continuing Survey of Food Intakes by Individuals (1997) showed that older women tend to consume more fruits and vegetables than younger women and older men; therefore, the results of the current study may not be an overestimation. Often our subjects reported eating very large portions of fruit and vegetables daily. Moreover, many reported growing large vegetable gardens for themselves and to share with friends in their small rural communities. As a result vitamin A, vitamin C, folate, and fruit and vegetable intakes were relatively high while protein and iron intakes were slightly less.

About 60% of those aged 65-74 appeared to have the highest risk of insufficient energy intake. This may be due to high rates of overweight and obesity within this younger-old group, which results in high calculated energy needs. Three nutrients were most frequently consumed at ≤ 75% of recommended amounts: calcium, folate and fiber. Compared to young-old and old-old, a larger percntage of those aged 85 and older reported consuming ≤ 75% of recommended amounts of protein and iron.

Overall, approximately 1/3 of the women had a TNR score ≥ 4. The youngest group had the highest percentage of women with a TNR score ≥ 4 (40%), whereas those aged 75-84 had the lowest percentage of women with TNR score ≥ 4 (26%). Many of the women in the youngest group had not retired and had not adopted the healthier eating habits that the slightly older women had adopted.

The nutrient intake reported in the current study is similar to that reported in other studies with elderly women (Block et al., 1990; Mares-Perlman et al., 1993). In contrast, Phillips and

Read (1997) reported much higher mean nutrient intakes than found in the current study. They used a SQFFQ which has not been validated in older women (Rimm et al., 1992). Moreover their use of closed frequency interval responses lead to misclassification and overestimation of energy and nutrient intake (Tylavsky and Sharp, 1995). Our subjects reported similar mean energy intake and lower protein intake but higher intake of other nutrients than in Posner et al. (1993). One explanation for the difference may be that our subjects reported consuming many more fruits and vegetables. Posner et al. (1993) relied on a single 24-hour recall, which tends to underestimate usual intake.

The DETERMINE Checklist risk score indicated that half of our subjects were at low nutritional risk. The current results are similar to those reported from convenience samples (Phillips and Read,1997; Spangler and Eigenbrod, 1995) and from congregate meal (CM) participants (Stouder and Spangler, 1996). Two statewide screenings of elderly nutrition program (ENP) participants, found slightly fewer at low nutritional risk—41-45% (Vailis and Nitzke, 1995; Benedict et al., 1995); while one found slightly more—57% (Rood et al., 1996). Thus our study falls somewhere in the middle. These convenience samples came from a state fair, senior groups and religious organizations. Most of these participants were active in the community, whereas ENP participants may be more likely to have the risk factors identified by the DETERMINE checklist.

In the current study, almost 42% were at moderate risk. This is a much higher percentage than in most previous reports (Posner et al., 1993; Vailis and Nitzke, 1995; Benedict et al., 1995; Rood et al., 1996; Phillips and Read, 1997). The high percentage of moderate risk in the current study can be explained by the low proportion of those with high nutritional risk—only 7.2%. Only one study has reported a lower proportion of subjects at high nutritional risk (Stouder and Spangler, 1996), The subjects in that study were visitors to a senior health fair, clearly a healthy enough group to be out and about.

At least one-third of the participants reported having an illness that resulted in a dietary change, eating alone, and taking multiple medications. These same high-risk areas were common among subjects in previous studies (Benedict et al., 1995; Rood et al., 1996; Melnik et al., 1994; Spangler and Eigenbrod, 1995; Stouder and Spangler, 1996; Vailas and Nitzke, 1995; Vailas et al., 1998). Less than 5% of the current study's participants reported having the following risk factors: (1) eating fewer than 2 meals per day, (2) eating few fruits, vegetables, or dairy products, (3) consuming ≥ 3 alcoholic beverages per day, and (4) not having enough money to buy food. Previous studies have also found that eating fewer than 2 meals per day was an identifier in only a small proportion of respondents (Sahyoun et al., 1997; Spangler and Eigenbrod, 1995; Vailas et al., 1998; Melnik et al., 1994). In the current study 5% of the respondents reported low intake of fruits, vegetables, or dairy products, which compares to 10% reported by Ryan and Bundrick (1995). Reasons might be a questionnaire adaptation that quantified the desired serving amounts, or interviewers who may have interpreted the question for the respondents. The low percentage of alcohol consumption is consistent with other Midwest reports (Vailas et al., 1998; Spangler and Engenbrod, 1995).

Using a convenience sample, Melnik et al. (1994) reported very poor correlation between most of the DETERMINE checklist questions and dietary intake. Most questions showed no relationships at all. Two questions—having an illness and eating few fruits, vegetables or milk—correlated with a diet of higher nutrient density. Eating alone was the only DETERMINE checklist item that was highly correlated with low nutrient intake (Melnik et al., 1994). In the current study, eating alone was only predictive of intake of < 75% of recommended amounts of protein and calcium. Eating few fruits, vegetables or dairy products predicted < 75% of recommended intakes of vitamin A, vitamin C, fruit and vegetable servings and TNR score, but did not predict < 75% of recommended intakes of folate, calcium or fiber. Perhaps this checklist item misses those who do not use dairy products, but do consume fruits and vegetables. Frequently, individuals responded to this question by saying, "I eat a lot of fruits and vegetables, and eat a few dairy products so the answer is 'no'."

If each of the DETERMINE checklist questions helps to predict overall nutritional risk, more questions than just "eating few fruits, vegetables, or dairy products" should be in the model that predicts TNR score. In fact the DETERMINE checklist score at moderate or high nutritional risk did not predict high TNR score.

Developers of the DETERMINE checklist described it as an educational and screening tool to identify nutritional risk (NSI Technical Review Committee, 1995). As a self-administered screening tool, the DETERMINE checklist may raise awareness of nutrition risk, but it did not identify those with < 75% of recommended intake for nine key nutrients. This is not a new finding (Melnik et al., 1994; Sahyoun et al., 1997, Phillips and Read, 1997). Yet no changes in the DETERMINE checklist have occurred at the national level since it was first released (Posner et al., 1993). Although all the areas addressed in the DETERMINE checklist increase nutritional risk (White et al., 1991), perhaps changes in wording or eliminating several questions may increase the ability of this screening tool to identify those with poor nutritional intake.

Because the checklist is self-administered, questions are left to individual interpretation. Frequently the elderly individual may not understand the question even though the statements are written at the fourth to sixth grade reading level (NSI Technical Review Committee, 1995). Negative phrasing leads to confusion. About a third of the women questioned, "What is a meal?", "What is a few?", "What if I have changed my diet, but not due to an illness?" or "What if I can't shop because of care-giver responsibilities?" Moreover, only one individual admitted that there was not always enough money for food, yet many discussed the problems associated with limited income and increasing medical costs. Many participants reported growing gardens, preserving food and practicing prudent spending, yet did not feel they had inadequate money for food even though 22% reported household incomes below $9,000. If left up to the older individual's discretion, especially if the screen is self-administered, many older persons would not be identified at-risk when in fact they are.

Another problem is that several questions ask about more than one behavior. Fruits and vegetables are not similar to dairy products and including all three food items in one question only complicates the thought process for many elderly. Even those with more education than the average had difficulty answering this question.

The current findings have the limitations common to other cross-sectional studies, which are limited to one point in time, and therefore can not provide insight into dynamic relationships. A built-in bias may result in selective survivorship, that is, death because of poor dietary intake. Only longitudinal studies can eliminate this bias. The current study used a cohort of randomly selected, rural, community-dwelling, older white women who were well-educated and had a higher income than the census norm for the area. As a result, the current findings may not be generalizable to all older women. Although the response rate was good, some participation bias may have occurred, resulting in fewer subjects at higher nutritional risk, even though those who chose not to participate were not older than participants.

Conclusion

Although the DETERMINE checklist was designed to identify those with nutritional risk, it falls short of that goal. Few DETERMINE checklist questions identify those with at-risk nutrient intake. Even collectively, the DETERMINE checklist does not identify those with the most at-risk nutrient intake. Although each question on the DETERMINE checklist was meant to find elderly individuals with warning signs of poor nutritional health, only three checklist questions actually ask about dietary intake. Several questions are vague and open to a variety of interpretations. Without more definitive guidelines, the elderly will not self-select to be found at increased nutritional risk. For many, current eating patterns have been established throughout a life time. Again, without more decisive guidelines necessary for screening, many who are at risk will not be identified. Inadequate intake is due to many causes, most of which are not asked about on the DETERMINE checklist. A re-evaluation is necessary to increase the capabilities of the DETERMINE checklist as a screening tool to identify those with poor nutritional intake.

Sahyoun et al. (1997) suggested the DETERMINE checklist is a better educational tool than a screening tool. These results also indicate that the DETERMINE checklist is not an effective tool to identify nutritional risk.

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Table 1: Frequency of selected demographic characteristics of Iowa women 65 years of age and older: overall and stratified by age.

Variable	overall	65-74 years	75-84 years	85+ years
Number of Participants	242	104	92	46
Household Income < $9,000	53	11	23	19
Education:				
< High school diploma/GED	50	19	19	12
High school diploma/GED	111	53	44	14
> High school diploma/GED	81	32	29	20
Lives alone	121	27	55	39

Table 2: Frequency and percentage of "yes" responses, from rural, community-dwelling, older women, overall and by stratified by age, to each DETERMINE checklist question, and in each nutrition risk category based on total score.

DETERMINE checklist question and corresponding points	Overall n=242	65-74 years	75-84 years	85+ years
Do you have an illness or condition that made you change the kind and/or amount of food you eat? 2 points	91 (38%)	43 (41%)	36 (38%)	12 (26%)
Do you eat fewer than 2 meals per day? 3 points	2 (<1%)	2 (2%)	0	0
Do you eat few fruits or vegetables or milk products? 2 points	12 (5%)	6 (6%)	5 (5%)	1 (2%)
Do you have 3 or more drinks of beer, liquor, or wine almost every day? 2 points	1 (<1%)	1	0	0
Do you have tooth or mouth problems that it hard for you to eat? 2 points	24 (10%)	9 (8%)	7 (7%)	8 (17%)
Do you always have enough money to buy the food you need? (Coded inversely) 4 points	1 (<1%)	0	1 (1%)	0
Do you eat alone most of the time? 1 point	119 (49%)	28 (27%)	54 (57%)	38 (83%)
Do you take 3 or more prescribed or over the counter drugs a day? 1 point	138 (57%)	53 (51%)	60 (64%)	25 (54%)
Without wanting to have you lost or gained 10 pounds in the last 6 months? 2 points	26 (11%)	10 (11%)	9 (10%)	8 (17%)
Are you always physically able to shop, cook and/or feed yourself? (Coded inversely) 2 points	21 (9%)	3 (3%)	7 (7%)	11 (24%)
Total with DETERMINE score at low risk (0-2 points)	124 (51%)	59 (57%)	44 (48%)	21 (45%)
Total with DETERMINE score at moderate risk (3-5 points)	100 (41%)	42 (40%)	41 (45%)	17 (37%)
Total with DETERMINE score at high risk (≥ 6 points)	18(7%)	3 (3%)	7 (8%)	8 (17%)

Table 3: Dietary intake of selected nutrients of community-dwelling elderly women.

