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MICRONUTRIENT INTAKES IN TWO US POPULATIONS OF OLDER ADULTS: LIPID RESEARCH CLINICS PROGRAM PREVALENCE STUDY FINDINGS

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Abstract: Dietary intakes of several minerals and vitamins were assessed in two US sub-populations of older men and women between 60 and 80 years as part of the Lipid Research Clinics Program Prevalence Study conducted in the mid-1980s prior to widespread fortification. Dietary intakes were analyzed from 24-hour recalls using the Minnesota Nutrition Coding Center. Descriptive statistics on the two diverse sub-populations were generated for the elderly subjects at the two clinic sites, southern California and Oklahoma. Regression analyses of specific micronutrients were performed while controlling for several variables, namely, age, sex, clinic (region), education, Body Mass Index (BMI), alcohol consumption, and smoking status. Compared to current (1999-2004) Estimated Average Requirements (EARs) and Adequate Intakes (AIs) for three micronutrients without EARs for the US and Canada, several micronutrients were consumed at or close to their EAR values. Exceptions include intakes of vitamin A, vitamin E, folic acid, potassium and calcium which were very low; intakes of thiamin, riboflavin, niacin, and vitamin C were low but closer to the published EAR or AI values. High intakes approaching cut-offs for practically all subjects were found for both groups of elders at the two clinic sites for iron, phosphorus, and sodium. In general, California elderly had somewhat better consumption patterns for the vitamins, but the Oklahomans, males at least, had higher overall mineral intakes. The micronutrient deficits found in this small study suggest that most elderly US citizens were likely to be deficient in five micronutrients and marginally insufficient in four others in the mid-1980s and, despite even greater fortification currently, elderly intakes seem not to have improved substantially since the 1980s, except for subjects who are regular multi-supplement users.

Key words: Dietary survey, 24-hour recall, elderly, folic acid, vitamin A, vitamin E, potassium, calcium, phosphorus, sodium, and iron.

Abbreviations: LRC = Lipid Research Clinics; DRI = Dietary Reference Intake; USDA = U.S. Department of Agriculture; US NHANES = U.S. National Health and Nutrition Examination Survey; EAR = Estimated Average Requirement; AI = Adequate Intake; BMI = Body Mass Index.

Introduction

Surveys of the nutritional intakes of vitamins and minerals by healthy free-living elderly subjects in the US have been limited to few reports (1). General agreement exists in support of the concept that a healthy dietary pattern, including foods that provide micronutrients in good amounts, supports health and survival of the elderly (2-5). When combined with other healthy lifestyle behaviors, such dietary patterns help maintain organ-system functions and delay the onset of chronic diseases and death. The aging process itself may also compromise functional status and, therefore, optimal micronutrient intakes, such as calcium and vitamin D for bone health, may slow the declines in function. Data on 1999-2000 intakes of many micronutrients by the elderly in the US suggest that the elderly in the US may be deficient, either marginally or more severely, in a few micronutrients (1). Multiple vitamin and mineral supplement users in the US have considerably higher circulating levels of practically all micronutrients compared to non-users (6). US elderly intakes from NHANES (1999-2000) (1) are listed in Table 1 along with the current Dietary Reference Intakes (DRIs) for the United States (7).

Table 1
Mean Elderly Dietary Intakes of Selected Vitamins and Minerals, and Current RDAs and EARs by Sex: US*

	Actual Intakes		Current RDAs		Current EARs	
	Male	Female	Male	Female	Male	Female
Vitamins						
Thiamin, mg	1.8	1.3	1.2	1.1	1.0	0.9
Riboflavin, mg	2.1	1.6	1.3	1.1	1.1	0.9
Niacin, mg	24.1	17.4	16	14	12	11
Folic acid, μg	387	312	400	400	320	320
Vitamin A, RE (RAE)	1117	997	900	700	625	500
Vitamin C, mg	110	99	90	75	75	60
Vitamin E, αTE, mg	9.2	7.6	15	15	12	12
Minerals						
Calcium, mg	797	660	1200	1200	NA	NA
Iron, mg	17.3	12.8	8	8	6	5
Phosphorus, mg	1305	990	700	700	580	580
Potassium, mg	3059	2367	4700	4700	NA	NA
Sodium, mg	3447	2532	1300	1300	NA	NA

