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# Older Adults Need Guidance to Meet Nutritional Recommendations

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## Abstract

**Objective—**The purpose of this study was to compare the diet of healthy, free-living senior volunteers to the dietary reference intakes (DRIs) and Food Guide Pyramid recommendations.

**Methods—**This study was a cross-sectional assessment of dietary habits, as measured using a standardized food frequency questionnaire, among 1740 healthy Southwestern U.S. adults, aged 51 to 85 years. Assessment of independently-living volunteers to chemoprevention trials provides an efficient mechanism to profile typical dietary habits among the older adult population.

**Results—**Daily estimated macronutrient intakes exceeded recommended proportions of protein and fat. In contrast, more than 60% of this senior population reported dietary vitamin D, vitamin E, folate and calcium intakes below estimated average requirements (EAR). Based on the Food Guide Pyramid recommendations, fewer than 10% of the older adults consumed the recommended daily dairy and grain servings. More females than males consumed recommended vegetable (49% *versus* 40%) and fruit (53% *versus* 48%) servings ($p <$, 0.05). More males consumed recommended grain (11% *versus* 7%) and protein (78% *versus* 73%) servings ($p <$, 0.05) than females.

**Conclusions—**Mean micronutrient intakes compared well with DRIs, although fewer than one-half of these older adults consumed recommended levels for vitamin D, vitamin E, folate, and calcium or daily food servings of dairy, grains, vegetables or fruits. Since the beneficial aspects of foods are not limited to essential nutrients, nutrition recommendations to older adults may be improved by emphasizing daily servings of nutrient-dense choices within the Food Pyramid.

### Keywords

dietary reference intakes; estimated average requirement; recommended dietary allowances; Food Guide Pyramid; Modified Food Guide Pyramid; older adults; seniors; supplement use; tolerable upper limit

## INTRODUCTION

The US population is aging, with the Census Bureau predicting that the number of citizens over the age of 65 years will increase from 34.6 million in 2000 to 69.4 million in the year 2030 [1]. One of every five Americans will be among this group for whom nutrition standards continue to be a subject of discussion [2-5]. Studies of current dietary practices have not always separated the eating patterns of healthy, free-living senior adults from older adults whose

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patterns may be altered by chronic disease, disabilities, or institutionalization [1,2,5,6]. While institutionalized or diseased populations are an important focus, research which describes the dietary needs of the free-living, healthy older population is essential to understanding nutrition challenges for the next century [7-13].

The Recommended Dietary Allowances (RDAs) and the Food Guide Pyramid provide two distinct approaches to evaluating dietary adequacy [14,15]. Several researchers have suggested that specific RDA levels of essential nutrients need to be modified for males and females over the age of 50 years [2-5,7], a change which is occurring as the Dietary Reference Intakes (DRIs) are established [16-19]. Development of the DRIs includes review of data that link nutrient needs to physiological changes and protection against specific age-related chronic diseases or conditions and provide a broader framework for counseling individuals or groups with specific diseases or disease-risks [16-19]. A modified Food Guide Pyramid has also been developed recently to meet the needs of older individuals whose total energy intakes may be diminishing [20]. Comparison of actual dietary practices with the Food Guide Pyramid recommendations might be particularly useful for older population groups, since there appears to be a reliance on nutritional supplements to meet vitamin and mineral requirements in this population [21-26]. Use of supplements enhances the apparent specific nutrient density of diets without increasing the level of other food components whose beneficial roles are just beginning to be appreciated [9,27,28].

In this paper we present an analysis of the dietary intake of men and women aged 51 years and older who participated in a large, phase III chemoprevention trial of persons at risk for skin cancer [29,30]. The typical dietary intake of these healthy adults, as assessed by food frequency questionnaires, was compared to standards for evaluating dietary adequacy. Use of dietary data collected at baseline in such large trials is an economical and efficient source of data for healthy, free-living older adults.

## METHODS

### Population

Moderately sun-damaged, healthy adults living in Arizona who were between the ages of 21 and 85 were eligible for the double-blind trial of the efficacy of oral vitamin A (25,000 I.U. daily) *versus* placebo as a skin chemopreventive agent. In this study moderate sun damage was defined as having ten or more clinically apparent precursor lesions on the forearms. Approval for the trial was received by the University of Arizona Human Subjects Committee. The design and results of this trial have been previously published [29,30]. Exclusion criteria included fewer than ten clinically apparent precursor lesions (actinic keratoses) on forearms, greater than two previous non-melanoma skin cancers, any other cancer or treatment for cancer within the preceding five years, supplementation of vitamin A exceeding 10,000 I.U. daily (>2 × the RDA) or blood assessment values outside of normal limits. Between 1985 through 1989, 1955 participants aged 51 years and older were randomized into the five-year study. This report focuses on the 1740 men and women who completed the baseline dietary questionnaire, 89% of the eligible older participants.

Participants were excluded from this analysis if baseline food frequencies were not completed (9.2%), multiple items on the questionnaire were skipped (1.2%) or reported daily energy levels were greater than 200% or less than 50% of estimated energy expenditure (0.6%), based on the World Health Organization equations for daily energy needs [31]. Reported daily energy intake compared to estimated daily requirement has been used by other studies to assess the appropriateness of dietary information [32,33]. There were no statistically significant differences between those without diet data and those with diet data for age, level of education,

gender, smoking history, supplement use, physical activity or body mass index (BMI - kg/$m^2$).

## Diet Assessment

Shortly after recruitment, study staff provided verbal, in-person introduction of the Arizona Cancer Center semi-quantitative food frequency questionnaire (AFFQ) to each study participant. Participants were given the choice of completing the questionnaire at the clinic or taking it home and returning it at their next clinic visit. The questionnaire was designed to be self-administered. Returned questionnaires were reviewed by study staff for completeness or clarification, if necessary.

The AFFQ was the dietary assessment portion of the Block Health Habits and History Questionnaire (HHHQ) [34]. The precision, accuracy and validity of this questionnaire has been examined through comparison with four-day food records and repeated administration [34-37]. Since its validation, the questionnaire has been used in numerous regional and National assessments of dietary intakes. The AFFQ consists of 98 food items grouped into nine categories of foods. Pictures and reference measurements of commonly used portion sizes for food items were used to assist in questionnaire completion. Information was sought regarding preparation methods and commonly used ingredients. This information modified the nutrient composition analysis to account for food preparation choices.

