The Journal of Nutrition, Health & Aging©
Volume 5, Number 4, 2001

NUTRITIONAL RISK IN AN URBAN HOMEBOUND OLDER POPULATION
THE NUTRITION AND HEALTHY AGING PROJECT

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Abstract: PURPOSE: To establish the prevalence of nutritional problems and their related socio-demographic and health-related risk factors in the homebound elderly population. METHODS: Subjects included 239 men and women, ages 65 to 105 years. Trained, two-person field teams conducted comprehensive in-home assessments. Medical record reviews assessed co-morbidity and medication use. RESULTS: The majority of these urban study subjects are of very advanced age (mean age 81 years), female (72%), non-white (73%), living alone (51%), of low income (76%), and somewhat socially isolated (26% had no weekly social contact). More older women than men were widowed (60 vs. 33%, respectively) and poor (80 vs. 67%). The disease burden and functional dependency were both high in men and women; 77% had three or more chronic medical conditions; 76% were functionally dependent in one or more ADL's and 95% in one or more IADL's. Poor dietary quality was universal in these older men and women; half or more consumed diets that deviated from recommended standards for at least 13 of the 24 nutritional guidelines studied. Five percent of subjects were underweight (Body Mass Index (BMI) <18.5); 22% were overweight (BMI 25.0-29.9); and 33% were obese (BMI >30.0). Fasting albumin, hemoglobin, and absolute lymphocyte concentrations were borderline to very low in 18-32%. Dyslipidemia was more common in women; however, men and women had similar Total:HDL cholesterol ratios. CONCLUSIONS: Nutritional status is poor in homebound persons of very advanced age with substantial co-morbidity and functional dependency. The complexities of nutritional risk necessitate multi-disciplinary and individualized nutritional intervention strategies.

Key words: Aging, elderly, malnutrition, obesity, homebound, preventive home health services.

Introduction

The progressive aging of the US population and rapid expansion of the numbers of those 85 years and older has underscored the importance of the development of a coordinated continuum of community-and home-based health and related supportive social services, including nutrition services (1,2). These services are intended to prevent or delay costly institutionalization and promote dignity, independent living, and quality of life into advanced years (1-4). Their importance is emphasized by evidence that those 65 years and older constitute 12.7% of the population (5) yet they generate over one-third of the total US health care expenditures, which reached nearly $1.04 trillion in 1996 (6). They also account for 40% of hospital admissions, nearly half of all hospital days of care, twice the rate of physician contacts compared to those under age 65 years, 72% of home care visits, and most nursing home placements (7).

Between 1990 and 1997, reimbursements for home care services to Medicare recipients grew 24% annually. However, the Balanced Budget Act of 1998 changed home health care from a community-based long term care benefit to an abbreviated, episodic form of care; these dramatic changes left many frail older adults in tenuous circumstances and much more vulnerable to perturbations in their health status (8). Clearly, an understanding of the health status and risks for functional decline and adverse health outcomes in the frail homebound population is a national priority and essential for effectively promoting their health, managing their health care, and decreasing their risks for preventable institutionalization.

Malnutrition is among the major factors associated with poor health consequences in the older population (9). Both nutrient deficiencies and clinical conditions associated with nutritional excess (such as obesity) have been associated with adverse health-related outcomes in the elderly. These include: increased morbidity and mortality; elevated rates of chronic disease and their complications; increased surgical risks; functional decline and increased dependency; delayed recovery from physical traumas; recurrent hospitalizations; and extended long-term care (1,9-11). Conversely, nutritional well-being is integral to the health, independence, and quality of life of older individuals (10,12,13).

Maintenance of nutritional well-being is recommended as integral to the mitigation of existing health problems,

improvements in many chronic disease outcomes, and the extension of years of healthy living into advancing age (1,10-13). Little is known though about the extent of malnutrition or its specific etiology, its association with chronic disease states and co-morbidities that are common among the aging, or its full range of health-related consequences, especially within high-risk populations such as the frail, homebound elderly (9,12,13). The efficacy of nutritional interventions among homebound, chronically-disabled older men and women is particularly poorly understood (1,12-19).