* Data on subjects 60 years and older, 1999-2000 from CDC: Advance Data No. 339 (2004) and 341 (2004) (1). RDAs = Recommended Dietary Allowances and EARs = Estimated Average Requirements, as specified by the Institute of Medicine, National Academies of Science, Washington, DC, 1997-2003 (7). NA = Not Available.

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Several specific micronutrients with their common US food sources are cited in Table 2, since a few of these were found to be deficient or excessive in the present report. Because insufficient or excessive intakes of these micronutrients may contribute in one or more ways to most of the common chronic diseases, including cardiovascular diseases, diet-related cancers, and osteoporosis in the world, a better understanding of how well the elderly are meeting their dietary intake recommendations and the effects of lifestyle variables on these intakes may help health practitioners provide better guidance. Such guidance would focus on elderly patients and nursing home residents, and it would assist public health experts with better information for disease preventive programs. This report is based on dietary data of elderly men and women collected in the Lipid Research Clinics (LRC) Program Prevalence Study in the mid-1980s at two sites or regions, Oklahoma and southern California. A report on the macronutrient intakes, by the same subjects at the two sites, was previously published (8).

Table 2
Common US Food Sources and General or Specific Micronutrient Functions Affected by Deficiencies or Excesses. (Exclusive of Nutrient Supplements)

Micro-Nutrient	Common Food Sources Animal	Plant	Functions
Calcium	Milk, cheese	Dark greens,*	Bone mass, cell signals, other
Iron	Meats, eggs	Legumes	Red cells, muscle, enzymes
Phosphorus	All foods	All foods	Bone mass, cell energy, other
Potassium	Meats, milk	Fruits, vegetables	Electrolyte balance
Sodium	Milk	Celery, carrots	Electrolyte balance
Folic acid	Dairy, eggs	Dark greens, fruits, legumes	Cell renewal, methyl donor, reduced risk of cancer (colon)
Niacin	Meats	Grains	Energy generation
Riboflavin	Meats, eggs, milk	Grains	Energy generation
Thiamin	Meats, eggs	Grains	Energy generation
Vitamin A	Fish, eggs	Vegetables**	Vision, antioxidation+, growth
Vitamin C	None	Fruits, vegetables	Antioxidation+
Vitamin E	None	Vegetable oils, legumes	Antioxidation+

From: USDA and other sources. * Wheat flour with calcium propionate also provides considerable amounts of calcium. ** Dark green yellow, and orange vegetables especially plus some fruits. + Antioxidants may reduce risk of cancer.

The objective of this study was to determine the amounts of selected micronutrient intakes obtained by 24-hour recalls of elderly citizens in the US at the two LRC sites. Several lifestyle variables, namely, educational level, Body Mass Index (BMI), alcohol consumption, and smoking, have been included in statistical analyses in order to determine whether they account for age- and site-specific differences in micronutrient consumption.

Methods

As part of the national LRC Program conducted in the mid-1980s, 78% of the 7,791 white residents in a geographically defined, suburban, upper middle class community in southern California and 75% of a random sample of 9,522 mostly rural, lower middle-class residents in Oklahoma participated in a survey for heart disease risk factors. A two stage screening procedure was used. At Visit 1 participants were asked to answer a brief questionnaire and had their fasting plasma cholesterol and triglyceride measured. A select group of participants was invited to a second and more extensive evaluation, including a 24-hour dietary recall. This group was selected as a simple random sample of the Visit 1 participants with a sampling rate of 15%. From the remaining 85% of participants, persons with elevated lipids or who were taking lipid lowering medications at visit 1 were also invited to the Visit 2 examination. The present study, thus, uses the combined sample of 15% of the random sample plus the selected subjects with elevated lipids or those taking lipid-lowering medications.