The AFFQ has an extensive and comprehensive food composition database that is updated and maintained to ensure current and accurate nutrient information [38]. The United States Department of Agriculture (USDA) composition database is used and enhanced with nutrient data from the National Food Consumption Survey and other sources as available [39,40]. Modifications include the addition of commonly eaten Southwestern foods and increased detail for fiber-containing foods [38].

Baseline assessments also included demographic and medical history questionnaires that assessed supplement use. Brand name information was used to code vitamin and mineral supplement intake.

## Analysis

Estimated daily nutrient intakes from diet alone and diet plus supplements were summarized for each participant. Mean micronutrient intakes were calculated along with the proportion consuming less than the recommended level. Recommended levels of micronutrients were the Estimated Average Requirement (EAR) or Average Intake (AI) according to DRI definitions of intake values to assess nutrient adequacy among population groups [16,17,19]. Unlike RDA levels that are set at values above that required for most persons, the EAR levels are nutrient intakes that should meet requirement levels for half of the healthy individuals in a group [16, 17,19]. Using this definition, it is expected that reported intakes of 50% of the population will be above the DRI level and 50% will be below. If more than 50% of a population report consuming a specific nutrient in amounts below the recommended level, that nutrient is at risk for inadequate intake and considered a cause for concern. Having more than 50% of the population report intakes below the EAR is equivalent to having two-thirds of the population report intake levels below the RDA. Two-thirds of the (1989) RDA level was used as the recommended level for nutrients for which no DRIs were available [14].

Using the frequency and serving size information, each subject's number of daily Food Guide servings was calculated. The daily food servings of the five Food Guide Pyramid Food groups were then estimated by combining the number of servings of all items included in the specific major food group. Food items such as sugar, butter, coffee, tea and diet drinks were not primary

contributors to any major food group and did not add to the daily serving intake. Mixed food items such as spaghetti, pizza, or macaroni and cheese contributed to each food group category for which the item added one-fourth of a serving amount or more. This method of summarizing food servings based on obvious classifications is consistent with other studies [7,9,41]. This method, however, underestimates servings compared to assessments using the USDA food grouping system, which includes small amounts extracted from dis-aggregated food mixtures, for example adding the amount of nonfat milk solids found in hamburger buns to dairy servings rather than simply considering the entire bun within the grain servings [43,44]. Age- and gender-specific daily recommended servings of each food group were from the USDA documentation of the derivation of the Healthy Eating Index [42]. Each participant's daily food servings were energy adjusted to minimize confounding. The USDA reference male and female older than 50 years of age is light to moderately active and consumes 2300 and 1900 kilocalories daily, respectively. Adjusted daily servings equaled daily servings divided by the ratio of caloric intake to caloric intake of the appropriate reference (i.e. adjusted fruit servings for a male participant = estimated daily fruit servings ÷ daily caloric intake/2300 daily kcals of reference male).

Daily food servings were also compared to recommended levels of the modified Food Guide Pyramid, developed for adults older than 70 years of age [20]. The recommended daily servings of the Modified Food Guide Pyramid were not gender specific. These recommendations were based on minimal servings of nutrient-dense foods within the five food groups to ensure adequacy when daily energy intake was 1200 to 1600 kilocalories [20].

Participant characteristics were summarized from the demographic and medical history questionnaires. Demographic information of study participants was self-reported, including the weight and height data that were utilized to calculate body mass index (BMI = $kg/m^2$). The validity of self-reported weights and heights has been shown in previous studies [45].

Mean macronutrient, micronutrient and daily food servings for the Food Guide Pyramid were calculated by gender for two age groups: 51 to 70 and 71 to 85 years of age. Macronutrient intake was compared to the RDAs for energy and protein and Healthy People 2000, which specifies levels of carbohydrate, total and saturated fat and dietary fiber [14,46]. Also, the percentage of individuals consuming a specific nutrient or food group below recommended levels was determined by age and gender.

The SAS Statistical software program, version 6.12, was used for all statistical analyses [47]. Student's *t* test was used to examine BMI differences by gender. Mean nutrient levels were tested for age and gender differences using the general linear model procedure for unequal group size. Chi square analysis was used to test the difference in distribution of percentage of participants consuming less than nutrient DRI levels or Food Guide Pyramid recommended servings between age groups and gender. A $p$ value of less than 0.05 was considered significant.

## RESULTS

As shown in Table 1, this Southwestern population of volunteers in a chemoprevention trial was highly educated and reported low current smoking but high previous tobacco use. More than two-thirds reported use of dietary supplements. Significantly more males were married (89% *versus* 64%), engaged in active sports (7% *versus* 3%) and were current or former smokers (66% *versus* 48%) compared to females. Females reported more daily supplement use than males (58% *versus* 43%). The mean body mass index (BMI ± SEM) was 25.7 ± 0.1 and 24.8 ± 0.2 for males and females, respectively. Among males, BMI decreased significantly with age ($p$ <, 0.00002) whereas no difference with age was observed among females (data not shown).

Mean energy and macronutrient intakes of study participants are provided by age and gender and compared with recommendations (Table 2). The RDAs recommend daily energy intakes of 2300 and 1900 kilocalories for males and females older than 50 years of age, including 63 grams and 50 grams of protein daily [14]. Healthy People 2000 recommends that no more than 30% of daily energy should be consumed as fat, of which a maximum of one-third should be saturated fat [46]. The objectives include increased consumption (up to 60% of daily energy) of complex carbohydrates, specifically vegetables, fruits and grains, including a minimum of 10 grams of dietary fiber per 1000 kilocalories of daily energy [46]. Mean protein and fat intakes among the older adults were above recommendations for all gender and age strata, while reported energy, carbohydrate and fiber intakes were substantially below current goals. Males aged 51 to 70 years reported significantly higher intakes of daily energy, protein, total and saturated fat compared to males aged 71 to 85 years.