The purpose of this research project was to assess the nutritional risk profile and the socio-demographic and health-related characteristics of a clinical population of frail, homebound older men and women in order to identify potential opportunities for multi-disciplinary follow-up and interventions for improving the nutritional status of homebound elderly.

Methods

The Boston University (BU) Geriatric Services of the Department of Medicine's Geriatrics Section provides in-home medical care to homebound elderly patients. The mission of the BU Geriatric Services is to enable older patients to remain living in community settings by providing medical care and case management in collaboration with other community-based social services.

Subjects. All 572 BU Geriatrics Service home care patients were reviewed by one investigator (RAS) in conjunction with their primary care teams to assess study eligibility. Patients were eligible if they were considered to have a life expectancy greater than six months, had either no or only mild cognitive impairment, were not severely mentally ill, and spoke English unless an English-speaking proxy was available. 435 patients were eligible and they or their proxies were sent letters that explained the study. An experienced research assistant contacted patients and proxies by telephone to discuss the study in detail and to answer questions. Willing patients or their proxies provided written informed consent during a home visit prior to study enrollment. The study protocol was reviewed to ensure its consistency with institutional procedures for responsible research and approved by the Institutional Review Board of Boston University Medical Center.

The sample consisted of 239 persons (171 women; 68 men), aged 65 to105 years (mean age 81 years) representing 55% percent of eligible patients. Enrollees did not differ from non-enrollees in age and gender suggesting the overall representativeness of our study sample (for reasons of patient confidentiality, we were unable to determine if the enrolled patients differed in other characteristics from those not enrolled). Volunteer proxies provided information for 44 (18%) of the subjects.

In Home Assessment Protocols. In-home assessments were conducted by trained, two-person field research assistant teams. During the home visits, one person conducted the interview or assessment while the other recorded responses.

Interviews. Field teams conducted interviews using a standardized data collection instrument comprised of the domains that are displayed in Tables 1 and 2. In addition to sociodemographic characteristics, the variables included perceived health and health-related quality of life (20), depression (21); cognitive function (22), self-reported medical conditions and non-prescription medication or health product use (23-26) and bed restricted days (27,28). Also included were the validated ten-item Nutrition Screening Initiative Checklist of nutritional risk factors (29); use of vitamin or mineral supplements, daily number of meals, use of congregate or home meal programs offered by the federal Elderly Nutrition Program (ENP) (30), and appetite and chewing ability; tobacco and alcohol use; ability to perform activities of daily living (ADLs)(31) and instrumental activities of daily living (IADLs)(32); perceived physical functioning (20), social support (23), and oral health (33-36).

Vision, Hearing, Oral Health and Physical Performance Testing. Visual acuity was evaluated according to a standardized protocol using the Snellen Eye Chart (37). Subjects were asked to wear corrective lenses, if normally worn. Hearing, also evaluated by standardized protocol (38), was considered to be impaired if the participant reported being unable to hear a finger-rubbing sound in either or both ears while wearing hearing aids if normally worn. The oral health assessment included an assessment of dysphagia, tooth count and, among those who wore dentures to eat, an assessment of denture stability and retention. Grip strength (39), chair stands (40), measured walks (40) and 360 degree turns (41) were also assessed.

Dietary Assessment. Three 24-hour dietary recall interviews were collected using standardized protocols to characterize subjects' usual food and nutrient intake (42,43). The first recall was collected during the subjects' home interviews. The second and third recalls were collected by telephone on randomly selected days. For those subjects who had any difficulty with the telephone recall protocol, subsequent recalls were collected in-person. However, we note the relative feasibility of the telephone-administered protocols; 85% of respondents to the dietary interviews were able to complete them using telephone-administered procedures.

Participants were asked to recall all foods and beverages consumed in the previous 24-hour period. A standardized interview script and protocol were guided by the multiple-pass approach for collecting detailed information on foods and preparation methods. Food portions were determined using a validated, two-dimensional food portion visual (42). Nutrient calculations were performed using the Nutrition Data System for Research (NDS-R) software, developed by the Nutrition Coordinating Center (NCC), University of Minnesota, Minneapolis, MN (NDS version 4.01) (44). Three-day mean nutrient intakes were estimated for each individual, based on whole foods consumed, excluding any intakes from vitamin or mineral supplements. Daily estimated dietary intakes of

essential nutrients were compared to the age- and gender-specific Daily Reference Intakes (DRI) (45) for persons 70 years and older, or the Recommended Dietary Allowances (RDA) for persons 51 years of age or older (46). Fiber, dietary lipids, and sodium were compared with expert recommendations (47-50).