Eighty nine percent of the California and 84% of the Oklahoma invitees participated. Those persons aged 60-79 years form the basis of this report. After eliminating unreliable recalls, 498 participants (215 males, 283 females) from California and 265 participants (91 males, 174 females) from Oklahoma remained in the analysis. A comparison of nutrient intakes of drinkers and nondrinkers in the California population has been reported earlier (9).

Height and weight were measured in light clothing, without shoes, by standardized procedures. The level of formal education attained and the nature of employment, either currently or prior to retirement, of the head of the household were established by a standard questionnaire. A 24-hour diet recall was obtained from each participant by trained and certified LRC dietitians who used standardized forms developed by the LRC program (10). Food models and containers of various sizes were used as aids in establishing the quantity of each food and beverage consumed. Based on a subjective assessment of the participant's memory and the credibility of the described diet, the dietitians judged 98% of the 24-hour recalls as reliable and usable (10). Interviews were conducted in the morning and recalls covered the 24 hours prior to an overnight, 12-hour fasting period, which was a requisite for blood sampling. No recalls of Friday evening or Saturday daytime intake were obtained.

Dietary recall data were entered on standard forms and sent to the LRC Nutrition Coding Center in Minneapolis (10). Macronutrient content was calculated using USDA Handbook No. 8 (11) and updated USDA tables of nutrient composition, information that was supplied by food manufacturers, and a file of recipe data. Nutrient intake of each individual as well as other relevant data was processed further by the LRC Central Patient Registry and Coordinating Center in Chapel Hill.

Methodologies of the recall and computations of nutrient content have been described elsewhere (12). The aggregate distribution of nutrient intake in the 10 North American populations that were investigated in the LRC Prevalence Study has been published previously (12-14).

Descriptive statistics of nutrient intake by sex and age groups (60-69, 70-79) were calculated separately for the two sites. Because hyperlipidemics in the Visit 2 study population were over-sampled (100%) compared to normolipidemics (15%) from the initial Visit 1 population, calculations of these summary statistics required adjustment for the differential selection probabilities of the subjects. Sampling weights were calculated as the reciprocal of the sampling fraction (15%). Use of these sampling weights makes estimates of dietary intake reflect the dietary patterns of the Visit 1 population rather than those of the Visit 2 population. Also, weights were calculated separately for males and females. Comparisons of subject intakes of each micronutrient were made to the EAR or AI of each; this analysis yielded percentages of intake to EAR or AI for each micronutrient, according to the method of Barr et al. (15).

Regression analyses were performed to compare differences of older populations in southern California and Oklahoma in micronutrient intakes, controlling for age, site, education, BMI, alcohol intake, and smoking status. For each nutrient, separate models were constructed for males and females because the descriptive analysis suggested important gender differences. Because hyperlipidemic subjects were over-sampled in the study, the regression models were estimated by taking into account the differential probabilities of selection (SAS Version 9.1).

Results

Descriptive statistics of elders at the two geographic study sites in the USA are given in Table 3. Means are presented for weight, height, BMI, and percentages are given for drinkers of alcoholic beverages, smokers of cigarettes, high school graduates, and white collar and blue collar occupations. These data, collected in the 1980s, show that many elderly were on the edge of being overweight (BMI cut-point of 25) and only the means of California women in their 60s and Oklahoma men in their 70s were within the normal range for BMI (18.5-25), although the means were near the upper limit of this range. Both a high percentage of California males and females consumed alcohol on a regular basis, i.e., 90-100%, whereas Oklahomans had much lower percentages, 30-60%. The high school educational level of the Californians was similarly high, 85-100%, compared to the Oklahomans, 30-55%. Finally, the vast majority of Californians held white collar positions, whereas the Oklahomans had a fairly even mix of both white and blue collar jobs.