	Overall N=242		65-74 years N= 104	75-84 years N= 92	85+ years N= 46
Nutrient	Mean ± SD	(Range)	Mean ± SD	Mean ± SD	Mean ± SD
Energy (kcal)	1511 ± 429	(647 - 3688)	1474 ± 393	1570 ± 487	1474 ± 374
Protein (g)	57.8 ± 15.9	(17.1 - 109.3)	57.6 ± 16.2	59.3 ± 16.6	55.4 ± 13.9
Folate (μg)	273 ± 85	(64 - 578)	269 ± 86	279 ± 86	270 ± 83
Vitamin A (IU)	7187 ± 2657	(2496 - 16591)	7322 ± 2798	7234 ± 2636	6791 ± 2377
Vitamin C (mg)	150 ± 60	(7 - 359)	148 ± 59	151 ± 56	152 ± 70
Calcium (mg)	802 ± 353	(137 - 2010)	758 ± 363	836 ± 355	834 ± 320
Iron (mg)	10.7 ± 2.7	(4.7 - 20.9)	10.8 ± 2.6[a]	11.0 ± 2.9[a]	9.8 ± 2.4[b]
% total kcal from fat	31.8 ± 7.1	(13.1 - 58.0)	31.1 ± 7.1	32.3 ± 6.7	32.2 ± 8.1
% total kcal from sat. fat	11.5 ± 3.1	(4.9 - 22.0)	13.8 ± 3.7	11.8 ± 3.1	11.7 ± 3.3
Weekly servings of fruit and vegetables	42.6 ± 12.61	8.4 - 80.9	41.1 ± 11.6	43.1 ±13.3	42.1 ±13.2

[a] Using ANOVA analysis, letters with different superscripts are significantly different from each other at the 0.05 level.

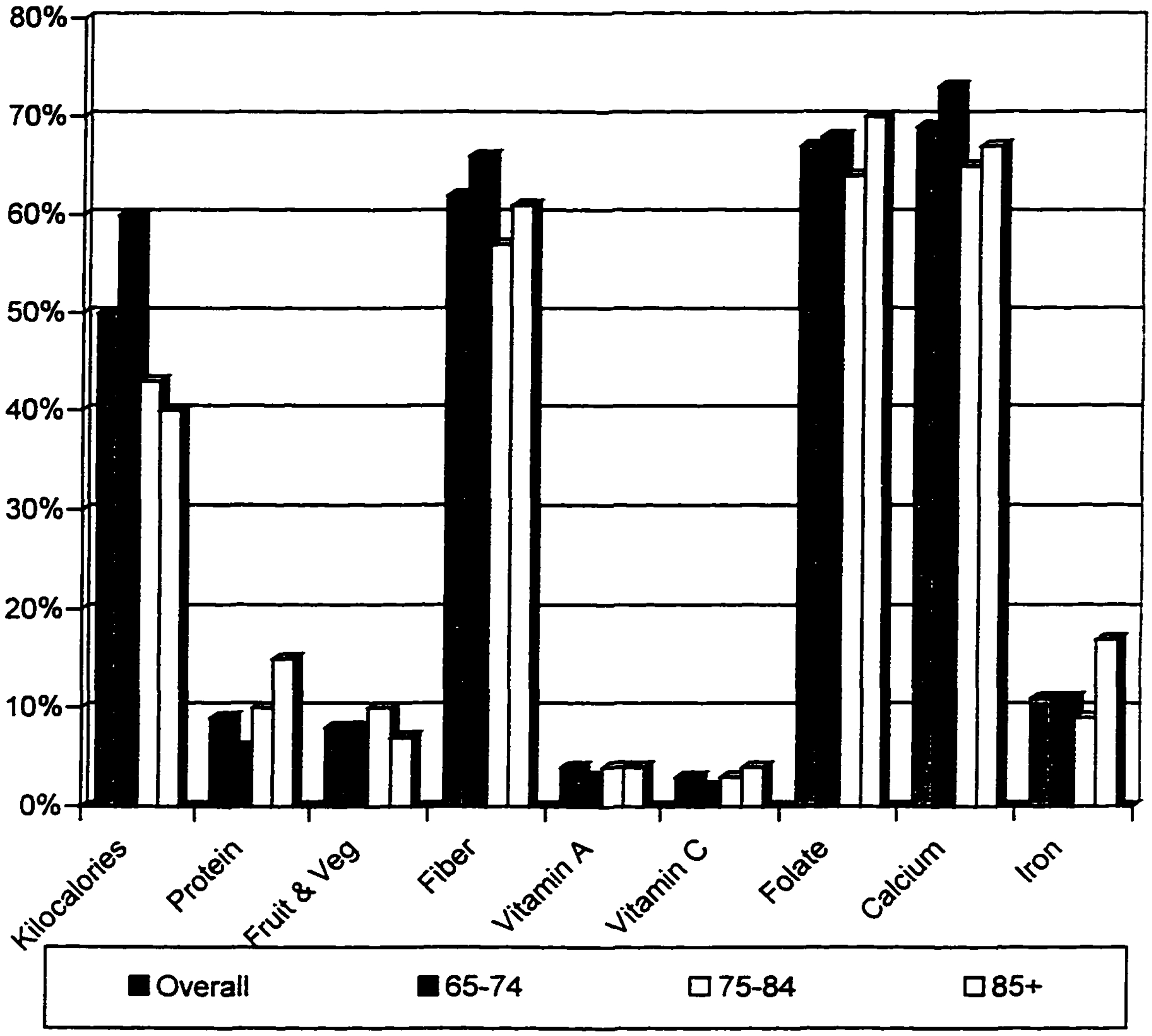

Figure 1: Dietary inadequacy among rural, community-dwelling elderly women. Percentage of women with dietary intake below 75% of the recommended levels.

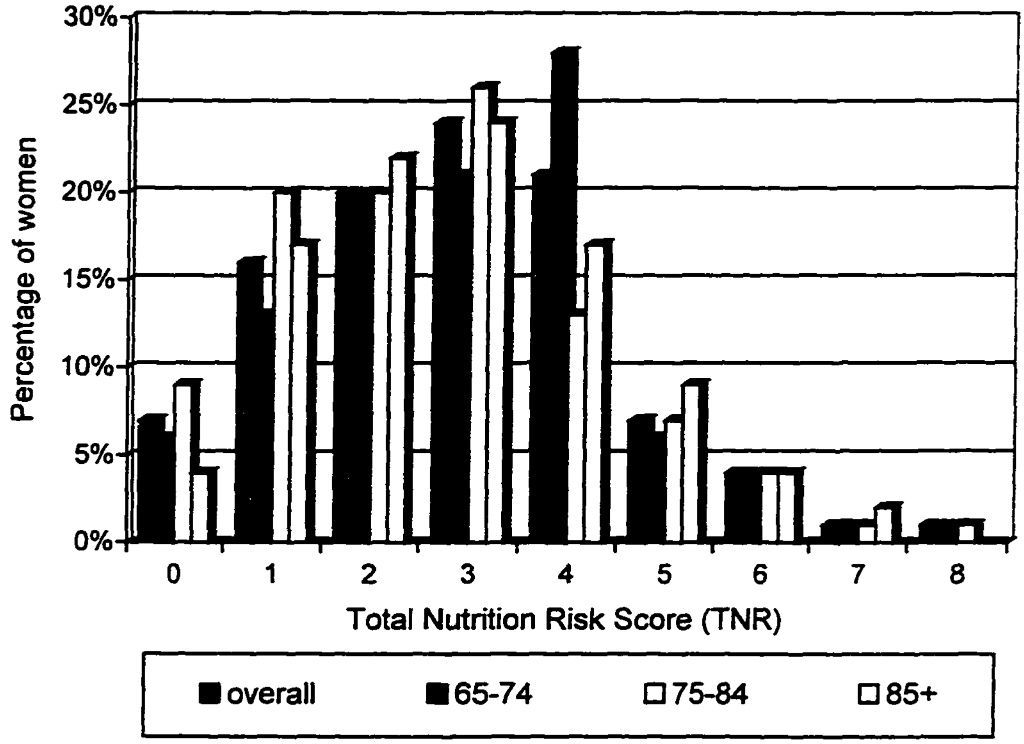

Figure 2: Percentage of rural, community-dwelling, elderly women who have increasing risk due to the cummulative effect of consuming nutrients at-risk levels (TNR).

ABILITY OF SOCIAL SUPPORT TO PREDICT AT-RISK DIETARY INTAKE AND ANTHROPOMETRIC MEASURES IN WHITE, RURAL, COMMUNITY-DWELLING ELDERLY WOMEN

A paper submitted to *The Journal of Nutrition for the Elderly*

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Abstract

Using a stratified random sample of 249 rural, community-dwelling, older women, this study evaluated if higher levels of associative and functional solidarity with family and others in the community would lead to lower at-risk dietary intake and anthropometric measures. Factor analysis identified 5 factors associated with nutritional measures: Contact with family members, non-family others, senior center attendance, and emotional and instrumental support. Overall, attendance at a senior center predicted adequate protein intake. For younger elderly, in addition to attending a senior center, having contact with non-family others, having a higher income, and living with someone decreased the likelihood of at-risk protein intake. For the oldest women, social factors did not predict at-risk dietary intake or anthropometric measures.

Key words: Social support, aged, food frequency, anthropometric measures, elderly women, factor analysis

Introduction

Most eating occurs in the presence of others. When people eat alone social facilitation effects lead to lower levels of food consumption (de Castro et al., 1990). Conversely, higher levels of food consumption occur when individuals eat in a group setting, especially when the groups are composed of familiar people (de Castro, 1995). McIntosh et al. (1989) reported that having a dinner companion improved dietary intake, even in those who reported having a poor appetite.