Anthropometry. Body measurements were taken in participants' homes according to standardized procedures (51-53) with patients wearing paper hospital gowns and light undergarments. Subjects were weighed after voiding, if feasible, and without shoes. Weight was measured to the nearest 0.1kg, using a calibrated portable SECA 770 digital scale (54). Two weight measurements were taken in immediate succession and, if they differed by more than 0.1kg, were repeated until differences were 0.1kg or less.

Some patients were not able to stand with their backs straight and their heads positioned in the Frankfort plane (55). Hence, knee height was used instead of standing height, as others have found appropriate in disabled populations (51-53). Knee height was measured to the nearest 0.1cm using Ross Laboratories' knee height calipers. As with weight, two measurements were taken in immediate succession and, if they differed by more than 0.5cm, additional measurements were taken until differences were 0.5cm or less. Here, we present only the data on body mass index (BMI) calculated as weight (kg)/height $(m)^2$, where height was estimated from knee height using established protocols (51-53) and compared with published guidelines from the International Obesity Task Force (56).

Nutritional Biomarkers. Fasting blood samples were drawn by a trained phlebotomist. Plasma samples were analyzed and interpreted according to standard laboratory procedures in the NIH-certified medical laboratory at the Boston University Medical Center (57) or its affiliated external laboratories. Serum albumin, absolute lymphocytes, plasma lipids (total-, LDL-, and HDL-cholesterol and triacylglycerol concentrations), glucose, hemoglobin, folate, and vitamin B12 were measured.

Medical Record Abstraction. Subjects' home care medical records were reviewed by a trained research assistant to obtain information on medical conditions and their severity. Adaptations of the Greenfield Index of Co-Existent Disease (58,59) and the Cumulative Illness Rating Scale (60,61) were used in order to capture the severity of specific diseases (e.g. ischemic heart disease, congestive heart failure, hypertension, diabetes mellitus, and chronic obstructive pulmonary disease), as well as organ dysfunction due to a variety of conditions (e.g. renal, liver, and gastrointestinal disorders). The names of medications being taken regularly or as needed were coded according to the American Hospital Formulary Service Pharmacologic Classification System (62).

Statistical Analysis. Gender-specific and overall summary descriptive statistics are presented to characterize the study population in the following variable domains: socio-demographic profile, health and functional status, oral health, nutrient intake, nutritional biomarkers, and BMI. As noted previously, certain variables (such as nutrient intake and BMI) were compared with published guidelines or reference standards in order to estimate the levels of compliance with expert nutrition recommendations. Gender comparisons were made using the Chi-square test and the Fisher's Exact test where appropriate. Data analyses were conducted using SAS statistical software (63).

Results

The sociodemographic characteristics of study subjects are summarized overall and by gender strata in Table 1. These urban, homebound subjects were of very advanced age (mean age 81 years), predominantly Black (55%); somewhat socially isolated (51% live alone; 26% have no weekly social contact), and poor (76% had estimated annual incomes below $10,800). Some 72 percent of these subjects were women who were more likely than men to be widowed (60%) and poor (80%).

Table 1
Sociodemographic Characteristics of Nutrition and Healthy Aging Project Participants.

Characteristics	Overall N=239* %	Men n=68 %	Women n=171 %
Age (years)			
65-74	23	28	22
75-84	42	44	41
85+	35	28	37
Ethnicity			
White	27	32	25
Black	55	50	57
Other	18	18	18
Education			
6th Grade or less	22	28	20
7th through 12th Grade	62	57	64
>12th Grade	16	15	16
Marital Status			
Widowed	52	33	60***
Married	16	30	11
Other	32	37	29
Living Situation			
Lives alone	51	47	52
Social Contact			
No weekly social contact	26	27	25
Estimated Annual Income			
<$10,800	76	67	80**

* Data are complete for at least 90% of sample on all variables except income for which data were 88% complete for women; **p<.05; ***p<.01

The health and functional characteristics of these homebound elders are summarized in Table 2.