Micronutrient intakes of the elderly by sex at the two sites for those 60-69 and 70-79 years of age in comparison to current DRIs are presented in Table 4A and percentages of micronutrient intakes to Estimated Average Requirements (EARs) or Adequate Intakes (AIs) are presented in Table 4B (7). Means and standard errors are listed separately for males and females for calcium, iron, phosphorus, potassium, sodium, folic acid, niacin, riboflavin, thiamin, vitamin A (including -carotene), vitamin C, and vitamin E (Table 4A). Compared to the current DRIs males and females had good intakes for some micronutrients, but they typically were low in folic acid, vitamin A, vitamin E, calcium, and potassium. The intakes of both the male and female southern Californians were quantitatively somewhat better than those living in Oklahoma. Relative to the DRIs, the intakes of the three B vitamins (thiamin, riboflavin, and niacin) and iron used in fortification of wheat flours were adequate, but less than 100% of study subjects consumed enough. Folic acid intakes were lower when the LRC survey was conducted because folic acid fortification was not mandated by the FDA for wheat flours until 1998. The women had lower intakes of calcium, and with the high phosphorus intakes their Ca:P ratios were closer to 0.65 rather than the recommended ratio of 1.3:1, or at least more than 1:1, since their phosphorus intakes were higher than recommended. Also, the men and women were consuming

Table 3
Descriptive Statistics of Older Adults in California (CA) and Oklahoma (OK): Lipid Research Clinics Prevalence Study

	Males				**Females**			
	60-69 y		**70-79 y**		**60-69 y**		**70-79 y**	
	CA	**OK**	**CA**	**OK**	**CA**	**OK**	**CA**	**OK**
Sample size (unweighted)	122	76	93	15	185	122	98	52
Sample size (weighted)*	610	394	380	87	650	384	351	162
Weight, kg (mean)*	76.6	77.1	74.4	72.5	62.1	65.8	62.2	63.2
Height, cm (mean)*	173.9	172.7	172.0	172.5	160.1	158.2	157.7	158.6
BMI (mean)*	25.3	25.8	25.1	24.3	24.2	26.3	25.0	25.2
Drinkers (%)*	95.5	56.5	94.7	58.8	94.5	31.4	86.8	32.3
Current Smokers (%)*	20.8	29.2	11.7	22.5	17.7	18.7	7.3	7.5
High School Grad (%)*	97.8	46.5	86.9	37.5	91.5	52.0	84.0	33.1
White Collar (%)*	99.6	62.2	88.3	72.5	83.5	43.6	78.1	42.2
Blue Collar (%)*	0.4	37.8	11.7	27.5	9.5	39.4	6.2	18.0

y = years; BMI = body mass index (no units); * Weighted by the reciprocal of the sampling fraction to make the Visit 2 sample represent those at Visit 1. Each Visit 2 participant was either part of a 15% random sample of Visit 1 participants or had elevated lipids or was taking lipid-lowering medication at Visit 1.

adequate amounts of sodium and potassium, although mean sodium intakes were higher and mean potassium intakes were lower than recommended. The southern Californians did better than the Oklahomans for practically all the vitamins assessed, but not for the minerals (Tables 4A and 4B).

Table 4a

Mean and Standard Error of Micronutrient Intakes of Elderly in Oklahoma (OK) and California (CA): Lipid Research Clinics Prevalence Study: By Age, Sex, and Region*