Table 3 presents results of diet alone and diet plus any supplemental amounts for the entire study population. As noted in Table 1, 73% of the study subjects took supplements which significantly increased the mean intake of all nutrients except the rarely supplemented vitamin K. Mean dietary intake of all vitamins except vitamin D, vitamin E and folate met recommended levels. However, the percentage of persons with low intake, as recommended by the EAR, varied. Incorporating supplement use into the assessment generally decreased the proportion with low intake. For vitamins A, K and $B_{12}$, fewer than 10% reported intakes below recommended levels. In contrast, over 90% of the older adults reported dietary vitamin D intake below EAR levels, over 73% reported low vitamin E intakes and over 50% reported folate intakes below EAR. The mean level of niacin intake among the study population was substantially increased from supplementation by 45% and 53% of the older males and females, respectively. Supplemental niacin amounts reached or exceeded DRI tolerable upper limits (ULs) among 35% of the older adults.

Mineral intake from diet alone and diet plus any supplemental amounts for the entire study population are given in Table 4. Mean dietary intakes of all minerals, except calcium, met recommendations. Supplement use slightly decreased the percentage reporting low intakes; however, fewer older adults reported taking mineral supplements compared to vitamins. Phosphorus and iron were the only minerals for which less than 10% of the population reported intakes below the EARs. More than 80% of the older men and women reported calcium intakes below recommended levels. Dietary magnesium intake was below recommendations for more than 55% of older adult males, although the majority of females met EAR intake levels. Supplementation only minimally reduced the proportion of males with intakes below EAR levels. More than 23% of the older adults reported supplemental intakes of magnesium (not including dietary amounts) at levels which met or were above the tolerable upper limits (ULs) as recommended by the DRIs.

Table 5 compares daily energy-adjusted food group servings to recommendations of the traditional Food Guide Pyramid and mean daily food servings (not energy-adjusted) to the Modified Food Pyramid for older adults. Regardless of the standard used for food group assessment, men and women of this Southwestern population reported consuming daily grain and dairy servings at substantially fewer than the recommended level. Ten percent or fewer of the older adults consumed the recommended daily servings of grain and dairy foods. Mean daily servings of vegetables and fruits approximated the recommended levels, although less than 50% of the study population met daily vegetable intake recommendations and only slightly more met daily fruit serving recommendations. Significantly more women than men consumed the recommended daily servings of vegetables (49% *versus* 40%) and fruits (53% *versus* 48%, $p <$, 0.05). Both men and women on average exceeded recommended levels for daily servings of meats/proteins.

## DISCUSSION

This cross-sectional assessment of dietary habits among healthy, free-living, aging volunteers compared usual nutrient intake information among older adults to two primary standards of intake: DRIs and Food Guide Pyramid recommendations. Although participants were from a specific geographical region, the observed levels and age-related reductions in total energy and macronutrients in these Southwestern senior adults compared well with results from other studies, including NHANES III [7,11,41,48-52]. Typical daily energy intakes approximating 2000 kcals and 1600 kcals for older males and females respectively, are reported in studies despite differences in assessment methods that range from a single 24-hour recall used in NHANES III to multiple-day recalls, food records and FFQs [7,11,23,48-50,52]. The less than recommended level of energy intake and nutrients at risk for low consumption seen in this study and others, provide evidence that nutritional guidance to older citizens should emphasize selection of more nutrient-dense foods to ensure recommended nutrient levels are met in spite of the age-related reduction in intake.

Vitamin D was inadequately consumed by more than 90% of older participants and calcium intakes were substandard for more than 80%. Fewer than 5% of study participants consumed the recommended daily dairy servings, foods that are rich sources of calcium and vitamin D. Other studies have reported recent declines in dairy consumption, suggesting that the public health emphasis to decrease dietary fat also diminished consumption of dairy products [10, 53]. This decreased intake of vitamin D may be a particular problem among the elderly who are concerned with skin cancer and who purposefully limit their ultraviolet light exposure, another important mechanism for maintaining vitamin D status. Increasing consumption of lower fat dairy products would provide seniors with a high quality protein source along with concentrated sources of calcium and vitamin D. The new DRIs for vitamin D and calcium are above the previously recommended levels of intake. Failure to maintain bone mineralization with aging and the need to reduce the growing prevalence of osteoporosis among the aging factored into the higher standards [2-5,17,18]. Previous studies in which inadequate intakes were defined as intake levels at less than 2/3rds of the RDA reported inadequate intakes of vitamin D among 31% to 74% and of calcium among 13% to 54% of older adults [11,21,52]. The critical need for improvement in nutrients associated with bone health is apparent with the finding that more than four out of every five older adults reported inadequate intakes of vitamin D, calcium and dairy foods.

More than half of study participants reported low dietary folate intakes. Intakes of dietary folate at levels below 2/3rds of the RDA are reported among 28% to 84% of other older adult populations [11,21,23,52]. Leafy vegetables, yeast, legumes and some fruits are rich folate sources, although folate is prone to destruction during food preparation and storage. In this study, more than half of senior participants consumed inadequate servings of vegetables and fruits. Increased consumption of daily servings of uncooked vegetables and fruits would substantially increase the observed low dietary folate intakes. Recommended levels for folate are higher in the current DRIs to reflect evidence that folate intake can lower the atherogenic rise in plasma homocysteine associated with aging [14,16,18]. Eating in accord with recommendations from the Food Guide Pyramid would not only reverse low dietary folate levels, but could also provide additional benefits. Fruits and vegetables are low fat sources of essential micronutrients, phytoestrogens and fiber, and increased consumption is associated with reductions in coronary mortality and cancer incidence [27,54,55]. Other studies have also reported low daily consumption of these important food groups [7,9,22,25]. Significantly more women than men consumed the minimal daily vegetable and fruit servings of the Modified Food Guide Pyramid.

Dietary vitamin E intakes were below the EAR for more than 70% of the older adults. Previous studies have reported 17% to 48% of older adults with vitamin E intakes at levels below 2/3rds of the RDAs [7,23,52]. Vegetable oils, nuts, peanut butter and wheat germ are good dietary sources of vitamin E along with whole grains. In this study, older adults reported eating fewer than half of the recommended daily servings of grains. Whole or unrefined grains provide fiber and other non-nutritive components and are associated with reduced risk of cardiovascular disease, diverticulosis, other chronic diseases and some cancers [9,20,56,57]. In addition to its being a rich source of fiber, older adults should be encouraged to select whole grain, enriched and fortified grain foods to provide additional sources of B vitamins and improve intake of vitamin E and fiber. Enriched and fortified grains are recommended due to uncertainty in the physiological availability of vitamin $B_{12}$ and the ease with which folate can be destroyed during food preparation [16,18].