Table 2
Gender Comparisons of Health and Functional Characteristics in Nutrition and Healthy Aging Project Participants.

Variables	Overall N=239 %	Men n=68 %	Women n=171 %
Perceived Current Health†			
Poor/Fair	54	55	54
Good	27	29	25
Very Good/Excellent	19	16	21
At Least One Bed Restricted Day in Past 3 Months	25	25	26
Selected Chronic Diseases			
Hypertension	77	74	78
Arthritis	56	47	59*
Neurologic Condition, incl stroke (not dementia)	40	51	36**
Dementia	30	26	32
Ischemic Heart Disease	28	28	27
Diabetes	27	21	29
Chronic Obstructive Pulmonary Disease	22	28	19
Congestive Heart Failure	21	18	22
Independent in All Six Katz' Activities of Daily Living	24	22	25
Independent in All Seven OARS' Instrumental Activities of Daily Living	5	6	5
Nutritional Risk (NSI Scores)			
Very High Risk (>11)	35	35	35
High Risk (6-10)	47	42	50
Low-Moderate Risk (0-5)	18	23	15
Elder Nutrition Program Participation			
Congregate Sites (yes)	11	9	11
Home Delivered (yes)	31	38	28
Both (yes)	3	2	3
Self Reported Use of Any Vitamin or Mineral Supplement (yes)	50	37	56***
Current Tobacco Use (yes) ‡	17	29	12***
Vision Impaired (yes)	90	92	90
Hearing Impaired			
One Ear (yes)	21	22	20
Both Ears (yes)	40	38	40
Both Vision & Hearing Impaired (both ears) (yes)	36	34	37
Number of Currently Prescribed Medications			
0-3	23	31	21
4-6	30	26	32
7-8	19	19	19
9+	28	24	29
Oral Health			
Edentulous (yes)	63	62	64
Functional Units (no pairs of opposing teeth)	46	43	47
Chewing Difficulty (yes)	76	73	77

Note: Data are complete for at least 90% of sample on all variables except perceived current health, NSI scores, impaired vision, and both vision & hearing impaired for which data were 80%-83% complete, and current tobacco use for which 57% of data were complete.
Characteristics are self-reported unless otherwise noted as derived from medical record abstraction or physical assessement. Significance levels for gender comparisons made by Chi-square and Fisher's Exact test. Chewing difficulty is defined as Leake Score <4.
*.05<p<.10; **p<.05, ***p<.01
† Question on perceived health was excluded in the 44 cases where proxies were respondents.
‡ Of the 135 men and women who had ever used tobacco, 30% were current users

About half reported their health to be fair or poor and one-quarter had been confined to bed for at least one day in the three months prior to the interview. Some 29% men and 12% of women reported being current smokers ($p < .01$). Chronic diseases were common (in particular, hypertension and arthritis); about three-quarters of these subjects were taking 4 or more prescribed medications. Neurologic problems were somewhat more common in men whereas women were more likely to have arthritis. Nearly all subjects (90%) had visual impairments and 61% had hearing impairments in one or both ears. The majority reported chewing difficulties. Only about one-quarter were able to perform all six Katz ADLs and 5% were able to manage all seven OARS IADLs independently.

With respect to nutrition-related health characteristics, nearly half of these subjects had "high risk" scores (score 6-10) and 35% had "very high risk" scores (score 11+) on the Nutrition Screening Initiative Checklist (29). About half (56%) of women and 37% of men reported taking nutrient supplements ($p<.001$); 11% participated in congregate and 31% received home-delivered meals.

Table 3 shows respondents' levels of nutrient intake and rates of compliance with expert recommendations for maintaining nutritional status and health promotion (45-48).