The United States Select Committee on Nutrition and Human Needs (Todhunter, 1971) proposed that apathy and social isolation contribute to reduced food intake in the elderly, especially

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in those who live alone. Empirical evidence suggests that elderly persons who live alone often suffer from poor social resources (Zyzanski et al., 1989), yet living alone does not increase risk for mortality (Davis et al., 1997). Moreover, it appears that living alone does not necessarily mean older women are at increased risk for malnutrition. Holcomb (1995) reported that older women had more nutrient dense diets with similar consumption patterns and levels as younger women. Ryan and Bower (1989) reported no difference in dietary intake between those living alone and those living with others. Walker and Beauchene (1991) reported that perceived loneliness rather than social isolation is what decreases dietary intake and nutrient adequacy. In their study, degree of perceived loneliness showed a strong negative correlation to the number of social contacts.

Other social factors beside living alone may influence mortality and health behaviors. Yasuda et al. (1997) reported that contact with a social network and neighborhood integration can reduce mortality in women over age 75. These researchers go on to show that women who lived longer than ten years in the same neighborhood or had interaction with the merchants had twice the survival rate. Moreover, lack of contact with family, friends, or group organizations negatively impacted survival rates in older women over age 75 years.

In assessing specific behaviors associated with higher dietary intake, Morgan et al. (1986) reported that eating breakfast significantly impacted total daily nutrient intake. Married women are more likely to eat breakfast than widows (Schone & Weinick, 1998). Breakfast eaters also lived in households with more family members, had a higher educational level and more frequent social contact (Schone & Weinick, 1998). The authors concluded that individuals who are integrated into the community and have frequent contact with friends and family members may perceive their health is more valuable to both themselves and others; and therefore adopt preventive health practices such as eating breakfast. These findings are consistent with earlier reports suggesting that social support, especially close physical proximity to significant others including family and friends is associated with higher dietary intakes including energy and protein (McIntosh & Shifflett, 1984); and that a more extensive social network and more frequent social contact is associated with more adequate diets (McIntosh et al., 1989; Tonner & Morris, 1992; Keller et al., 1997).

Adequate energy and protein intake is necessary to maintain good health. There is little clinical evidence that significant malnutrition occurs in any normal person as a result of the aging process itself (Lovat, 1996). Evidence does indicate that good nutrition promotes vitality and independence, whereas poor nutrition can increase the risk of illness, prolong recovery from illness, and lead to poorer quality of life (Mowe et al., 1994). Aging in the United States is associated with a decline in physical activity (Ruuskanen and Ruoppila, 1995). If an older adult reduces energy intake in compensation, overall nutrient intake can be compromised. This poor intake becomes critical if protein decreases to $\leq$ 1 gram (g) protein per kilogram (kg) of body weight (Campbell et al., 1994). Dietary intake that does not meet energy, protein, and other nutrient requirements can place an older adult at risk (Lipschitz, 1995). It is this undernutrition coupled with a trigger event that sets the stage for progressive decline (Lipschitz, 1995).

Perceived health may have an impact on dietary intake and anthropometric measures. Keller et al. (1997) reported that higher perceived health was consistently linked to higher diet quality. Miller et al. (1996) reported that health self-rated as fair or poor was associated with limited intake of fruits, vegetables and milk.

The basic underpinnings of our research are taken from Roberts, Richards, and Bengtson's Family Solidarity Model (1991). This model consists of six constructs: structural, consensual, associative, affectual, functional, and normative solidarity. *Structural solidarity* involves demographics of the family including geographical proximity and the number and types of relationships possible. *Consensual solidarity* refers to the amount of agreement that exists among family members about important life values, attitudes, and beliefs external to the family, like religion or politics. *Associative solidarity* refers to the patterns and frequency of intergenerational contact with each other, including phone, letter, and face-to-face contact as well as common shared activities. *Affectual solidarity* refers to the perceived degrees of positive sentiment that each generation has for each other and the degree of reciprocity of these sentiments. *Functional solidarity* refers to the amount of goods, financial resources and services that each generation shares/gives with each other. *Normative solidarity* or obligation refers to the commitment to performance of familial roles and to meeting familial obligations (Roberts et al., 1991).

Most of the constructs within the Family Solidarity Model are positively related to one another. Structural solidarity leads to functional solidarity and association. Normative obligation positively leads to affectual, associative, and functional solidarity. Functional solidarity positively leads to both affectual solidarity and association. Affectual solidarity positively leads to association. Consensual solidarity is an independent construct which stands alone in this model.

We suggest that several dimensions of family solidarity extend to non-family others and community involvement, especially if the structural aspects of family solidarity are unavailable. We propose that structural solidarity with friends and a sense of community will lead to both functional solidarity with friends and participation in community activities. An exchange of goods and services with friends and neighbors will lead to increased association with these individuals. Increased functional solidarity with friends and neighbors will not be limited to just these individuals but will extend to association and involvement in community activities as well.

Building on the work of Schone and Weinick, (1998) we tested the hypothesis that those who have higher levels of functional solidarity and associative solidarity have adopted preventive health behaviors, here defined as consuming adequate diets. The purpose of this study is to determine if higher levels of functional solidarity and associative solidarity with family, friends, neighbors, and community will lead to fewer at-risk nutrition measures.

Methods

This study was approved by the Institutional Review Committee on Use of Human Subjects in Research. We collected data in a stratified random sample at two time points -- baseline and six months later. This paper presents baseline results only. The population for sampling was community-dwelling older women in counties with high risk profiles for the elderly: 1) at least 16% of those 65 and older were in poverty, 2) at least 50% of those 65 or older did not have a high school diploma, 3) at least 65% of those 65 or older lived in rural areas, 4) at least 10% of the population were 75 or older, 5) at least 40% of those 75 or older lived alone, and 6) the county had three or fewer senior nutrition program sites.

Eight counties met these criteria. Four counties were randomly selected to form the sampling population. Using the white pages of the telephone book and driver's license applications, a market survey company drew the sample of 1,000 women to our specifications: three equally distributed age groups of women 65-74, 75-84 and 85 years or older who lived in the identified counties, and who lived in single family dwellings or small apartment buildings. Those who did not have a phone or had an unlisted number were excluded from the sample.

Four hundred ninety eight women were sent introductory letters and subsequently contacted by telephone asking for an in-home interview. Of these contacts 181 refused to participate and 68 were not eligible due to death or move to a dependent living arrangement,, leaving a total sample size of 249 (59.2% response rate). The mean age difference between participants [76.8 ± 7.19 (range 65-94)] and those refusing to participate [76.3 ± 7.21 (range 65-95)] was not statistically significant.

Data collection

A trained interviewer who is a registered dietitian conducted the in-home interviews. The data collection instruments and methods were pilot tested with five volunteers over age 75, who had similar levels of education and income as the study population. The instrument was revised and then retested with eight female volunteers who were over age 70. The survey consisted of a semi quantitative food frequency questionnaire (Block et al., 1986), anthropometric measures, categorical questions concerning frequency of contact with the social support network, and categorical demographic questions.

Associative solidarity was measured by frequency of contact with the entire social network within a two week time frame and frequency of contact with a single relied-on individual over the past year. Questions were asked about frequency of visiting face-to-face and by phone with relatives, friends, and neighbors. Other categorical questions estimated church and community involvement. Questions concerning a relied-on individual measured frequency of visiting and eating together. Functional solidarity was measured by the amount of functional assistance shared between the older person and the relied-on individual.

Knee height, weight, triceps skinfold (TSF), mid-arm circumference (MAC), and calf circumference (CC) were measured. Anthropometric measurements were collected using the techniques described in Lohman's *Anthropometric Standardization Reference Manual* (Lohman et al., 1988). Left knee height was measured using a sliding caliper (Ross Labs) by having the subject sit so that the knee and ankle were at 90° angles. Weight was measured on a portable beam balance scale (Detecto) with each participant wearing only light clothing (no shoes). TSF was measured three times on the left arm at a point between the acromion and the olecranon over the triceps muscle with a Lange skinfold caliper. MAC was measured three times at midpoint of the left upper arm with a plastic insertion tape (Ross Labs). While the subject was seated, CC was measured three times at the fullest part of the left calf. A mean was calculated for TSF, MAC, and CC. Repeated measures were not significantly different from each other.

Dietary intake was estimated with a 116-item semi-quantitative food frequency questionnaire (SQFFQ) designed by Block and associates (Block et al., 1986) and used by the National Cancer Institute (1989). Respondents categorized intake according to portion size (small, medium and large) and frequency of consumption. The results of the SQFFQ provide valid information on dietary intake over an extended period of time when compared to biochemical indicators and food records (Block et al., 1990; Block et al., 1992). This instrument was validated in middle-aged and older women (Mares-Perlman et al., 1993).

Data analysis: The mean of two knee height measures was used to calculate height (Chumlea et al., 1998). Body mass index (BMI) was calculated by dividing the individual's weight in kilograms by their height in meters squared. BMI, MAC, TSF, and CC were used in analysis as a continuous measure as well as discrete measures. Nutrition risk level was established for each participant using selected anthropometric risk cut-off points to establish nutrition risk.

Nutrient analysis was performed using the National Cancer Institute DIETANAL computer program (NCI, 1989). Nutritional intake was assessed by absolute intake and at-risk/not at-risk intake. Subjects were classified at nutritional risk for poor energy intake if energy intake was less than 75% of need. Need was calculated as basal energy needs plus an activity factor of 20% of basal needs (Williams, 1993). Risk for low protein intake was identified as 75% or less of protein need, which was calculated as one gram of protein per kilogram of body weight (Campbell et al., 1994).

Statistical analysis

Descriptive statistics consisting of means, standard deviations, percentages and frequencies were calculated using the Statistical Analysis System (SAS Institute, 1997). Principal component factor analysis was done to collapse 13 social isolation indicators to the smallest number of common factors that best explained the correlation among the indicators. Two principal components, accounting for 53% of the total variance for 6 items involving a single, relied-on person and three principal components accounting for 59% of the total variance for 7 items involving all other social contacts were rotated by the normal varimax criterion. The Scree test (Cureton & D'Agostino, 1983) which focuses on a significant drop in eigenvalues was also used as a criterion in selecting factors. For each factor variable, those questions that contributed > 0.50 are presented in Table 1. Logistic regression models were used to assess the ability of these social contact factors, the instrumental support factor, and other demographic and health variables to predict nutritional risk. Finally, logistic regression analysis by 10-year age groupings was done to assess the differences among the groups.

Insert Table 1.

Results

Demographic variables are presented in Table 2. This group of women was well-educated with one-third having some post secondary education. The lowest mean level of education was in the young-old and the highest mean was in the oldest-old. In those aged 85+, 43% had post-secondary education. Total mean household income was <$25,000. Approximately 22% of the women had household income ≤ $9,000 and about half had household income <$15,000. The percentage of women with household income of ≤ $9,000 increased from 7.3% in those aged 65-69 to 42.6% in the oldest-old. Approximately 47% of all the women were married. This percentage progressively decreased from 83% in the 65-69 aged group to just 12% in the group aged 85+. Almost half of the women lived alone. This percentage progressively increased from 12% in the young-old to 85% in the oldest-old. Perceived health was significantly better (p=0.016) for those aged 65-74 compared to the older age groups.