Sex	Nutrient	Age, y	OK Mean	Standard Error	CA Mean	Standard Error	DRIs (unit/day)
Males	Calcium, mg	60-69	1055.51	119.14	820.42	47.12	1200
		70-79	878.28	125.60	742.53	38.51	1200
	Iron, mg	60-69	15.30	0.78	13.79	0.46	8
		70-79	12.20	1.00	14.30	0.59	8
	Phosphorus, mg	60-69	1435.44	100.48	1252.04	46.77	700
		70-79	1127.93	105.85	1115.91	42.96	700
	Potassium, mg	60-69	3131.47	178.96	2702.20	77.17	4700
		70-79	2295.30	207.67	2545.16	84.73	4700
	Sodium, mg	60-69	2953.94	205.11	2595.74	106.04	1300
		70-79	2615.96	298.37	2522.04	126.40	1300
	Folic Acid, mcg	60-69	293.98	32.64	252.77	12.72	400
		70-79	221.06	29.96	250.68	15.96	400
	Niacin, mg	60-69	23.80	1.61	21.75	0.76	16
		70-79	15.49	1.62	20.65	0.74	16
	Riboflavin, mg	60-69	2.58	0.21	2.12	0.10	1.3
		70-79	2.00	0.24	2.01	0.11	1.3
	Thiamin, mg	60-69	1.85	0.13	1.43	0.06	1.2
		70-79	1.36	0.14	1.49	0.07	1.2
	Vitamin A, IU	60-69	543.06	59.86	778.27	99.60	900
		70-79	465.46	83.51	702.45	81.43	900
	Vitamin C, mg	60-69	88.43	9.12	112.98	7.68	90
		70-79	81.72	20.12	108.37	6.82	90
	Vitamin E, mg	60-69	8.84	0.68	10.27	0.49	15
		70-79	9.10	1.57	9.45	0.57	15
Females	Calcium, mg	60-69	631.30	39.38	642.13	35.65	1200
		70-79	562.40	37.26	646.80	43.31	1200
	Iron, mg	60-69	11.07	0.59	11.15	0.41	8
		70-79	9.61	0.43	11.95	0.76	8
	Phosphorus, mg	60-69	926.80	36.52	953.44	34.21	700
		70-79	801.28	43.82	985.43	36.18	700
	Potassium, mg	60-69	2118.93	83.17	2376.68	65.70	4700
		70-79	1883.63	114.15	2205.53	85.51	4700
	Sodium, mg	60-69	1930.56	103.39	2019.62	73.73	1300
		70-79	1654.87	110.42	1849.61	96.42	1300
	Folic Acid, mcg	60-69	188.88	12.41	225.54	13.32	400
		70-79	175.10	17.44	211.43	20.37	400
	Niacin, mg	60-69	15.59	0.80	16.45	0.51	14
		70-79	14.05	0.76	16.89	0.93	14
	Riboflavin, mg	60-69	1.55	0.07	1.55	0.06	1.1
		70-79	1.42	0.07	1.75	0.10	1.1
	Thiamin, mg	60-69	1.21	0.06	1.23	0.05	1.1
		70-79	1.08	0.06	1.23	0.08	1.1
	Vitamin A, IU	60-69	424.98	34.60	625.46	53.51	700
		70-79	455.75	71.89	642.86	94.25	700
	Vitamin C, mg	60-69	87.29	9.31	128.08	6.90	75
		70-79	80.26	9.73	95.57	8.66	75
	Vitamin E, mg	60-69	7.34	0.39	8.63	0.48	15
		70-79	6.71	0.68	9.82	1.12	15

Table 4b

Percent of Elderly Subjects from Oklahoma and California Meeting or Exceeding EARs or AIs of Selected Micronutrients: Weighted Proportions*