Table 3
Mean and Median Nutrient Intakes and Comparison by Gender of Compliance with Dietary Guidelines

	Men (n=44)† Mean ± SD	Median	% Compliance	Women (n=129)† Mean ± SD	Median	% Compliance
Macronutrients						
Energy (kilojoule)	6406 ± 2418	6121	21%	5385 ± 2247	5042	21%
Carbohydrate (%)	53.9 ± 9.5	52.5	36%	54.7 ± 10.2	55.9	38%
Protein (%)	15.6 ± 3.4	15.2	45%	15.8 ± 3.7	15.4	40%
Total Fat (%)	30.9 ± 8.3	31.9	41%	30.7 ± 7.9	29.7	53%
Saturated Fat (%)	11.2 ± 4.0	11.3	39%	11.0 ± 3.4	10.4	41%
Monounsaturated Fat (%)	11.9 ± 3.4	11.8	84%	11.6 ± 3.5	10.9	85%
Polyunsaturated Fat (%)	5.2 ± 1.9	4.8	98%	5.5 ± 2.2	5.2	95%
Other Dietary Components						
Alcohol (# of drinks)	0.19 ± 0.89	0	98% (<2/day)	0.03 ± 0.14	0	99% (<1/day)
Fiber (gm)	12.8 ± 7.0	10.7	18%	11.3 ± 5.3	11.2	6%**
Cholesterol (mg)	255 ± 225	194	73%	199 ± 143	149	83%
Sodium (mg)	2228 ± 1067	2082	61%	1818 ± 849	1605	75%*
Micronutrients						
Vitamin A (IU)	3622 ± 4938	1875	27%	3640 ± 3530	2647	49%**
Vitamin C (mg)	92.2 ± 88.9	66.2	55%	87.2 ± 68.5	71.0	58%
Vitamin D (mg)	5.66 ± 3.81	4.60	0%	4.26 ± 2.89	3.53	1%
Thiamin (mg)	1.38 ± 0.68	1.23	52%	1.15 ± 0.56	1.08	44%
Riboflavin (mg)	1.70 ± 1.14	1.38	59%	1.38 ± 0.73	1.21	55%
Niacin (mg)	17.4 ± 7.5	15.9	48%	14.8 ± 7.1	13.2	47%
Folate (mg)	236.2 ± 176.9	183.7	14%	206.1 ± 124.3	177.4	5%*
Vitamin B6 (mg)	1.62 ± 0.97	1.39	30%	1.40 ± 0.77	1.23	36%
Nutrient						
Vitamin B12 (mg)	4.62 ± 8.17	3.05	68%	3.61 ± 4.94	2.26	50%**
Calcium (mg)	689 ± 528	553	11%	555 ± 315	460	3%**
Phosphorus (mg)	962 ± 502	879	68%	784 ± 356	738	51%*
Magnesium (mg)	232 ± 114	209	9%	191 ± 85	176	9%
Iron (mg)	11.4 ± 6.0	10.2	52%	10.5 ± 5.7	9.5	43%

Note: Comparisons examine differences in the rates of nutrient compliance between men and women. Dietary guidelines (47) and scientific recommendations of expert groups (48-50) were used to define compliance values for macronutrients, cholesterol, sodium and fiber. Gender and age-appropriate DRI standards (45) were used to determine compliance for micronutrients with the exception of iron and vitamins A and C. For these three nutrients, RDA (46) standards were used since DRI values do not exist.
*.05<p<.10; **p<.05; ***p<.01
†N's include only those men and women for whom three days of baseline diet recall data were available.

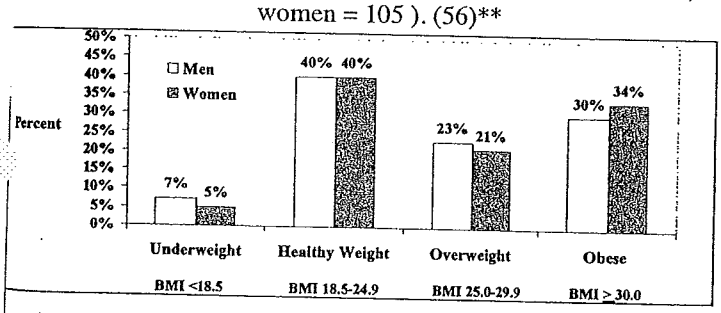
All of these men and women failed to meet expert recommendations for at least one or more essential micronutrients or

key dietary constituents. Half had dietary intakes that deviated from 13 or more of the 24 dietary constituents studied. Dietary compliance was particularly poor for fiber, vitamin D, folacin, calcium and magnesium; fewer than 20 percent of respondents met standards for these dietary constituents. Men were more likely than women to achieve dietary compliance for folacin, vitamin B12, calcium, and phosphorus; however, fewer than two-thirds of men met these standards and compliance was generally quite low.