Insert Table 2.

Social contact measures

Six women, three aged 65-74 and three aged 75-84, reported they had no one to rely on. The remaining women all reported either having a child, sibling, other relative, or close friend on whom they could rely. Ages of these relied-on individuals ranged from the 20's (1%) to the 80's (0.4%), with a mean age in the 40's. Significant differences in the age of the person relied-on was identified among all three age groups, with increasing age of the individual relied-on increasing with the subject's age.

Differences between the three age groups were seen in three questions: frequency of having the relied-on person talk with the doctor, the frequency of talking on the telephone with a neighbor, and frequency of volunteering. There were differences (p=0.0001) among all three groups for talking with or going to the doctor with the subject. Talking on the telephone with neighbors occurred less frequently in those aged 65-74 compared to the older two groups. Volunteering dropped significantly for those aged 85 and older compared to the younger groups, but there was no difference between those aged 65-74 and those aged 75-84. Other areas of social contact within a two week period, i.e. attending church or church related activities, visiting with friends and neighbors, visiting with family, talking on the telephone with family, or attending a senior center, did not differ among the different age groups. Moreover, the frequency of contact in the five measured activities with the relied-on person did not differ according to age groups.

The five social factors that were characterized are shown in Table 1. Analysis of these social factors showed no difference between the various age groups except for one. Frequency of instrumental support (p=0.004) was lower for younger women (65-74) compared to the older two groups of women.

Anthropometric measures

Total and age-specific mean and standard deviation distributions for BMI, MAC, TSF, and CC are presented in Table 3. The mean measures of BMI, TSF, MAC, and CC decreased with age. The overall mean BMI was 28.4 (±5.3). The mean BMI steadily decreased (p=0.02) from

29.3 (±5.1) in the young-old to 27.0 (±5.1) in the oldest-old. The mean BMI of the oldest-old women was 8.9% less than the BMI for the young-old women ($p=0.015$).

The overall mean MAC, TSF, and CC were 31.9 (±4.7) cm, 28.7 (±10.3) mm, and 37.3 (± 4.2) cm, respectively. Mean MAC differed among the age groups ($p=0.0001$), but TSF was only significantly higher ($p=0.0001$) in young-old. CC was also higher ($p=0.0002$) in the young-old. TSF and MAC measures consistently dropped over the age groups at lower percentiles, but this was not true for measures in the upper percentiles. At higher percentiles, age did not appear to be the determining factor in identifying upper limits.

Insert Table 3.

Anthropometric risk was defined by three anthropometric measures and BMI. The total and age specific percentages of women with at-risk anthropometric measures are presented in Table 4. At-risk BMI was significantly higher for those aged 74-84 compared to the other two age groups. The number of those aged 65-74 with at-risk MAC was lower ($p<0.001$) than the older two age groups, yet no significant difference was seen between the percentage of those with at-risk TSF. At-risk CC was higher ($p<0.001$) in the women aged 85 and older.

Insert table 4.

Dietary intake

Overall mean intake of energy and protein was 1520± 435 kcal and 58.4± 16.4 g protein. Mean intakes among the age groups did not differ significantly. The overall percentage of women not meeting 75% of calculated energy needs, as seen in Table 4, was about half which decreased across the three age groups, from 60.2% in the young-old to 40.4% in the oldest-old. The overall percentage of women not meeting protein needs was 9.6% which steadily increased from 6.5% in the young-old to 17.0% in the oldest-old. The percentage of the oldest women with inadequate protein intake was 2.5 times higher than in the youngest women.

The model for at-risk protein and at-risk anthropometric measures

The logistic regression model, seen in Figure 1, shows the overall relationship between the five factors of frequency of social behaviors and contacts, socio-demographic variables, perceived health, at-risk protein intake, and resulting anthropometric measures. Those with adequate protein intake were twice as likely to attend a senior center ($p=0.04$). Approaching significance, those with poorer perceived health were more likely to have at-risk protein intake [odds ratio (OR)=1.66, $p=0.07$]. Increasing age predicted at-risk MAC (OR=1.10, $p=0.01$) and at-risk CC (OR=1.09, $p=0.02$). Individuals who do not to have contact with children and other relatives are almost twice as likely (OR=1.90, p=0.02) to have an at-risk CC. Overall, at-risk protein intake identified those with at-risk anthropometric measures: At-risk BMI (OR=13.06, p=0.0001), at-risk TSF (OR=8.40, p=0.0001), at-risk MAC (OR=6.12, p=0.003), and at-risk CC (OR=6.53, p=0. 0002).

Insert Figure 1.

Logistic regression analysis for at-risk protein intake revealed that the model for younger individuals (65-74) was somewhat different than for the older women (75-84 and 85+). Not going to the senior center increased in significance (OR=216, p=0.01) and not having contact with others outside the family (OR=4.88, p=0.04) increased the risk for at-risk protein intake. Moreover, young-old subjects who lived alone had increased risk of at-risk protein intake (OR=11.39, p=0.05). At-risk protein intake was able to identify at-risk MAC (OR=40.0, p=0.005) and at-risk CC (OR=19.8, p=0.007) in women age 65-74.

Models for other age groups did not identify any predictors for at-risk protein intake. For women aged 75-84, at-risk protein intake identified those with at-risk BMI (OR=26.25, p<0.001), at-risk MAC (OR=7.70, p=0.008), at-risk TSF (OR=10.53, p=0.003) and at-risk CC (OR=12.8, p=0.002). For those aged 85 and older, the only predictor for an at-risk anthropometric measure (CC, OR=4.53, p=0.05) was poorer perceived health.

The model for at-risk energy and at-risk anthropometric measures

The logistic regression model predicting at-risk energy intake and at-risk anthropometric measures from the five principal components of social behaviors and contacts, perceived health, and socio-demographic variables is shown in Figure 2. Poorer perceived health was the only variable that predicted at-risk energy intake (OR=1.55, p=0.01). At-risk energy intake predicted at-risk BMI (OR=5.37, p=0.001), at-risk TSF (OR=3.31, p=0.015), at risk MAC (OR=6.06, p=0.001) and at-risk CC (OR=4.27, p=0.005).

As with at-risk protein, the model for those aged 65-74 was different from the model for subjects aged 75–84, and 85 and older. Having low frequency of contact with others outside of the family (OR=1.97, p=0.001), having a low income (OR=3.58, p=0.03) and having poorer perceived health (OR=1.88, p=0.04) all predicted at-risk energy intake in those aged 65-74. In this age group, an at-risk energy intake predicted at-risk BMI (OR=8.42, p=0.05) and at-risk TSF (OR=8.42, p=0.05).

Within the group aged 75-84, subjects who were older were less likely to have an at-risk energy intake (OR=0.80, p=0.02). At-risk energy intake predicted at-risk BMI (OR=4.32, p=0.03). For those aged 85 and older, none of the variables predicted at-risk dietary intake. Moreover, at-risk energy intake only predicted at-risk MAC (OR=8.53, p=0.05).

Discussion

Mean BMI is consistently higher than has been reported in previous studies (Czajka-Narins et al., 1991; Baumgartner et al., 1995; Kubena et al., 1991). Most of the data in these studies were collected over a decade ago (Czajka-Narins et al., 1991; Baumgartner et al., 1995; Kubena et al., 1991). Over the past ten years, BMI has increased in the U.S. population (Flegal et al., 1998). It would seem reasonable to assume that mean BMI is also increasing in the elderly as well. In a more recent study in a similar rural population (Jensen et al., 1997), BMI measures calculated from self-reported height and weight measures were very similar to those found in the current study in which height and weight were measured.

In this study, half of all the women had at-risk energy intake. About 60% of those aged 65-74 were at risk for insufficient energy intake compared to 40% for the oldest-old. In contrast, developers of the Nutrition Screening Initiative have theorized that the oldest-old are more likely to have an at-risk energy intake (White, 1991). One explanation for the high prevalence of at-risk energy intake among the young-old in the current study is that their energy needs may have been overestimated due to the significantly higher rates of obesity. Another possible reason is that these individuals are trying to control weight gain, and thus restricting energy intake.

There is a dearth of information concerning dietary intake and social support. Most studies have concerned themselves with living arrangements (Zipp & Holcomb, 1992; Davis et al., 1990; Ryan & Bower, 1989), and have assessed overall adequacy of the diet (Davis et al., 1990; Holcomb, 1995, Walker & Beauchene, 1991), not at-risk status. This study is unique in that it used a social model to assess dietary intake. Social needs may change as one ages, therefore, an important contribution of this study was the analysis of the differences in social support among three age cohorts.

The purpose of this study was to determine if higher levels of functional and associative solidarity with others would lead to a lower prevalence of at-risk nutritional measures. We did not necessarily find this to be the case; however, each age group of women showed changing nutritional risk associated with social factors. Of the one functional and four associative solidarity factors investigated, only attending a senior center predicted adequate protein intake. In small rural communities, the elderly nutrition program meal site is referred to as the senior center. Thus, going to the senior center generally means eating a congregate meal. These meals are planned to meet approximately one-third of the daily energy and protein needs for most older adults (Posner, 1979). Only one other social variable predicted at-risk nutritional indicators—low contact with family members which predicted at-risk CC. Since at-risk CC is indicative of less skeletal muscle, those who have at-risk CC may not be physically able to go visit family members and rely on family members to come visit them.

For young-old women, aged 65-74 years, social factors, perceived health, and demographic variables predicted at-risk dietary behavior, but did not directly predict at-risk anthropometric measures. For these younger women, having contact with their social network, by either volunteering, participating in religious activities, visiting on the phone or in person with friends and neighbors, going to a senior center, or living with a companion (spouse, child or some other individual) increased the likelihood that energy and protein intake would be adequate. Lower income and poorer perceived health identified at-risk energy intake in these younger women. At-risk protein intake predicted at-risk CC and MAC, which are indicative of protein stores. At-risk energy intake predicted at-risk BMI and TSF, which are indicative of energy stores.

The women aged 75-84 appear to be in transition—having some of the behaviors and risks of both the young-old and oldest-old. They were still volunteering as much as the young-old, but were beginning to talk on the telephone with friends and neighbors as frequently as the oldest-old. Moreover, this transition becomes more apparent in eating behaviors, because the younger subjects in this cohort were more likely to have an at-risk energy intake. The social factors from component analysis did not appear to impact dietary behavior, but at-risk dietary intake did identify those with at-risk anthropometric measures.