The high use of supplements within this population, 73%, was above the use reported in other studies of older adults [11,17,23-26]. Almost half of the study participants reported daily use of vitamin and/or mineral supplements, while another 25% reported regular use, but not on a daily basis. Other studies have noted an association between education and supplement use [26]. Supplementation levels may be higher in this study due to the fact that participants were volunteers to an intervention trial of an oral agent, which purposely selected adults who could consistently take pills. Although most participants reported use of some supplements, substantial proportions still did not meet some of the recommended DRI for all nutrients. Recommended levels of vitamins $B_{12}$ and folate stated in the DRIs assume intake of fortified or supplemental forms to ensure bioavailability among older adults. The Modified Food Guide Pyramid also recommends that adults over seventy years of age consume vitamin D, $B_{12}$ and calcium supplements. In general, results from this population of older adults supports these recommendations for supplements. Only one-fifth of the older adults reported adequate intake levels of vitamin D and calcium. Although dietary vitamin $B_{12}$ intakes were at acceptable levels, poor absorption prevalent among older individuals, in contrast to the potential for neurologic benefit, suggests supplementation may be advantageous [16,18]. Widespread supplementation of micronutrients, however, should be discouraged. More than 20% of the older adults assessed in this study population consumed supplemental magnesium at levels which reached or exceeded the Tolerable Upper Limit (UL) levels of the DRIs. More than one-thirds of the older adults reported supplemental niacin intake that met or exceeded ULs. It is possible that a proportion of the high niacin supplementation was pharmacologic, used for lowering serum cholesterol. While supplementation may play an important role in achieving physiological or preventative levels of specific micronutrients, supplements do not contribute other beneficial dietary components, such as fiber [7,22,21]. Although dietary levels of vitamin C met recommendations, increased fruit and vegetable consumption would also increase fiber intake that was at only half the recommended levels.

Comparison of dietary intake with the Food Guide Pyramid recommendations highlights the food groups at risk for critically low intakes in the diet of older individuals. High protein and meat intake reported here suggests latitude for dietary improvement. In this population, reported intake exceeded all the protein recommendations, whether assessed as proportion of macronutrient intake or daily servings of foods from the meat and protein group. In contrast to studies of aging adults living in care facilities, studies of community-dwelling older adults and NHANES III report protein intakes at or above recommended levels. Mean daily grams of protein intake among older adults range from 67 grams to 85 grams for males and 52 grams to 68 grams daily for females in these previous reports [7,11,23,48,49,52]. The relatively high meat consumption among these Southwestern seniors ensured that vitamin $B_{12}$ intakes were also above recommended levels, in contrast to studies that identified vitamin $B_{12}$ as a problem nutrient for older adults [11,21]. However, a substantial proportion of the excessive dietary fat intake among these older adults was a consequence of the protein consumption. The selection

of leaner protein sources and increased intake of fish would simultaneously decrease fat intake while allowing consumption of more grain, vegetable, fruit and nonfat dairy products within the same total energy intake.

As with any dietary survey, this study's findings are based on an estimate of intake which may not reflect tissue levels or variations in nutrient absorption. Although the dietary assessment occurred during baseline of a five-year chemoprevention trial, energy, macronutrient and micronutrient levels within the study population are consistent with results of other studies of older adults including NHANES III [7,11,21-23,41,48-52]. Most of the previous studies, however, assessed the dietary intake using three-day food records or a 24-hour recall [7,11, 48-50]. Food frequency questionnaires have been used reliably among older adults in previous studies [41,51,59]. FFQs are considered prone to both overestimates and underestimates of true intake, depending on both the cognitive ability of the population being sampled and the inclusiveness of the food list [60,61]. Few FFQs among this older volunteer population were excluded due to being incomplete (1.2%) or reporting energy intakes in extreme excess or deficiency compared to estimated daily energy requirements (0.6%). However, FFQs are designed to assess the nutrient intake over a longer, more representative time period (e.g. one year). Since determination of usual dietary habits among healthy, free-living, older adults was a primary goal of this study, the completion of dietary assessments using AFFQs should be viewed as a strength. FFQs, however, are list-based assessments and may inadequately prompt for items not listed resulting in reports of fewer foods and nutrients than truly consumed. The food group serving method used in this study classified foods simply by obvious food group classifications; this could also reduce reported food serving intake. Despite the potential for low food group serving counts compared to actual intake, results of the present study indicating inadequate consumption of dairy, vegetable, fruit and grain foods among older adults are consistent with food groups found to be at risk for low consumption in previous research [7, 41,48-51,56,58]. Inadequate dairy food consumption was a primary finding among studies assessing the diets of older adults [7,41,62]. Results of the Behavioral Risk Factor Surveillance System (BRFSS) and NHANES III indicate fewer than one-third of older Americans are consuming the recommended five or more fruits and vegetables daily [58,63]. Two National dietary surveys indicated grain intake among older adults “needs improvement,” with more whole grain foods encouraged [58,62]. The protein intake found among older Americans in NHANES III raised concern as higher intakes are associated with increased urinary calcium excretion and potential fracture risk [58]. Similar to the food group results, nutrients found at risk for low intake among the Southwestern older adults, vitamin D, vitamin E, folate and calcium, have been found to be at risk for low intake in other studies of older adults [7,11,23, 41,53].

The study population may not be reflective of all older individuals since the clinical trial included only participants who were considered at moderate risk for skin cancer as determined by a dermatological screening. As the occurrence of sun-induced premalignant lesions and risk of skin cancer are greater among males than females, the recruited study population was predominantly male (70%). Volunteers to prevention studies are typically healthy, educated, above poverty level in socioeconomic status and may express greater interest in their health and belief in being able to positively effect their well-being than members of the general population. Additionally, it is well accepted that there is geographical variation in dietary intake; fruits and vegetables are more readily available in a temperate climate, and seasonal differences in consumption are minimized.

Despite the aforementioned limitations, the age-related reductions in macronutrient intake, mean micronutrient intakes which approximated DRI levels and problem micronutrients among the study participants were similar to those reported in other studies of older adults. Vitamins D, E, folate and calcium were at critically high risk for low intake and remained so

even after including additional amounts from the high prevalence of supplementation. The similarity in the dietary habits of the study participants with those reported in other nutritional studies of older adults suggests that prevention trial subjects can provide a rich and cost-effective resource to characterize and monitor nutritional needs and trends for this growing segment of the U.S. population.