Body Mass Index (BMI) data are compared with international weight guidelines (56) in Figure 1. Some 40 percent of older men and women appeared to be in a healthy weight range (BMI, 18.5-24.9); nonetheless, 5% were underweight (BMI <18.5); 22% were overweight (BMI, 25-29.9); and 33% were obese (Classes I-III, BMI >30). No significant differences were found in BMI between men and women.

Figure 1

Distribution of Nutrition and Healthy Aging Project Participants' Body Mass Indices(BMI)* Based on International Obesity Task Force Guidelines (n overall = 148, n men = 43, n women = 105). (56)**



*Body Mass Index was computed using estimated height derived from knee height measurements using Chumlea equations (52). **p=0.918, overall Chi-square test of gender comparisons by weight category.

Subjects' fasting concentrations of laboratory indicators associated with nutritional risk are summarized in Table 4. Low to borderline-low concentrations of serum albumin (< 3.8 g/dL) and hemoglobin (< 11.9 g/dL) were found in 18% and 32% of subjects, respectively. Low absolute lymphocyte concentrations (< 1.5K/uL) were found in 29% but few (under 5%) had very low folate (< 4.9 ng/ml) or vitamin B12 concentrations (< 250 pg/ml) (64). About one-in-eight men and a third of women had LDL-cholesterol concentrations of 160 mg/dL or higher (48). One in six men and one in nine women had triacylglycerol concentrations 200 mg/dL or higher (65). Low Total cholesterol levels (<160mg/dL) were found in 6% of subjects overall, including 3% of women and 12% of men.

Although dyslipidemia was more common in women than in men, thirty-five percent of both men and women had a Total:HDL cholesterol ratio of 3.5 or less. A higher proportion of women than men had higher Total- and LDL–cholesterol levels. However, the Total:HDL cholesterol ratios were similar in both genders and reflected the higher HDL-cholesterol levels we observed in women.

Table 4

Comparisons by Gender of Biomarkers Associated with Nutritional Risk in Nutrition and Healthy Aging Participants.

Biomarker	Units	Overall %	Men %	Women %
Albumin	g/dL	n=170	n=57	n=113
	<3.5	4	5	3
	3.5-3.8	14	16	13
	3.9-4.2	30	25	33
	>4.2	52	54	51
Absolute Lymphocytes	(K/mL)	n=140	n=48	n=92
	<1.5	29	37	25
	>1.5	71	63	75
Total Cholesterol	mg/dL	n=170	n=57	n=113***
	<160	6	12	3
	160-200	29	37	26
	200-239	28	28	27
	>240	37	23	44
LDL	mg/dL	n=168	n=55	n=113**
	<130	45	54	40
	130-159	28	33	26
	>160	27	13	34
HDL	mg/dL	n=170	n=57	n=113***
	<35	6	14	2
	35-60	55	58	53
	>60	39	28	45
Total Cholesterol: HDL Ratio	<3.5	35	35	35
	>3.5	65	65	65
Triacylglycerols	mg/dL	n=170	n=57	n=113**
	<200	88	84	89
	200-399	11	12	11
	400-1,000	1	4	0
Glucose	mg/dL	n=170	n=57	N=113
	<110	70	70	70
	110-125	10	7	11
	>126	20	23	19
Hemoglobin	g/dL	n=165	n=56	N=109
	<10.0	3	2	4
	10.0-11.9	29	21	32
	12.0-13.0	25	21	27
	>13.0	43	56	37
Folate	ng/ml	n=169	n=57	n=112
	2.8-4.9	2	4	2
	>4.9	98	96	98
Vitamin B12	pg/ml	n=169	n=56	n=113
	150-250	3	5	3
	251-350	18	18	18
	>350	79	77	79