Sex	Mineral	Age, y	Oklahoma %	California %	EAR or AI
Males	Iron	60-69	96.6	99.6	6
	mg/d	70-79	99.2	99.5	6
	Phosphorus	60-69	96.2	98.5	580
	mg/d	70-79	99.2	94.3	580
	Folic Acid	60-69	32.2	25.0	320
	mcg/d	70-79	13.7	27.4	320
	Niacin	60-69	95.9	90.2	12
	mg/d	70-79	64.5	88.6	12
	Riboflavin	60-69	91.3	92.2	1.1
	mg/d	70-79	77.4	85.8	1.1
	Thiamin	60-69	90.9	66.2	1.0
	mg/d	70-79	76.6	75.9	1.0
	Vitamin A	60-69	0.4	3.9	625
	mcg/d	70-79	0.8	4.6	625
	Vitamin C	60-69	52.8	66.2	75
	mg/d	70-79	49.2	64.6	75
	Vitamin E	60-69	20.2	29.1	12
	mg/d	70-79	25.0	22.0	12
	Calcium**	60-69	30.3	19.5	1200
	mg/d	70-79	24.2	10.9	1200
	Sodium**	60-69	90.7	92.8	1300
	mg/d	70-79	100.0	93.6	1200
	Potassium**	60-69	12.3	0.2	4700
	mg/d	70-79	0.0	0.3	4700
Females	Iron	60-69	97.6	97.3	5
	mg/d	70-79	93.8	97.3	5
	Phosphorus	60-69	88.1	87.7	580
	mg/d	70-79	74.1	93.0	580
	Folic Acid	60-69	11.9	19.4	320
	mcg/d	70-79	14.1	12.4	320
	Niacin	60-69	75.1	84.6	11
	mg/d	70-79	66.2	78.9	11
	Riboflavin	60-69	84.8	90.1	0.9
	mg/d	70-79	81.2	86.6	0.9
	Thiamin	60-69	67.4	67.3	0.9
	mg/d	70-79	55.8	62.9	0.9
	Vitamin A	60-69	0.6	3.8	500
	mcg/d	70-69	3.2	7.0	500
	Vitamin C	60-69	53.0	79.6	60
	mg/d	70-79	52.7	59.2	60
	Vitamin E	60-69	11.1	17.2	12
	mg/d	70-79	11.8	21.4	12
	Calcium**	60-69	6.7	6.9	1200
	mg/d	70-79	6.4	11.4	1200
	Sodium**	60-69	80.3	77.7	1300
	mg/d	70-79	75.6	74.2	1200
	Potassium**	60-69	0.0	1.1	4700
	mg/d	70-79	0.0	0.3	4700

y = year; *Weighted by the reciprocal of the sampling fraction to make the Visit 2 sample represent those of Visit 1. Each Visit 2 participant was either part of a 15% random sample of Visit 1 participants or had elevated lipids or was taking lipid-lowering medication at Visit 1. ** Micronutrients with Adequate Intakes (AIs); all others have Estimated Average Requirements (EARs). Units are in milligrams (mg) or micrograms (mcg) per day (d).

Table 5 presents a summary of the regression analyses. (See Table 4A for absolute intakes of micronutrients.) The results show statistically significant regional and age differences among males and females. While California females have higher calcium consumption than Oklahoma females, California males have lower calcium consumption. California females have higher vitamin E intake, while Oklahoma females have higher iron consumption. The only significant site difference is higher vitamin A intake by California males. In terms of age differences, the older age group has significantly lower intakes of several nutrients: phosphorus, potassium, and niacin for males, and potassium, sodium, and vitamin C for females. Overall, after adjustments in the regression models, many nutrients that were significant in unadjusted analyses lost significance.

Table 5

Age and Site Differences in Micronutrient Intakes of Older Populations from California and Oklahoma: Lipid Research Clinics Prevalence Study. Coefficients (Standard Errors) from Regression Analysis#