The lower levels of energy intake reported among this and other populations of older adults indicate several nutritional challenges. More daily servings of dairy, grain, fruit and vegetable foods are needed although, on average, these seniors do not report weight loss associated with negative energy balance. Fifty-eight percent of these older adults reported maintaining a constant weight, while 21% report gaining five pounds or more over the previous year. More than 27% of the study population reported BMIs above 27; more than half of the older adults had BMIs above 25. A recent report from the Centers for Disease Control and Prevention estimates that 47% to 63% of adults older than 55 years are overweight and an increasing prevalence of overweight among older adults was specified as a public health concern in the NHANES III report [58,63]. Fewer than one-third of the healthy older volunteers reported regular exercise, and fewer than 6% reported that such exercise could be considered “active” exercise such as playing tennis. Healthy People 2000 objectives include increasing the proportion of adults who engage in physical activity to at least 85%, increasing the proportion of adults who engage in vigorous activity to 20% and decreasing total dietary fat intake to 30% of daily energy [46]. The addition of physical activity along with decreasing the 10% of daily energy from sweets and the 38% from dietary fat would allow these older adults to select the needed increased servings of dairy, whole grain and fiber-rich vegetables and fruits while maintaining energy balance. More than 30% of the men and almost 60% of the women in the study reported daily energy intakes below 1600 kilocalories. Nutrition messages aimed at older adults need to focus on the selection of nutrient-dense foods from the various food groups to ensure nutrient adequacy at these lower daily energy levels.

## CONCLUSIONS

The typical dietary results reported in this assessment of healthy, Southwestern seniors were consistent with nationally representative samples of adults aged 50 and older. Despite high levels of supplement use, more than half of the older adults were at risk for inadequate levels of vitamin D, vitamin E, folate and calcium. The majority of the older adults reported BMIs above 25, despite energy intakes which appeared “reduced” in comparison to those of younger or more active adults. Dietary components, however, indicate viable options for improvement. The selection of fewer daily servings of higher quality protein foods from the meat and protein group would allow the replacement of excessive dietary fat and protein with dairy and grain foods. Fiber and micronutrient levels associated with reductions in age-related disease risks could be improved through the selection of fortified and whole grain foods and fruit and vegetable intake. Only half of the surveyed older adults were meeting “5 A Day” recommendations for fruit and vegetable servings.

The results of this study, comparing nutrient and food group intakes among healthy, free-living, older adults, suggest guidance and encouragement in the selection of nutrient-dense foods from the five food groups of the Food Guide Pyramid may provide specific, yet tangible tools to improve dietary intake among the growing older adult population.

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**Table 1**

Demographic Characteristics of the Healthy, Older Free-Living Study Population, by Gender

| Characteristic | Males | Females | *p* value* |
|---|---|---|---|
| | number (%) | number (%) | |
| Age group | | | |
| 51−70 years | 976 (78.6) | 409 (82.1) | 0.097 |
| 71−85 years | 266 (21.4) | 89 (17.9) | |
| Marital status | | | |
| Single, never married | 27 (2.2) | 19 (3.8) | 0.001 |
| Married | 1103 (88.8) | 321 (64.5) | |
| Widowed | 45 (3.6) | 104 (20.9) | |
| Divorced/separated | 67 (5.4) | 54 (10.8) | |
| Education | | | |
| Less than high school | 92 (7.4) | 33 (6.6) | 0.009 |
| High school graduate | 2105 (16.5) | 110 (22.1) | |
| Some post-high school | 412 (33.2) | 182 (36.6) | |
| College graduate | 245 (19.7) | 80 (16.1) | |
| Graduate school | 288 (23.2) | 93 (18.7) | |
| How often do you engage in physical exercise? | | | |
| Often | 357 (28.7) | 153 (30.7) | 0.292 |
| Sometimes | 492 (39.6) | 210 (42.2) | |
| Never | 387 (31.2) | 1382 (26.5) | |
| No response | 6 (0.5) | 3 (0.6) | |
| How often do you engage in active sports? | | | |
| Often | 91 (7.3) | 15 (3.0) | 0.001 |
| Sometimes | 141 (11.4) | 31 (6.2) | |
| Never | 1000 (80.5) | 446 (89.6) | |
| No response | 10 (0.8) | 6 (1.2) | |
| Smoking status | | | |
| Current smoker | 134 (10.8) | 55 (11.0) | 0.001 |
| Former smoker | 690 (55.6) | 182 (36.6) | |
| Never smoker | 418 (33.7) | 261 (52.4) | |
| Do you take vitamin or mineral supplements? | | | |
| Yes, daily | 536 (43.2) | 290 (58.2) | 0.001 |
| Yes, sometimes | 327 (26.3) | 118 (23.7) | |
| No, never | 379 (30.5) | 90 (18.1) | |
| Mean BMI $kg/m^2$ (SEM) | 25.7 (0.1) | 24.8 (0.2) | 0.0002 |

* The Chi square test was used to determine gender differences in categorical distribution of characteristics, the Student's *t* test was used to determine gender differences in mean values.

**Table 2**

Estimated Daily Dietary Energy and Macronutrient Levels of Older Free-Living Seniors by Gender and Compared to Dietary Recommendations

| | Males | | Females | |
|---|---|---|---|---|
| | Mean ± SEM | % Goal* | Mean ± SEM | % Goal* |
| Energy (kcals) | | | | |
| 51−70 yr | 2001 ± 21.4[a] | 87.0 | 1571 ± 29.3 | 82.7 |
| 71−85 yr | 1863 ± 37.4 | 81.0 | 1555 ± 63.2 | 81.8 |
| Protein (g) | | | | |
| 51−70 yr | 76 ± 0.9[a] | 120.6 | 63 ± 1.3 | 126.0 |
| 71−85 yr | 71 ± 1.5 | 112.7 | 60 ± 2.7 | 120.0 |
| Carbohydrate (g) | | | | |
| 51−70 yr | 210 ± 2.3 | 60.9 | 171 ± 3.6 | 60.0 |
| 71−85 yr | 202 ± 4.3 | 58.6 | 172 ± 7.6 | 60.4 |
| Total fat (g) | | | | |
| 51−70 yr | 87 ± 1.2[a] | 113.4 | 67 ± 2.1 | 105.9 |
| 71−85 yr | 79 ± 2.1 | 103.0 | 66 ± 3.3 | 104.3 |
| Saturated fat (g) | | | | |
| 51−70 yr | 30 ± 0.4[a] | 117.2 | 22 ± 0.6 | 104.3 |
| 71−85 yr | 27 ± 0.8 | 105.5 | 22 ± 1.3 | 104.3 |
| Dietary fiber (g) | | | | |
| 51−70 yr | 16 ± 0.2 | 69.6 | 15 ± 0.4 | 79.0 |
| 71−85 yr | 17 ± 0.4 | 73.9 | 15 ± 0.7 | 79.0 |

Males: 51−70 years, n = 976; 71−85 years, n = 266.