*.05<p<.10, *p<.05; ***p<.01

Discussion

We have characterized the demographic, health, functional, and nutritional status profiles of an urban, homebound elderly cohort of advanced age, a population that is largely underrepresented in previous research. This population has many unique demographic characteristics, including its high concentration of minority individuals (particularly Black Americans) and the high proportions of persons who are living alone and relatively socially isolated. Women were particularly likely to be widowed and poor. High prevalence rates exist in both men and women for nutrition-related chronic diseases (including hypertension, heart disease, and diabetes) and disabling medical conditions (such as arthritis and dementia) that may increase nutritional risk and functional dependency. Poor dietary quality is a universal concern in these homebound men and women. High nutritional risk is also evident by anthropometric and laboratory criteria which confirm high rates of overweight and obesity, dyslipidemia, and selected nutritional biomarker abnormalities.

The rates of chronic medical problems we observed are similar to the levels demonstrated in research on representative samples of homebound persons of advanced age (13,29,30,66,67). The relatively low perceived health of this population and their high level of functional limitations also concurs with recent national research that included a comparison of selected health characteristics in a national sampling of ambulatory and homebound elderly (30). The prevalent co-morbidity and functional dependency in our population is consistent with the profile of high nutritional risk as demonstrated in previous research (9,10,12-17) and lends support to the recommendations of the Administration on Aging (30), the Institute of Medicine (68), and others (10,14, 69,70) for the development and delivery of appropriate, professionally-managed preventive nutrition interventions and medical nutrition therapies to older persons.

Our finding that only 40 percent of our sample were at healthy weight for height is a concern. This rate concurs with recent evidence that only about 40 percent of women and one-third of men 60 years and older in the United States have weights considered healthy (66,67). The observation that half of our subjects were overweight, including 33% who were obese (Class I to III), is somewhat higher than findings reported in homebound US elderly (30) and is likely to reflect the minority profile of our population (71,72). There is considerable emerging evidence of the adverse impacts of obesity and moderate weight gain in adulthood on the development of chronic diseases with advancing age (such as ischemic heart disease, hypertension and stroke, and diabetes); their complications (including physical disability and loss of independence); and mortality (1,10,12-17,66,72-74). Therefore, we are reluctant to conclude that moderate overweight and obesity in those of advanced age is favorable to survival. When smoking status is controlled for in longitudinal studies of older populations, favorable bivariate effects of moderate overweight and weight gain on mortality tend to be attenuated (74).

Five percent of our study population had clinical evidence of underweight. Our observed rate of underweight is lower than findings in previous research on homebound older persons (29,30). Such differences may reflect the high degree of medical management or the minority composition of our cohort. While underweight is relatively rare in this sample, its adverse implications (including increased risk for institutionalization and mortality) should not be overlooked (1,9,11,12,14-17,68).

Dietary quality in all of our study subjects was compromised at both extremes of the nutrient intake distributions. Over half of these older individuals consume higher than recommended levels of key macronutrients, including total and saturated fat, and sodium and over 40 percent had lower than recommended levels for 11 of the 13 micronutrients studied. Data from NHANES III (75,76) and other population-based samples of free-living elderly (29), including homebound elderly (30), suggest that problems with both excess nutrient intake and very low micronutrient intake are prevalent. Such research has led experts to discuss these extremes in nutritional risk in the older adult populations and to emphasize the importance of achieving and maintaining dietary quality, including reducing dietary lipids while maintaining the overall micronutrient density of the diet (1,9,15-17). The Institute of Medicine (68) recently advocated the extension of routine nutritional assessments and medical nutrition therapies as a Medicare benefit to older persons, particularly those of advanced age and frailty. Their report also underscores the importance of further research on the efficacy of preventive and therapeutic nutritional interventions in this population. Standards of professional practice for nutrition professionals working with older adults have been published (77). At present, however, nutritional status monitoring and professionally managed nutritional interventions are rarely implemented in community and home-based health care and case management for older persons (12,13,68).