For the oldest women, aged 85 and older, none of the social or demographic variables tested identified at-risk protein or energy intake. Poorer perceived health was the only variable that identified an at-risk anthropometric variable—at-risk CC. Thus it appears other factors than dietary intake or social factors mediate at-risk anthropometric measures.

There are some limitations associated with the generalizability of the results. Even though this sample is random, selection bias may have occurred. The oldest-old were very well-educated, howbeit low income. Moreover, the entire sample was better educated than their peers in the county, according to reports by the U.S. Census Bureau (1995). These women appear to be well integrated into the community, perhaps life-long residents of the area. Therefore, these results may not be similar to more transient or urban populations.

It appears that the lack of associative solidarity predicts at-risk dietary intake in the young-old. Since this is not the case for those who are older, other mitigating factors are present, which do not increase risk in the young-old, but increase risk in the old-old and the oldest old. These factors need to be identified. Some possible factors may include increased burden of illness, increased disability associated with activities of daily living, or perhaps other physical or dietary behaviors.

Conclusion

The elderly are a heterogeneous group: some live a long productive life style while others are plagued by chronic disease, disability, and heredity factors that place them at increased health risk. By identifying those with increased risks and providing services to minimize these risks, the quality of life of these individuals will likely be improved. For all ages, not attending a congregate meal site, usually called the senior center, placed older women at-risk for poor protein intake. Low frequency of contact with individuals outside the family and living alone placed young-old at increased risk for poor dietary intake. At-risk dietary intake may be an early indication for at-risk anthropometry. As these individuals age, at-risk anthropometric measures appear. At-risk anthropometric measures place an individual at increased risk for physical disability, hospitalizations, and poorer quality of life. It is important that older adults maintain their contact with others outside of their family to minimize poor dietary intake and at-risk anthropometric measures.

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Table 1A: Factor content and loading from analysis of frequency of contact within 2 weeks.

Factor 1: Frequency of contact with non-family others	
Church or related activities	0.72
Volunteer activities	0.72
Talking on the phone with a neighbor	0.60
Visiting with friends and neighbors	0.53
Factor 2: Frequency of contact with family	
Visiting with children and relatives	0.78
Talking on the phone with children and relatives	0.76
Factor 3: Frequency of going to a senior center	
Going to a senior center	0.94

Table 1B: Factor content and loadings derived from analysis of frequency of contact with relied on individual.

Factor 4: Monthly frequency of emotional support	
Doing things together	0.82
Eating a meal together	0.78
Receiving prepared or purchased food	0.74
Factor 5: Frequency of instrumental support	
Yearly frequency of receiving money	0.81
Yearly frequency of giving money	0.56

Table 2: Demographic variables in total sample and stratified by age.

Variable	Total N = 249 %	65-74 years N = 108 %	75-84 years N = 94 %	85+ years N = 47 %
Household income <$15,000	47.4	32.4	44.7	66.0
Education				
< High school diploma/GED	21.3	19.4	21.3	25.5
High school diploma/GED	45.4	50.0	46.8	31.9
> High school diploma/GED	33.3	30.9	31.9	42.6
Live alone	49.8	25.9	40.4	85.1
Perceived health				
Excellent	9.6	11.1	10.6	4.3
Very good	38.2	46.3	31.9	31.9
Good	36.5	32.4	39.4	40.4
Fair	14.1	9.3	16.0	21.3
Poor	1.6	0.9	2.1	2.1

Table 3: Mean and standard deviations of anthropometric measures of total sample and stratified by age.

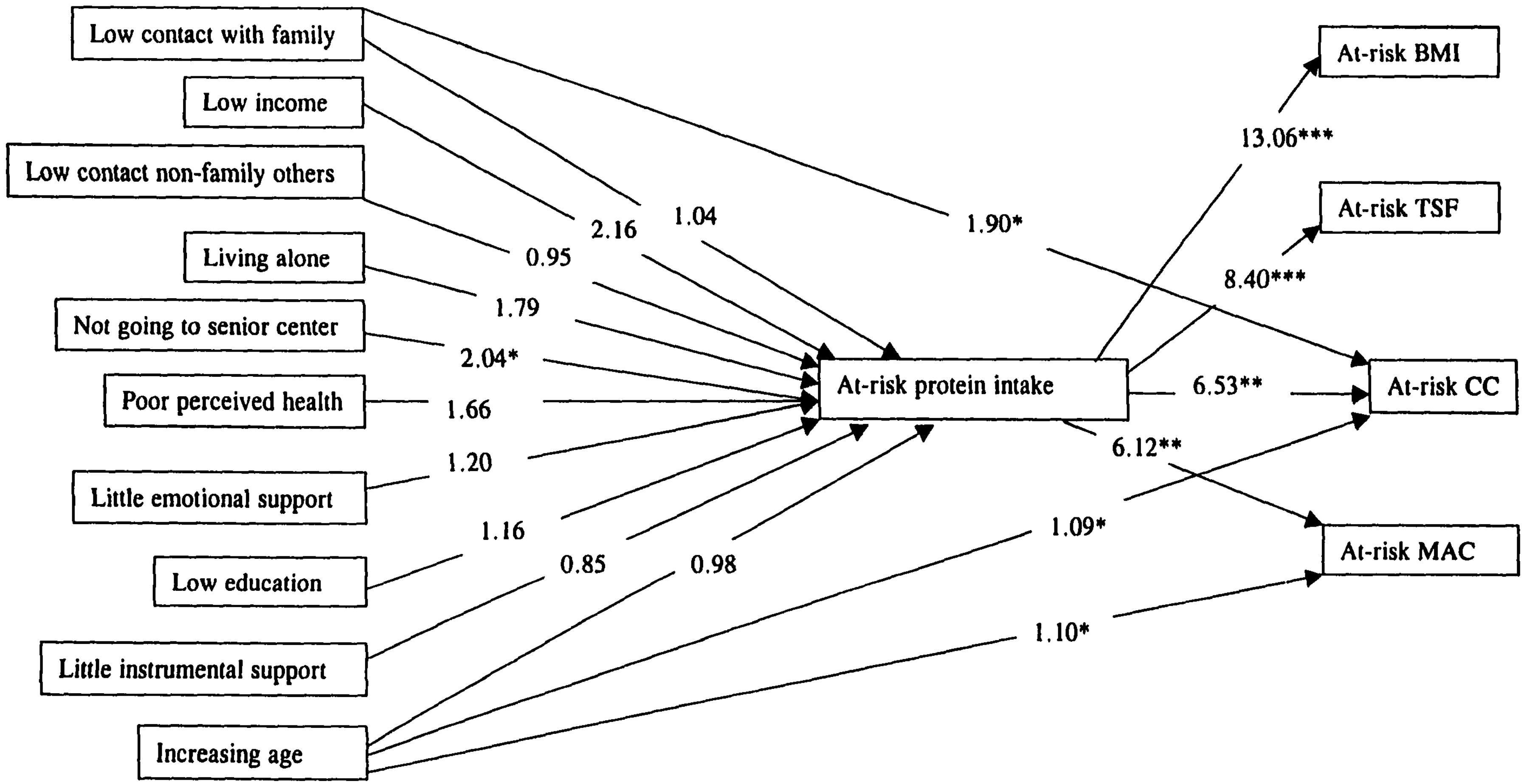
Variable	Total N = 249	65-74 years N = 108	75-84 years N = 94	85+ years N = 47
BMI	28.4 ± 5.3	29.3 ± 5.1[a]	28.1 ± 5.5[ab]	27.0 ± 5.1[b]
MAC (cm)	31.9 ± 4.7	33.2 ± 4.2[a]	31.4 ± 4.7[b]	29.7 ± 4.6[c]
TSF (mm)	28.7 ± 10.3	31.5 ± 9.6[a]	27.6 ± 9.9[b]	24.0 ± 10.4[b]
Calf Circumference (cm)	37.3 ± 4.2	38.4 ± 4.2[a]	36.8 ±3.8[b]	35.9 ± 4.3[b]

Using ANOVA analysis, letters with different superscripts are significantly different from each other at the 0.05 level.

Table 4: Percentage of subjects with at-risk anthropometric and dietary measures.

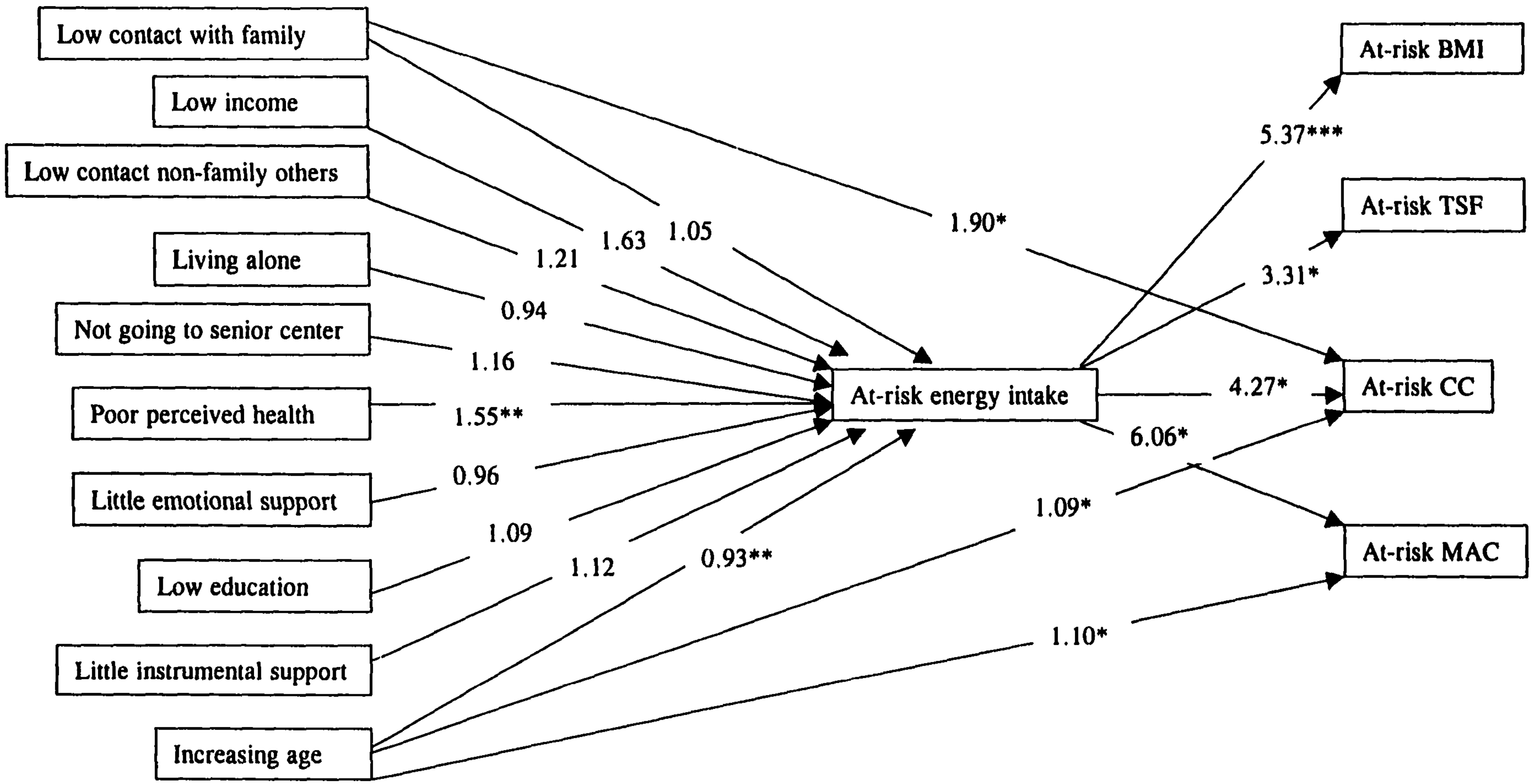
Variable	Total N=249	65-74 years N=108	75-84 years N=94	85+ years N=47
	%	%	%	%
At-risk BMI (≤ 22)	11.2	5.6[a]	18.1[b]	10.6[ab]
At-risk MAC (≤15.5 cm)	10.0	2.8[a]	12.8[b]	21.3[b]
At-risk TSF (≤26.0 mm)	9.6	5.6	10.6	17.0
At-risk Calf Circumference(≤32.3 cm)	9.6	3.7[a]	9.6[a]	23.4[b]
At-risk energy intake (≤0.75 x 1. 2 kcal/kg body weight x 24 hrs)	49.8	60.2[a]	42.6[b]	40.4[b]
At-risk protein intake (≤0.75 g/kg body weight)	9.6	6.5	9.6	17.0