Females: 51−70 years, n = 409; 71−85 years, n = 89.

*Goal levels of daily energy and protein are based on the RDAs [14]. Goal levels of carbohydrate, total and saturated fat, and dietary fiber are based on the Healthy People 2000 [46].

[a]significant difference between age groups, $p < 0.05$.

**Table 3**

Estimated Mean Daily Micronutrient Intake from Diet Alone and Diet Plus Nutritional Supplements with Comparisons to the Recommended Levels among Healthy, Free-Living Senior Volunteers (n = 1740)

| Micronutrient (unit) | Dietary Intake Alone | | Diet Plus Supplements | |
|---|---|---|---|---|
| | Mean ± SEM | <100% EAR/AI | Mean ± SEM | <100% EAR/AI |
| Vitamin A[a] (RE) | | | | |
| Males | | | | |
| 51–59 yr | 1459.9 ± 24.3 | 8.9[b] | 3931.3 ± 126.0 | 4.9 |
| 71–85 yr | 1505.2 ± 47.2 | 5.3[b] | 4076.1 ± 279.0 | 4.1 |
| Females | | | | |
| 51–70 yr | 1237.1 ± 31.6 | 7.1[b] | 4240.8 ± 220.7 | 4.7 |
| 71–85 yr | 1238.4 ± 72.5 | 6.7[b] | 4378.0 ± 497.5 | 3.4 |
| Vitamin D (μg) | | | | |
| Males | | | | |
| 51–70 yr | 5.9 ± 0.12 | 88.5[†] | 10.2 ± 0.34[*] | 56.7[†] |
| 71–85 yr | 5.9 ± 0.26 | 96.6 | 10.4 ± 0.54 | 81.2 |
| Females | | | | |
| 51–70 yr | 5.4 ± 0.22 | 90.2[†] | 11.4 ± 0.54[*] | 52.1[†] |
| 71–85 yr | 5.0 ± 0.42 | 97.8 | 10.3 ± 0.71 | 85.4 |
| Vitamin E (TE) | | | | |
| Males | | | | |
| 51–70 yr | 10.0 ± 0.14 | 72.6 | 120.7 ± 8.08 | 35.9 |
| 71–85 yr | 10.1 ± 0.37 | 75.9 | 92.3 ± 11.36 | 38.4 |
| Females | | | | |
| 51–70 yr | 8.3 ± 0.19 | 85.6 | 137.2 ± 12.71 | 36.4 |
| 71–85 yr | 8.5 ± 0.40 | 79.8 | 128.4 ± 26.70 | 31.5 |
| Vitamin K (μg)[c] | | | | |
| Males | | | | |
| 51–70 yr | 134.2 ± 2.48 | 9.0[b‡] | 134.2 ± 2.48 | 9.0[‡] |
| 71–85 yr | 132.3 ± 4.61 | 7.9[b] | 132.3 ± 4.61 | 7.9 |
| Females | | | | |
| 51–70 yr | 141.9 ± 3.78 | 3.2[b] | 141.9 ± 3.78 | 3.2 |
| 71–85 yr | 158.1 ± 11.25 | 4.5[b] | 158.1 ± 11.25 | 4.5 |
| Thiamin (mg) | | | | |
| Males | | | | |
| 51–70 yr | 1.3 ± 0.02 | 20.5[‡] | 5.8 ± 0.95 | 11.6[‡] |
| 71–85 yr | 1.3 ± 0.03 | 24.4 | 4.2 ± 0.57 | 15.4 |
| Females | | | | |
| 51–70 yr | 1.1 ± 0.02 | 48.9 | 5.8 ± 0.79 | 22.7 |
| 71–85 yr | 1.1 ± 0.04 | 40.5 | 7.9 ± 2.51 | 19.1 |
| Riboflavin (mg) | | | | |
| Males | | | | |