Some 18-32% of our homebound elderly study subjects had low to borderline-low fasting concentrations of specific nutritional biomarkers, including serum albumin, hemoglobin, and absolute lymphocytes; few had very low levels of HDL-cholesterol or vitamin B12 and folate. Plasma total- and LDL-cholesterol, and triacylglycerol concentrations were higher than recommended in 12-37% of subjects. These data are quite consistent with published research on the non-institutionalized older population (80-86). However, we note that about one-third of this sample (35%) had relatively favorable (48) serum Total:HDL cholesterol ratios (3.5 or less), a finding that may reflect selective survival in our cohort. Our findings that few of these subjects had very low vitamin B12 and folate levels were somewhat surprising given other published reports (78,79); and these data are likely to reflect the comprehensive medical management of our homebound subjects.

Our finding that a high proportion of this cohort had very high Nutrition Screening Initiative Checklist scores (11+) is not unexpected given their advanced age, functional dependency, and co-morbidity. It is noted that the Checklist is only a preliminary tool for identifying potential nutritional problems in a population (29). Nonetheless, we confirm in this report, the universal problems of poor dietary quality, high rates of overweight and obesity, and prevalent low to borderline low levels of other key nutritional biomarkers in the homebound older population.

The options for professionally-managed medical nutrition therapies in older adults include the following: individual and family nutrition education and counseling; coordinated delivery of congregate and home meals; assistance with instrumental activities (food shopping, cooking, or eating); enteral or parenteral nutrition support (as medically necessary); and targeted nutrient supplementation. In its recent recommendation, the Institute of Medicine (70) advocated that such professionally-managed nutritional therapies be evaluated and made available as appropriate to Medicare program beneficiaries. Guidelines are emerging for selecting among these options and managing nutrition-related acute and chronic health problems in the institutionalized and community-based older populations, including homebound elderly (14,77). The Nation's health policy directives, Healthy People 2000 and 2010 (1,69), also identified the improvement of nutritional status among older Americans as a national priority. Community-based health care providers, including community health centers, managed care organizations, hospitals, and related clinical services, were urged to develop multidisciplinary models and strategies for health promotion and coordinated clinical case management in older populations that include nutrition services. The recent national evaluation of the federal ENP demonstrates the effectiveness and cash efficiency of home and community based meals. Ponza et al. (30) also note the potential for developing preventive nutrition resources into the existing national infrastructure of this program. The importance of implementing these expert recommendations is further supported by our findings of high nutritional risk at the extremes of the nutritional status continuum in these frail urban homebound elderly.

The relatively unique sociodemographic and health-related characteristics of this population, the representativeness of our respondents in comparison with our eligible patient population, and the comprehensiveness of our in-home assessments and medical record abstractions are particular strengths of this research. It is noted, however, that there are certain limitations in this research. The data presented here are cross-sectional in nature and prevent the understanding of causal relationships between nutritional risk, and health outcomes. The study sample compares favorably with many earlier studies but is nonetheless limited in size and contains relatively few men.

Nutritional risk is prevalent in this frail urban, homebound older population of very advanced age and ethnic diversity. All persons had problems related to poor dietary quality and many were substantially overweight, including 33% who were obese. These characteristics were consistent with the population's high rates of nutrition-related chronic diseases, including hypertension, heart disease, and diabetes, and their associated functional impairments. In addition, there was also an indication of extreme underweight and laboratory evidence of potential malnutrition in a smaller but important segment of this medically-managed group of elderly patients. This research points to specific areas of nutrition-related concern in the frail, urban homebound older population and suggests the need for the identification of appropriate preventive interventions and medical nutrition therapies. It appears particularly critical that multidisciplinary teams evaluate nutritional risk in the context of an individual's medical status, including co-morbidity and disease severity, in order to identify correctly the etiology of nutrition-related problems and to design appropriate preventive and medical nutritional interventions. The diverse sociodemographic characteristics, physical frailty, and functional dependency of homebound older persons also need to be considered in order to develop feasible and efficacious nutritional interventions. These data also emphasize the importance of understanding the relationships between nutritional risk and health outcomes over time including mortality, functional decline, use of costly in-home services, and rates of institutionalization.

Acknowledgements: The research on which this manuscript is based was funded by the National Institutes on Aging (R01 AG14080) and the Novartis Foundation for Gerontological Research.

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