[a] Using ANOVA analysis, letters with different superscripts are significantly different from each other at the 0.05 level.



*= p<0.05, *** = p<0.001

Figure 1: Logistic regression model for predicting at-risk protein intake and at-risk anthropometric measures as indicated by odds ratios. (N=243)



*= p<0.05, ** = p<0.01 ***= p<0.001

Figure 2: Logistic regression model for predicting at-risk energy intake and at-risk anthropometric measures as indicated by odds ratios. (N=243)

GENERAL SUMMARY

The studies cited in the review of literature characterize the interrelationship between malnutrition and a broad spectrum of contributing factors. Malnutrition is not a result of normal aging; but rather malnutrition is the result of the synergistic effect of illness, isolation, poverty, depression, and dietary factors.

In order to best identify potential risk of developing poor nutritional status, the Nutrition Screening Initiative developed three tools to educate and screen older adults for risk of developing poor nutritional status. The first tool, the DETERMINE Your Nutritional Health checklist, is self-administered and seeks to identify those with increased nutritional risk. By identifying those with highest risk, individuals can be targeted for counseling or services to decrease their risk for malnutrition. By decreasing the potential deleterious effects of these risk factors, older Americans can have increased health and quality of life and decreased financial costs associated with malnutrition.

The primary purpose of this research was to assess the ability of the DETERMINE checklist to predict at-risk nutritional status in a random sample of community-dwelling older women. A secondary purpose was to determine if any of several social isolation factors would lead to increased nutritional risk. A stratified random sample of older, rural, community-dwelling women was selected from counties where the population is older, less well-educated, poorer, and more socially isolated with few nutritional services available.

Analysis of anthropometric and dietary measures revealed a very heterogeneous group of older women. Age distributions of mean BMI, triceps skinfold, mid-arm circumference, and calf circumference showed a trend toward decreasing measures with age. However, the upper anthropometric percentiles were not as consistent with age as were the lower percentiles, showing fat and protein stores vary widely between age groups. Anthropometric measures identified approximately 10% of the population at-risk; however, this percentage increased dramatically in the oldest-old (85 years and older). On the other hand, the percentage of women with at-risk energy intake was highest in the young-old (64-74 years) and dropped significantly in the oldest women. At-risk protein intake was more prevalent in the oldest old. Assessing inadequate nutrient intake as ≤ 75% of recommended levels, more that 60% of the women were at-risk in three nutrients—calcium, folate and fiber. Cumulative risk of inadequate intake showed that one-third of the women consumed ≥4 nutrients at inadequate levels, but this percentage dropped to 13% for ≥ 5 nutrients.

(Only dietary intake, not including supplements, was considered in these analysis.) In comparison, the DETERMINE checklist identified 7% of the women as being at high nutritional risk with another 42% at moderate nutritional risk.

The three DETERMINE checklist questions most often answered yes (indicating risk) were taking ≥ 3 medications, eating alone, and having an illness. On the other hand, four questions had ≤ 5% positive response rate: eating < two meals per day; consuming ≥ three alcoholic beverages daily; eating few fruits, vegetables, or dairy products; and having insufficient money for food. Cohort differences were evident in the responses to the DETERMINE checklist questions: the percentage of young-old who had started dietary changes due to an illness was much higher than the oldest-old; whereas, a larger percentage of the oldest-old (aged 85 and older) had difficulty shopping, cooking and feeding themselves; experienced oral problems that made it difficult to eat; and were more likely to eat alone compared to the young-old (aged 65-74). Seventeen percent of the oldest-old scored at high risk compared to only 3% in the young-old.

In general the DETERMINE checklist is a poor predictor of at-risk anthropometric measures. Overall a score of ≥ 6 only predicted at-risk mid-arm circumference. Frequently, insufficient numbers of at-risk women responded positively to the individual checklist questions. Four questions identified at-risk anthropometric measures: having an illness; eating few fruits, vegetables or dairy products; involuntary weight loss or gain; and inability to shop, cook and feed oneself.

In general the DETERMINE checklist was a poor predictor of at-risk dietary measures. Overall, neither total score, a score of ≥ 6, nor a score of ≥ 3 on the DETERMINE checklist was predictive of at-risk intake or cumulative at-risk intake score. Only three questions predicted dietary intake—eating few fruits, vegetables, or dairy products; eating alone; and involuntary weight change.

Both at-risk protein and at-risk energy intakes predicted all at-risk anthropometric measures. However social factors were poorer predictors of at-risk nutritional indicators than the DETERMINE checklist. Overall, only one social factor—not going to the senior center—was predictive of at-risk protein intake. None of the social variables was predictive of at-risk energy intake. Only one social factor—less frequent contact with family members—predicted an at-risk anthropometric measure, calf circumference.

Risk factors were not the same between cohorts. While living alone before age 75 identified risk, living alone after age 75 showed no difference in risk. Those aged 65-74 who ate alone were more likely to have low triceps skinfold and calf circumference. They were also more likely to have an at-risk protein intake. Less frequent contact with others outside the family placed young-old at risk but not the older women.

In epidemiological studies of the oldest-old, BMI ≤ 22 is predictive of increasing mortality. Other investigators have shown that perceived health status and involuntary weight loss are also predictors of increased mortality. Findings from this research of the oldest-old showed that both involuntary weight loss and poorer perceived health status were predictive of at-risk calf circumference. Moreover, inability to shop, cook, and feed yourself also predicted an at-risk calf circumference. Thus, calf-circumference seems to be an important measure of overall health. Very little previous research has emphasized calf circumference as a measure of health in the elderly. Yet, the World Health Organization recognizes this as a strong predictor of muscle (and health) in the older adult. Therefore future research should include this measure as a significant predictor of nutritional risk and overall health.

The results presented here indicate that the DETERMINE checklist is a poor predictor of current dietary or anthropometric risk. Perhaps rewording of the current components of the DETERMINE checklist may help. For example, asking only one concept or behavior with each question, eliminating negative phrasing, and reducing ambiguous wording may improve identification of those who are at nutritional risk. Although the DETERMINE checklist addresses risk factors that contribute to malnutrition, perhaps other questions concerning eating behaviors from Level I Screen would better identify those with increased at-risk nutritional measures.

Malnutrition marked by weight loss, and other decreasing anthropometric measures usually develops over a long period of time. According to the Nutrition Screening Initiative, the DETERMINE checklist identifies those with increased nutritional risk. These individuals should have reduced dietary intake in the short-run, decreased anthropometric measures in the long-term, and finally a decreased quality of life due to illness and disability associated with an inadequate nutritional status. Therefore, a longitudinal study that compares the results of the DETERMINE checklist with nutritional indicators is needed.

APPENDIX A

ABBREVIATIONS USED

BCM = body cell mass
BEE = basal energy expenditure
BMI = body mass index
CC = calf circumference
CI = confidence interval
CM = congregate meal
dL = deciliter
DRI = dietary reference intake
ENP = Elderly Nutrition Program
FFQ = food frequency questionnaire
g = grams
GED = high school equivalency diploma
HDM = home-delivered meals
HF = health fair
HMO = health maintenance organization
IBW = ideal body weight
kcal = kilocalorie
kg = kilogram
L = liter
MAC = mid arm circumference
MAMA = mid arm muscle area
mg = milligram
mL = milliliter
mmol = millimoles
NHANES = National Health and Nutrition Examination Survey
NSI = Nutrition Screening Initiative
OR = odds ratio
OTC = over-the-counter
RDA = recommended dietary allowance
RMR = resting metabolic rate
SQFFQ = semi-quantitative food frequency questionnaire
TNR = total nutrition risk
TSF = triceps skinfold
U.S. = United States

APPENDIX B

DETERMINE YOUR NUTRITIONAL HEALTH CHECKLIST

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

Read the statements below. Circle the number in the yes column for those that apply to you or someone you know. For each yes answer, score the number in the box. Total your nutritional score.

DETERMINE YOUR NUTRITIONAL HEALTH

	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 2 meals per day.	3
I eat few fruits or vegetables, or milk products.	2
I have 3 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 3 or more different prescribed or over-the-counter drugs a day.	1
Without wanting to, I have lost or gained 10 pounds in the last 6 months.	2
I am not always physically able to shop, cook and/or feed myself.	2
TOTAL	

Total Your Nutritional Score. If it's —

0-2 **Good!** Recheck your nutritional score in 6 months.

3-5 **You are at moderate nutritional risk.** See what can be done to improve your eating habits and lifestyle. Your office on aging, senior nutrition program, senior citizens center or health department can help. Recheck your nutritional score in 3 months.

6 or more **You are at high nutritional risk.** Bring this checklist the next time you see your doctor, dietitian or other qualified health or social service professional. Talk with them about any problems you may have. Ask for help to improve your nutritional health.