| Micronutrient (unit) | Dietary Intake Alone | | Diet Plus Supplements | |
|---|---|---|---|---|
| | Mean ± SEM | <100% EAR/AI | Mean ± SEM | <100% EAR/AI |
| 51−70 yr | 2.0 ± 0.03 | 11.8 | 4.7 ± 0.30 | 5.4 |
| 71−85 yr | 1.9 ± 0.05 | 13.2 | 4.4 ± 0.41 | 7.9 |
| Females | | | | |
| 51−70 yr | 1.7 ± 0.04 | 15.4 | 6.1 ± 0.41 | 6.9 |
| 71−85 yr | 1.7 ± 0.09 | 12.4 | 6.0 ± 1.07 | 7.9 |
| Niacin (mgNE) | | | | |
| Males | | | | |
| 51−70 yr | 20.2 ± 0.24* | 11.4‡ | 35.7 ± 1.84 | 6.1‡ |
| 71−85 yr | 18.9 ± 0.44 | 15.0 | 33.4 ± 1.58 | 9.4 |
| Females | | | | |
| 51−70 yr | 15.7 ± 0.32 | 22.3 | 33.6 ± 1.50 | 9.8 |
| 71−85 yr | 15.1 ± 0.59 | 23.6 | 37.1 ± 3.59 | 10.1 |
| Folate (μg) | | | | |
| Males | | | | |
| 51−70 yr | 329.4 ± 4.66 | 54.5‡ | 504.7 ± 9.02 | 31.9 |
| 71−85 yr | 333.0 ± 9.98 | 54.9 | 524.7 ± 22.3 | 33.5 |
| Females | | | | |
| 51−70 yr | 282.1 ± 6.9 | 71.9 | 504.3 ± 14.93 | 33.0 |
| 71−85 yr | 284.3 ± 12.9 | 70.8 | 507.5 ± 29.27 | 32.6 |
| Vitamin $B_6$ (mg) | | | | |
| Males | | | | |
| 51−70 yr | 2.0 ± 0.02 | 56.5 | 5.2 ± 0.35 | 12.2 |
| 71−85 yr | 2.1 ± 0.06 | 55.3 | 9.0 ± 3.86 | 14.3 |
| Females | | | | |
| 51−70 yr | 1.9 ± 0.04 | 38.1 | 7.5 ± 1.06 | 12.2 |
| 71−85 yr | 1.9 ± 0.08 | 37.1 | 6.4 ± 1.08 | 12.4 |
| Vitamin $B_{12}$ (μg) | | | | |
| Males | | | | |
| 51−70 yr | 5.9 ± 0.12 | 5.8 | 15.1 ± 1.66 | 4.6 |
| 71−85 yr | 5.7 ± 0.27 | 6.0 | 12.0 ± 0.94 | 5.6 |
| Females | | | | |
| 51−70 yr | 5.5 ± 0.19 | 8.8 | 21.2 ± 2.97 | 5.6 |
| 71−85 yr | 5.1 ± 0.51 | 14.6 | 24.8 ± 6.85 | 9.0 |
| Vitamin C (mg) | | | | |
| Males | | | | |
| 51−70 yr | 155.3 ± 3.28 | 15.0 | 424.1 ± 21.31 | 8.2 |
| 71−85 yr | 159.2 ± 4.71 | 12.0 | 356.4 ± 33.00 | 5.6 |
| Females | | | | |
| 51−70 yr | 155.2 ± 5.66 | 8.1 | 487.5 ± 31.76 | 3.2 |
| 71−85 yr | 162.6 ± 11.12 | 10.1 | 444.6 ± 44.68 | 1.1 |

| Micronutrient (unit) | Dietary Intake Alone | | Diet Plus Supplements | |
|---|---|---|---|---|
| | Mean ± SEM | <100% EAR/AI | Mean ± SEM | <100% EAR/AI |

[a] The total Vitamin A estimate takes into account both preformed retinol and assumed additional retinol formed in the metabolism of alpha-, beta-carotene, and cryptoxanthin.

[b] Recommended levels are ⅔ of the RDA level for adults over 50 years of age for micronutrients for which no DRI has been set.

[c] Vitamin K is not typically included in multivitamin and/or mineral supplements, nor did any of the participants report taking supplements enriched with phylloquinones or menaquinones.

* means across age groups within gender differ significantly, $p < 0.05$.

† percentage not meeting goal amount (100% EAR/AI or ⅔/RDA) differ significantly across age groups within gender, $p < 0.05$.

‡ percentage not meeting goal amount (100% EAR/AI or ⅔ RDA) differ significantly by gender, $p < 0.05$.

**Table 4**

Estimated Mean Daily Mineral Intake from Diet Alone and Diet Plus Nutritional Supplements with Comparisons to the Dietary Reference Intakes among All Healthy, Free-Living Senior Volunteers (n = 1740)

| Micronutrient (unit) | Dietary Intake Alone | | Diet Plus Supplements | |
|---|---|---|---|---|
| | Mean ± SEM | <100% EAR/AI | Mean ± SEM | <100% EAR/AI |
| Calcium (mg) | | | | |
| Males | | | | |
| 51−70 yr | 875.4 ± 14.05 | 82.7 | 964.0 ± 15.86 | 75.7‡ |
| 71−85 yr | 851.6 ± 26.34 | 83.8 | 937.6 ± 30.37 | 77.8 |
| Females | | | | |
| 51−70 yr | 814.5 ± 25.07 | 84.6 | 1131.0 ± 34.76 | 65.0 |
| 71−85 yr | 814.4 ± 61.52 | 88.8 | 1142.4 ± 85.25 | 66.3 |
| Phosphorus (mg) | | | | |
| Males | | | | |
| 51−70 yr | 1342.9 ± 15.69* | 2.6‡ | 1351.7 ± 15.72 | 2.5‡ |
| 71−85 yr | 1276.5 ± 28.11 | 3.4 | 1283.6 ± 28.11 | 3.4 |
| Females | | | | |
| 51−70 yr | 1145.0 ± 25.99 | 6.4 | 1163.6 ± 25.99 | 5.4 |
| 71−85 yr | 1113.0 ± 57.51 | 9.0 | 1128.9 ± 57.28 | 9.0 |
| Magnesium (mg) | | | | |
| Males | | | | |
| 51−70 yr | 344.8 ± 3.98 | 56.5‡ | 370.5 ± 4.54 | 50.1‡ |
| 71−85 yr | 347.6 ± 7.86 | 55.3 | 371.0 ± 8.34 | 47.4 |
| Females | | | | |
| 51−70 yr | 329.9 ± 7.48 | 38.1 | 365.1 ± 8.36 | 28.6 |
| 71−85 yr | 326.2 ± 14.29 | 37.1 | 359.5 ± 15.67 | 31.5 |
| Iron (mg) | | | | |
| Males | | | | |
| 51−70 yr | 14.3 ± 0.18 | 3.0a‡ | 20.7 ± 0.40 | 1.6†‡ |
| 71−85 yr | 13.8 ± 0.35 | 3.8a | 19.7 ± 0.80 | 3.8 |
| Females | | | | |
| 51−70 yr | 11.4 ± 0.25 | 9.8a | 21.5 ± 1.33 | 6.6 |
| 71−85 yr | 11.1 ± 0.46 | 10.1a | 19.5 ± 1.40 | 5.6 |
| Zinc (mg) | | | | |
| Males | | | | |
| 51−70 yr | 11.3 ± 0.14 | 42.6a‡ | 17.7 ± 0.67 | 29.7‡ |
| 71−85 yr | 11.7 ± 0.32 | 41.7a | 18.0 ± 1.06 | 32.0 |
| Females | | | | |
| 51−70 yr | 10.0 ± 0.21 | 35.2a | 17.0 ± 0.77 | 23.0 |
| 71−85 yr | 10.1 ± 0.49 | 39.3a | 17.2 ± 1.45 | 29.2 |
| Copper (mg) | | | | |
| Males | | | | |

| Micronutrient (unit) | Dietary Intake Alone | | Diet Plus Supplements | |
|---|---|---|---|---|
| | Mean ± SEM | <100% EAR/AI | Mean ± SEM | <100% EAR/AI |
| 51−70 yr | 1.5 ± 0.02 | 22.8[a†‡] | 2.0 ± 0.04 | 18.2 |
| 71−85 yr | 1.5 ± 0.04 | 22.2[a] | 2.0 ± 0.07 | 19.6 |
| Females | | | | |
| 51−70 yr | 1.4 ± 0.04 | 29.1[a] | 2.1 ± 0.07 | 21.0 |
| 71−85 yr | 1.5 ± 0.07 | 24.7[a] | 2.1 ± 0.13 | 19.1 |