Nutrient	Males		Females	
	Age (60-69) ##	Site (Cal) ###	Age (60-69) ##	Site (Cal) ###
Calcium	100.7 (67.3) NS	-174.5 (97.8) +	14.0 (38.7) NS	142.3 (68.5) *
Iron	0.54 (0.67) NS	-0.33 (0.92) NS	-0.28 (0.61) NS	-1.43 (0.83) +
Phosphorus	174.1 (61.4) **	-110.4 (91.6) NS	13.4 (37.2) NS	103.1 (69.1) NS
Potassium	336.3 (118.7) **	-233.1 (178.6) NS	159.4 (84.1) +	92.0 (130.1) NS
Sodium	137.8 (157.4) NS	-165.1 (212.3) NS	179.9 (93.8) +	72.0 (149.0) NS
Folic acid	17.4 (19.2) NS	-34.0 (43.4) NS	14.7 (17.9) NS	25.4 (21.8) NS
Niacin	2.88 (1.05) **	-0.26 (2.03) NS	-0.09 (.79) NS	-1.55 (1.03) NS
Riboflavin	0.20 (0.14) NS	-0.23 (0.21) NS	-0.10 (0.08) NS	0.06 (0.11) NS
Thiamin	0.10 (0.09) NS	-0.16 (0.16) NS	0.05 (0.07) NS	-0.01 (0.09) NS
Vitamin A	19.4 (89.0) NS	233.5 (92.6) *	-25.8 (77.5) NS	120.4 (75.0) NS
Vitamin C	4.9 (9.6) NS	20.3 (12.9) NS	23.5 (8.5) **	9.4 (13.1) NS
Vitamin E	0.67 (0.67) NS	0.06 (0.96) NS	-0.64 (0.84) NS	1.53 (0.91) +

** P < 0.01 * P < 0.05 + P <0.10 NS == non significant; Model is adjusted for education, BMI, alcohol consumption, and smoking status. (BMI = Body Mass Index); # Refer to Table 4A for differences in raw data on micronutrient intakes.; ## Reference group: age 70-79; ### Reference group: Oklahoma

Discussion

This survey, based on 24-hour recall data, revealed that micronutrient intakes of many elders in Oklahoma and southern California were being consumed at fairly optimal amounts in the mid-1980s, but that a few specific examples of insufficient consumption of micronutrients, but not severely deficient intakes, were evident. Folic acid, vitamin A, vitamin E, calcium, and potassium were marginally low in the LRC survey. These same vitamins and minerals were also low in the 1999-2000 US NHANES survey (1). Sodium and phosphorus intakes were higher than recommended in the LRC Study as well as in NHANES (1). The possibility that these insufficiencies may contribute to chronic diseases can only be suggested by our data. The findings of low intakes for a few minerals and a few vitamins suggest that inadequacies of these micronutrients may possibly have contributed to elevations of blood pressure, cardiovascular diseases, colorectal cancer, and to osteoporosis. Explanations for this statement follow; first the minerals and then the vitamins are briefly discussed.

Intakes of sodium were considerably higher than recommended in both men and women in Oklahoma and southern California and these intakes were lower in those in their 70s compared to the 60s. Potassium intakes, however, were too low at both sites and for both genders. Potassium intakes were even lower for those in their 70s compared to those in their 60s. The contribution of a high sodium and low potassium intake to blood pressure regulation has been well investigated. The DASH diet based on high potassium, low sodium, and adequate calcium intakes has been demonstrated to lower blood pressure in a significant way (16). These two populations, but especially the Oklahomans, were at high risk for hypertension, cardiovascular diseases, and possibly other diseases.

Calcium intakes were lower for both sites and both genders than the current DRIs, and mean intakes were lower in those in their 70s. On the other hand, phosphorus consumption was greater than recommended (DRIs) today for both Oklahoma and southern California men and women. Phosphorus intakes declined with age. A low-calcium, high-phosphorus diet has been hypothesized to increase bone loss and thereby to contribute to osteoporosis (17). Women in these two populations were especially at risk for developing osteoporosis if, as presumed, low dietary calcium and high dietary phosphorus are critical risk factors.

Iron intakes by almost 100% of the elderly males met their EARs at both sites, but this percentage was slightly lower for elderly women at both sites. Neither population was at risk for iron deficiency, which suggests that iron intakes from meats were adequate, if not more than adequate.