These materials developed and distributed by the Nutrition Screening Initiative, a project of:

AMERICAN ACADEMY OF FAMILY PHYSICIANS

THE AMERICAN DIETETIC ASSOCIATION

NATIONAL COUNCIL ON THE AGING

Remember that warning signs suggest risk, but do not represent diagnosis of any condition. Turn the page to learn more about the Warning Signs of poor nutritional health.

The Nutrition Screening Initiative
2626 Pennsylvania Avenue, NW, Suite 301
Washington, DC 20037

The Nutrition Screening Initiative is funded in part by a grant from Ross Laboratories, a division of Abbott Laboratories.

APPENDIX C

LETTER MAILED TO POTENTIAL SUBJECTS

Dear <Full Name>,

Congratulations!! You have been selected to participate in the Older Adults Nutrition Research. Senior citizens, especially women, have special food needs. Many of these needs have not been studied and that is why you are so important. You are part of a group of two hundred (200) older women from Iowa selected as part of on going research being conducted at Iowa State University. Your answers will help other older females remain healthy and independent in their own homes.

The purpose of this research is to find the relationship between health and the food that you eat. You can provide much needed information about independent living elderly women and their health.

To conduct this research, I will visit your home at your convenience to interview you, so you will not have to leave your home. If you wish, you may have someone there as I interview you. The time needed to complete the information should be no more than one and a half hours. I would like to return to your home six months later for a final interview.

Your name, address, and phone number will not be associated with your answers. We will guarantee your privacy and maintain confidentiality.

If you have any questions concerning this project please call me,

Ardith Brunt (515) 296-7230 or

Dr. Lee Alekel (515) 294-3552 or

Your local county extension office

This project is being directed by Dr. Elisabeth Schafer, Iowa State University.

Your participation is very important and may help other older women remain healthy longer and stay in their own homes. Your participation is strictly voluntary and non participation will not affect evaluations of you.

I will be making a phone call to you within the next two weeks to make an appointment to visit in person with you. I am looking forward to talking with you.

Sincerely,

Ardith R. Brunt, RD

APPENDIX D

SCRIPT FOR TELEPHONE CALL TO POTENTIAL SUBJECTS

Name:

Address

Telephone:

Hello This is Ardith Brunt. I am a graduate student at Iowa State University. You may recall that you received a letter from me with an Iowa State University letterhead within the last week. This letter described my research project and my desire to interview you for this research. You are important because the special food needs of older American women have not be studied. Your answers to the survey may help other older females remain healthy and living independently in their own homes.

I would like to set up an appointment with you. That would involve me coming to your home and asking questions about the food you eat and your activities such as eating, visiting, talking and volunteering. Then I would take measurements such as measuring around your arm and leg. This shouldn't take any more than an hour and a half.

When would be a good time for me to come?

If you like, you may have someone present when I come.

Do you have any questions that I can answer?

Also, because I need to take arm and leg measurements, would it be possible for you to wear short sleeve blouse or dress, and a skirt, or pants that can be pulled up above the knee?

Response:

Yes

Decline

Why? _____ No response/ answer

_____ Disconnected

_____ Refusal

APPENDIX E

QUESTIONNAIRE USED FOR IN-HOME INTERVIEW

Hello, I'm Ardith Brunt, a graduate student at Iowa State and a registered dietitian. Thank-you for agreeing to participate in this study. Your answers are important because they can help determine the relationship the food you eat and your health. This may help other older women remain healthy and independent in their own homes.

I want to remind you that the answers to your questions are confidential and are only identified by a number– your name or address is not part of the survey. No one else will see the answers you provide other than me. However, if there are some questions that you really don't care to answer, that's OK, but of course, try to answer most of them. First of all I'm going to ask you some questions about yourself.

Birth date: ____________________________ Race (ethnicity) ______________________

County: ______________________________ Today's date ________________________

Education: What is the highest level or education you have completed?

____ Grade school or less (1)
____ Some high school (2)
____ Completed high school (3)
____ Some college (4)
____ Bachelor's degree (5)
____ Some graduate school (6)
____ Graduate degree (7)

Card 1: Income: What was your estimated household income before taxes in 1996?

____ Less than $9,000 (1)
____ $9,001 - $14,999 (2)
____ $15,000 - $24,999 (3)
____ $25,000 - $34,999 (4)
____ $35,000 - $49,999 (5)
____ $50,000 - $74,999 (6)
____ $75,000 - $99,999 (7)
____ $100,000 or more (8)

Y N Do you spend less than $30 per person per week on food?

Now I'm going to ask some questions about some of your relationships and activities.

What is your marital status? Married (1) Widowed (2) Divorced (3) Never married (4)

Do you live:

Alone (1) With spouse (2) With children (3) With others (4)

In addition to your spouse, do you have a child, sibling, other relative or close friend on whom you can rely? Yes No **If no, go to ******

Is this person a: Child (1) Sibling (2) Other relative (3) Friend (4)

About how old is this person:

______ 20-29 (1)

______ 30-39 (2)

______ 40-49 (3)

______ 50-59 (4)

______ [redacted]

______ 70-79 (6)

______ 80+ (7)

Card 2: How often do you do things together with this relative or friend?

_____ About once a month (1)

_____ About once a week (2)

_____ Several times per week (3)

_____ Almost every day (4)

How often do you eat a meal with this person?

_____ About once a month (1)

_____ About once a week (2)

_____ Several times per week (3)

_____ Almost every day (4)

Card 3: How often does this person buy or prepare food for you?

_____ Almost never (0)

_____ About once a month (1)

_____ About once a week (2)

_____ Several times per week (3)

_____ Almost every day (4)

Card 4: Does this person go with you to appointments with your doctor or talk to your doctor by telephone?

_____ Never (0)

_____ Once in a while (1)

_____ Frequently (2)

_____ Every time I visit the doctor (3)

Card 5 In the past year, have you given this relative or friend any financial assistance?

_____ No not at all (0)

_____ Infrequently (1)

_____ Regularly I partially support him/her. (2)

_____ Regularly they get most of their support from me (3)

Card 6: In the past year, have you received any financial assistance from this relative or friend?

_____ No not at all (0)

_____ Infrequently (1)

_____ Regularly he/she partially supports me. (2)

_____ Regularly I get most of my support from him/her. (3)

Card 7**** In the past 2 weeks, have you talked on the phone with children or relatives?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

In the past 2 weeks have you talked on the phone with friends or neighbors?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

In the past 2 weeks have you gotten together with children or relatives?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

In the past 2 weeks have you gotten together with friends or neighbors?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

In the past 2 weeks, have you been to a senior center?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

In the past 2 weeks have you gone to church or synagogue service or other church -related activities?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

In the past 2 weeks, have you gone to the movies, a concert, a sports event, or museum?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

Ask only if a spouse: In the past 2 weeks, have you received help with your daily activities of personal care and eating from your spouse?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

In the past 2 weeks have received help with your daily activities of personal care and eating from relatives or friends?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

In the past 2 weeks, have you received help with your daily activities of personal care and eating from paid helpers (home health aides, nurses)?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

In the past 12 months have you participated as a volunteer?

_____ No (0)

_____ Once or twice (1)

_____ Multiple times (2)

_____ Nearly every day (3)

Next are some questions concerning your current physical health:

Card 8 How would you rate your overall health?

_____ excellent (1)

_____ very good (2)

_____ good (3)

_____ fair (4)

_____ poor (5)

Y N In the last 12 months, have you had any illness or injury that have required hospitalizations?

Y N Do you consider yourself homebound?

Do you usually need help with:

___ Bathing?	___ Toileting	___ Traveling outside home
___ Dressing	___ Eating	___ Preparing/cooking food
___ Grooming	___ Walking/moving about	___ Shopping for food & other necessities

The next set of questions deals with some general questions about eating. You can answer Yes or No to these questions.

2 Y N Do you have an illness or condition that made you change the kind and/or amount of food you eat?

3 Y N Do you eat fewer than 2 meals per day?

2 Y N Do you eat few fruits or vegetables or milk products?

2 Y N Do you have 3 or more drinks of beer, liquor, or wine almost every day?

2 Y N Do you have tooth or mouth problems that it hard for you to eat?

Y N Do you have difficulty chewing?

Y N Do you have difficulty swallowing?

Y N Do you have pain in mouth, teeth or gums?

4 Y N Do you always have enough money to buy the food you need?

1 Y N Do you eat alone most of the time?

1 Y N Do you take 3 or more prescribed or over the counter drugs a day?

2 Y N Without wanting to have you lost or gained 10 pounds in the last 6 months?

2 Y N Are you always physically able to shop, cook and/or feed yourself?

Y N Do you have enough food to eat each day?

Y N Do you skip eating on one or more days each month?

Y N Do have a poor appetite?

Y N Do you follow a special diet? If yes, what diet do you follow? _______

Y N Are you concerned about home security?

Y N Do you live in a home with inadequate heating or cooling?

Y N Do have a working stove (or microwave) and refrigerator?

___ Total

This section is about usual eating habits. Thinking back over the past year, how often do you usually eat these foods. There are about 100 items and I'll begin with fruits. **Card 9**

Fruits	**Med. serving.**	S	M	L		D	W	M	Y	R
Apples, applesauce, pears	(1) or .5 cup									
Bananas	1 medium									
Peaches, apricots: canned frozen or dried (year round)	1 piece or 1/2 cup									
Peaches, apricots, nectarines fresh (in season)	1 piece or 1/2 cup									
Cantaloupe (in season)	1/4 medium									
Watermelon (in season)	1 slice									
Strawberries (fresh in season)	1/2 cup									
Oranges	1 medium									
Orange or grapefruit juice	6 oz. glass									
Grapefruit	(1/2)									
Breakfast drinks like Tang, Start	6 oz glass									
Other fruit juices fortified fruit drinks	6 oz.									
Any other fruit i.e. berries, fruit cocktail	1/2 cup									

And now lets do the vegetables.