[a] recommended levels are ⅔ of the RDA levels (or Estimated Safe and Adequate Intakes) for all micronutrients for which no DRI has been set.

[*] means across age groups within gender differ significantly; $p < 0.05$.

[†] percentage not meeting goal amount (100% EAR/AI or ⅔ RDA) differ significantly across age groups within gender, $p < 0.05$.

[‡] percentage not meeting goal amount (100% EAR/AI or ⅔ RDA) differ significantly by gender, $p < 0.05$.

**Table 5**

Comparison of the Dietary Intake of Healthy Free-Living Senior Volunteers to Food Serving Recommendations of the USDA Food Guide Pyramid and the Modified Food Guide Pyramid for Older Adults

| Food Group | USDA Recommended Daily Servings[a] | Adjusted Daily Servings[b] Mean ± SEM | Percent Achieving Recommended Level | Modified Food Pyramid Recommended Servings[c] | Unadjusted Daily Servings Mean ± SEM | Percent Achieving Recommended Level |
|---|---|---|---|---|---|---|
| Grains | | | | | | |
| Males | | | | | | |
| 51–70 yr | 9.1 | 3.9 ± 0.13 | 3.2 | 6 | 3.4 ± 0.12 | 10.6‡ |
| 71–85 yr | 9.1 | 4.2 ± 0.22 | 3.0 | 6 | 3.5 ± 0.19 | 11.7 |
| Females | | | | | | |
| 51–70 yr | 7.4 | 3.3 ± 0.14* | 3.2† | 6 | 2.8 ± 0.14* | 6.4 |
| 71–85 yr | 7.4 | 4.5 ± 0.59 | 7.9 | 6 | 3.5 ± 0.35 | 12.4 |
| Vegetables | | | | | | |
| Males | | | | | | |
| 51–70 yr | 4.2 | 3.5 ± 0.05 | 27.0 | 3 | 2.9 ± 0.04 | 41.6†‡ |
| 71–85 yr | 4.2 | 3.6 ± 0.12 | 25.6 | 3 | 2.8 ± 0.09 | 34.6 |
| Females | | | | | | |
| 51–70 yr | 3.5 | 4.3 ± 0.11 | 57.2 | 3 | 3.3 ± 0.08 | 50.4 |
| 71–85 yr | 3.5 | 4.1 ± 0.22 | 56.2 | 3 | 3.2 ± 0.21 | 41.6 |
| Fruits | | | | | | |
| Males | | | | | | |
| 51–70 yr | 3.2 | 2.6 ± 0.58* | 27.0† | 2 | 2.1 ± 0.05* | 44.8†‡ |
| 71–85 yr | 3.2 | 3.1 ± 0.10 | 41.4 | 2 | 2.4 ± 0.08 | 57.5 |
| Females | | | | | | |
| 51–70 yr | 2.5 | 3.0 ± 0.09 | 54.8 | 2 | 2.3 ± 0.08 | 51.8 |
| 71–85 yr | 2.5 | 3.3 ± 0.22 | 60.7 | 2 | 2.5 ± 0.15 | 56.2 |
| Milk/Dairy | | | | | | |
| Males | | | | | | |
| 51–70 yr | 2.0 | 1.2 ± 0.03* | 13.9† | 3 | 0.5 ± 0.02 | 0.5 |
| 71–85 yr | 2.0 | 1.3 ± 0.06 | 21.8 | 3 | 0.5 ± 0.04 | 1.1 |
| Females | | | | | | |
| 51–70 yr | 2.0 | 1.0 ± 0.04* | 9.3 | 3 | 0.5 ± 0.03* | 0.7† |

| Food Group | USDA Recommended Daily Servings[a] | Adjusted Daily Servings[b] Mean ± SEM | Percent Achieving Recommended Level | Modified Food Pyramid Recommended Servings[c] | Unadjusted Daily Servings Mean ± SEM | Percent Achieving Recommended Level |
|---|---|---|---|---|---|---|
| 71−85 yr | 2.0 | 1.2 ± 0.10 | 13.5 | 3 | 0.7 ± 0.12 | 3.4 |
| Meats/Protein | | | | | | |
| Males | | | | | | |
| 51−70 yr | 2.5 | 3.9 ± 0.06 | 79.6 | 2 | 3.3 ± 0.06 | 78.6 |
| 71−85 yr | 2.5 | 3.9 ± 0.10 | 79.3 | 2 | 3.1 ± 0.09 | 75.6 |
| Females | | | | | | |
| 51−70 yr | 2.2 | 3.8 ± 0.10 | 85.1† | 2 | 3.0 ± 0.09 | 73.8 |
| 71−85 yr | 2.2 | 3.5 ± 0.15 | 76.4 | 2 | 2.7 ± 0.13 | 70.8 |

[a] The gender specific recommended daily servings for adults aged 51 years and older are those provided by the USDA Center for Nutrition Policy and Promotion in the development of the Healthy Eating Index [42].

[b] The estimated servings per day for study participants are adjusted to the energy intake of the gender-specific USDA reference individual, older than 50 years of age (2300 and 1900 kilocalories for males and females, respectively).

[c] The modified food guide pyramid for people over seventy years of age provides recommended servings for older adults in whom daily energy intake may be below the minimum of the USDA Food Guide Pyramid [20].

* estimated mean servings differ significantly among age groups within gender, $p < 0.05$.

† percentage achieving 100% differ significantly among age groups within gender, $p < 0.05$.

‡ percentage achieving 100% differ significantly by gender, $p < 0.05$.