Several water-soluble vitamins and two fat-soluble vitamins were assessed in these two elderly cohorts. Folic acid or folate intakes in the 1980s were low, i.e., only at ~50 to 60% compared to the recommendations (DRIs) applying today. Slight declines in intake of folate were observed for both men and women in their 70s compared to those in the 60s. Newer knowledge suggests that higher folate intakes may help reduce the risk of colorectal cancer and cardiovascular diseases, even if serum homocysteine concentrations are not appreciably lowered (18). Furthermore, our folate findings suggest that the lower intakes by the southern California and Oklahoma women and men may have put them at increased risk for cardiovascular diseases, including coronary and cerebrovascular damage, as well as for cognitive impairment (19).

Thiamin, riboflavin, and niacin intakes for both genders in each age-decade exceeded the current DRIs. Vitamin C consumption by men and women was close to the current DRIs, but southern California men and women had higher intakes. Declining intakes of vitamin C were found for those men and women in their 70s, but amounts ingested were slightly less than recommended for Oklahoma men, but not women.

Both vitamins A and E were significantly lower than the dietary recommendations for today, but intakes of these two fat-soluble vitamins were much lower in Oklahoma residents compared to those in southern California. Lower intakes of these two vitamins have been attributed to increased risks for several chronic diseases, but their roles as antioxidants have recently become controversial (20).

High intakes of sodium by study participants were not verified by 24-hour urinary collections, but it is inferred that the dietary recalls for sodium and potassium were reasonably accurate even if sodium consumption was underestimated. The high-sodium, low-potassium pattern supports the hypothesis that the typical diets at the two clinic sites contribute to high blood pressure.

High percentages of individuals in the two different populations in southern California and Oklahoma consuming too little thiamin, riboflavin, niacin, and vitamin C, compared to the EARs, was somewhat surprising because of the widespread fortification of these water-soluble vitamins in the USA in the 1980s. The reason for the low intakes of these four micronutrients seems to be poor consumption of fruits and vegetables and fortified flours and breads. The adequate intake of iron resulted most likely from sufficient intakes of meats and other iron-rich foods in these two older populations.

These micronutrient consumption trends are consistent with earlier reports for the USA and several populations in Europe (2-5). The somewhat higher micronutrient intakes of southern Californians suggest that their usual diets were slightly higher in fruits and vegetables than the diets of Oklahomans. Finally, the reductions in micronutrients consumed by older subjects, i.e., 70 years and older, closely parallel the reductions of total calories and protein (g) in septuagenarians compared to hexagenarians, as found in our previous report (8). Because of lower micronutrient intakes among the elderly, many authoritative groups are recommending that seniors take a multiple vitamin-mineral supplement at DRI levels once a day in order to assure adequate but not excessive amounts.

Limitations of this study relate to the use of 24-hour recalls and the possibility of inadequate ascertainment of energy intake (21) and, hence, of all nutrients, including the micronutrients assessed in this report. Further, no urinary or blood measurements of nutrients or their metabolites were available to corroborate estimated intakes of micronutrients. Since no assessments for intakes of vitamin B6, cobalamin (B12), vitamin D, magnesium, selenium, zinc, iodine, or copper were made in the LRC Study, comments can not be provided for these micronutrients. Finally, sample sizes, especially of 70-79 year olds in Oklahoma, were relatively small.

Conclusions

Data of several micronutrients consumed by elderly subjects in southern California and Oklahoma suggest that marginal deficiencies in intakes of a few micronutrients relate to location, i.e., midlands vs. coastal southern California, as well as to age, decade of the 60s vs. 70s. Specific deficits were found in both southern California and Oklahoma for the following nutrients: folate, vitamin A, vitamin E, potassium, and calcium. High, even excessive, consumption of sodium and phosphorus were also found. When this study was undertaken in the early to mid-1980s, very few elderly individuals in the USA were taking multi-nutrient supplements, so that the micronutrient deficits found were most likely valid across these two populations. Also, folic acid fortification had not been instituted until the late 1990s, so that the folate-insufficient diets were most likely real.

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