Vegetables		S	M	L		D	W	M	Y	R
String beans, green beans	1/2 cup									
Peas	1/2 cup									
Chili with beans	3/4 cup									
Beans, like baked beans, pintos limas, or kidney	3/4 cup									
Corn	1/2 cup									
Winter squash, baked squash	1/2 cup									
Tomatoes, tomato juice	1 or 6 oz									

Red chili sauce, taco sauce, salsa picante	2 Tbs. sauce								
Broccoli	1/2 cup								
Cauliflower or Brussels sprouts	1/2 cup								
Spinach (raw)	3/4 cup								
Spinach (cooked)	1/2 cup								
Mustard greens, turnip greens collards	1/2 cup								
Cole slaw, cabbage, sauerkraut	1/2 cup								
Carrots or mixed vegetables containing carrots	1/2 cup								
Green salad	1 medium bowl								
Salad dressing, mayonnaise including on sandwiches	2 Tbs.								
French fries and fried potatoes	3/4 cup								
Sweet potatoes, yams	1/2 cup								
Other potatoes, incl. boiled, baked potato salad, mashed	(1) or 1/2 cup								
Rice	3/4 cup								
Any other vegetable incl. cooked onions summer squash	1/2 cup								
Butter, margarine, or any fat on vegetables, potatoes etc.	2 pats								

This next section is about:

Meat, Mixed Dishes		S	M	L	D	W	M	Y	R
Hamburgers, cheese burgers, meatloaf	1 medium								
Beef – Steaks roasts	4 oz.								
Beef stew or pot pie with carrots and other vegetables	1 cup								

Liver, including chicken livers	4 oz								
Pork including chops, roasts	2 sm. chops 4 oz								
Fried chicken	2 sm. or 1 lg piece								
Chicken or turkey, roasted stewed or broiled	2 sm. or 1 lg piece								
Fried fish or fish sandwich	4 oz or 1 sand.								
Tuna fish, tuna salad, tuna casserole	1/2 cup								
Shellfish, shrimp, lobster, crab, oysters	5 pieces, 1/4 cup or 3 oz.								
Other fish, broiled or baked	4 oz.								
Spaghetti, lasagna, other pasta with tomato sauce	1 cup								
Pizza	2 slices								
Mixed dishes with cheese like Macaroni and cheese	1 cup								
Liverwurst	2 slices								
Hot dogs	2 dogs								
Ham, lunch meats	2 slices								
Soup: Veg, Veg beef, minestrone, tomato	1 medium bowl								
Other soups	1 medium bowl								

Now lets go on to: **Breads, Salty snacks, spreads**		S	M	L	D	W	M	Y	R
Biscuits, muffins, burger rolls (including fast foods)	1 medium piece								
White bread (incl. sand) bagels, crackers, flour tortillas, pita	2 slices. 1/2 bagel or 3 crackers								
Dark bread incl. whole wheat, rye, pumpernickel	2 slices								

Corn bread, corn muffins, corn tortillas	1 medium piece									
Salty snacks (chips, popcorn)	2 handfuls									
Peanuts, peanut butter	2 Tbs.									
Margarine on bread or rolls	2 pats									
Butter on bread or rolls	2 pats									
Gravies made with meat drippings, white sauce	2 Tbs.									

Breakfast foods are next.		S	M	L	D	W	M	Y	R
High fiber, bran or granola cereals, shredded wheat	1 medium bowl								
Highly fortified cereals like Product 19, Total, Most	1 medium bowl								
Other cereals like corn flakes, rice krispies,	1 medium bowl								
Cooked cereal	1 medium bowl								
Sugar added to cereal	2 tsp.								
Eggs 1 egg = small	2 eggs = medium								
Bacon	2 pieces								
Sausage	2 patties or links								

Now I'll ask how often you eat various sweets.

Sweets		S	M	L	D	W	M	Y	R
Ice cream	1 scoop								
Doughnuts, cookies cakes, pastry	1 pc. or 3 cookies								
Pumpkin, Sweet potato pie	1 medium slice								
Pie	1 medium slice								
Chocolate candy	small bar, 1 oz								
Other candy, jelly, honey, brown sugar	3 pieces or 1 Tbs.								

Next are the dairy products:

Dairy Products		S	M	L		D	W	M	Y	R
Cottage cheese	½ cup									
Cheese and cheese spreads	2 slices or 2 oz.									
Flavored yogurt, not frozen	1 cup									
Whole milk & bevs w/ Whole milk	8 oz glass									
2% milk & Bevs w/ 2% milk	8 oz glass									
Skim milk, 1% or buttermilk	8 oz glass									

We are to the last section:

Beverages		S	M	L		D	W	M	Y	R
Regular soft drinks, not diet	12 oz can / bottle									
Diet soft drinks	12 oz can / bottle									
Beer	12 oz can / bottle									
Wine	1 med. glass									
Liquor	1 shot									
Decaffeinated coffee	1 medium cup									
Coffee, not decaffeinated	1 medium cup									
Tea (hot or iced)	1 medium cup									
Non-dairy creamer in coffee or tea	1 Tbs.									
Milk in coffee or tea	1 Tbs.									
Cream in coffee or tea	1 Tbs.									
Sugar in coffee, tea or on cereal	2 tsp.									
Lemon in tea	1 tsp.									
Artificial sweeteners in coffee, tea	1 packet									
Glasses of water not counting tea or coffee	8 oz. glass									

17 How many hot meals do you consume per day or week? _______ per ________

Card 10 18. How frequently do you use congregate meals or home delivered meals?

_____ Daily

_____ 2-3 times per week

_____ 2-3 times per month

_____ monthly

_____ never

During the past year, have you taken any vitamin or minerals

No_____Yes, fairly regularly _____ Yes, but not regularly__

If yes, fairly regularly, What kind and brand name(s) do you take?

____

____

____

____

____

____

____

Complete formulas ______ Cans per ____________

And now the final thing we are going to do is take some measurements. The first one I'll take is knee height because I take this one when you are sitting down. If you could please slip off your shoe I'll put the bottom of the ruler under your heel and the top of it on top of your of your knee. I need to take two measurements for this measurement so that I can be as accurate as possible. It is best to take this measurement with no clothing between the ruler and skin, however, nylons are OK. (Long pants-- Is it possible to slip the pant leg over the knee?)

While you are sitting I would like to slip the measuring tape under your foot and measure you calf. I'll slip it up and down the calf so I can get the largest part of the muscle. This one I have to measure 3 times just to make sure the measurements are all the same. (Long pants--Is it possible to slip the pant leg up so that I measure your leg and not clothing?)

(If long sleeves, Ask to slip up sleeve or to change into short sleeves-- not sweaters or measuring through clothing).

Now if you can stand up, I would like to measure around your upper arm. I first have to do is find the mid-point and I will mark it with a very small dot. Then I will ask you to slip your hand and arm through the tape loop. I will then measure around your upper arm muscle. Again, this need to be done 3 times so I can make sure the measurements are the same. Bend your arm so that it forms a 90 degree angle. I use the bone that sticks out on your shoulder and your elbow to find the mid-point. I read it at the side of your arm so that I can make sure that I am measuring at the mid-point.

Now I am going to measure the thickness of skin on the back side of your arm. These are the calipers I will use to measure the thickness. They are going to exert a little pressure, but should not be painful. Here let me show you what to expect on your hand. Now let your arm totally relax at your side. (Self-demonstration of pinch) I am going to put my thumb and index finger slightly above the mid-point and pull the skin and fat slightly away from the muscle. Then I will measure this skin and fat with the calipers. Again this needs to be done 3 times, just to make sure I have an accurate measurement. Sometimes the pinch slips, so its really important that I get the right measurement.

And the very last thing of all, I am going to ask you to step on the scale.

Anthropometric measurements:

_______ _______ Knee height (in)

_______ Weight (LB)

_______ _______ _______ Mid upper arm circumference

_______ _______ _______ Triceps skinfold

_______ _______ _______ Calf circumference

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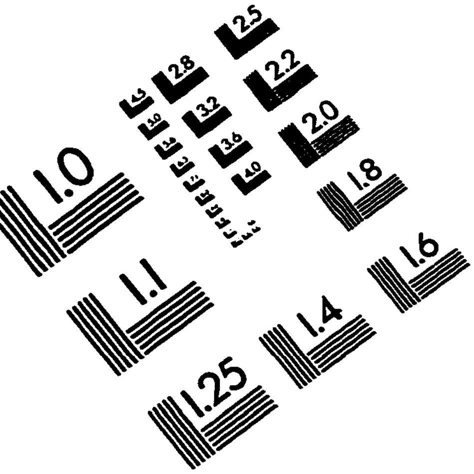
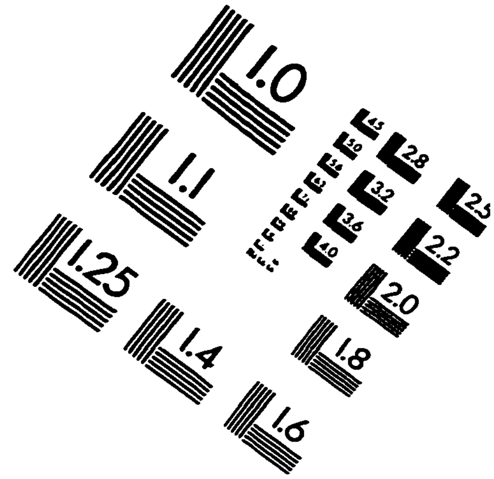
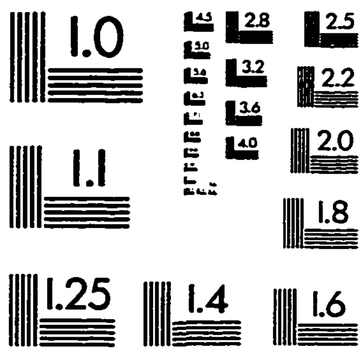
IMAGE EVALUATION TEST TARGET (QA-3)







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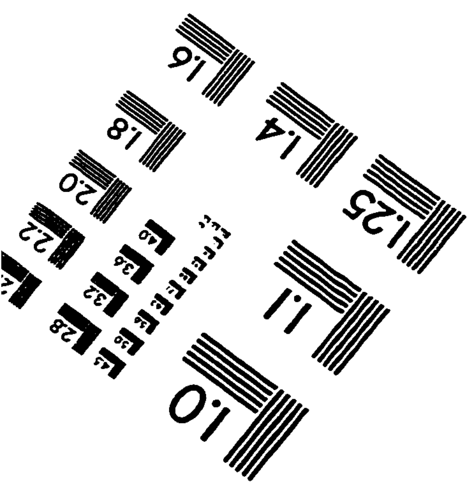

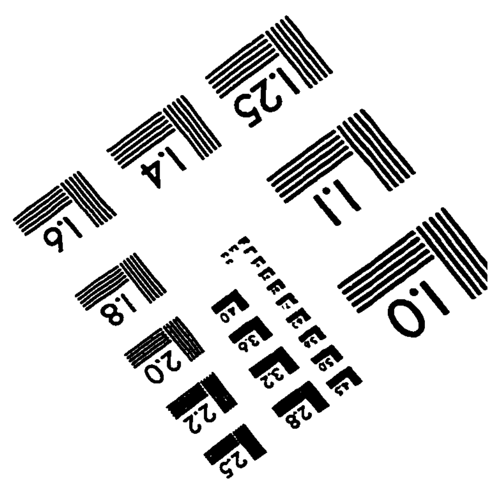

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