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Dietary Intake and Nutritional Status in Regard to Zinc of Institutionalized Aged[1]

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Dietary intake and nutritional status in regard to zinc were assessed in 65 institutionalized aged subjects. Dietary intake was generally adequate compared to the Recommended Dietary Allowances, except in regard to zinc and magnesium. Five percent of the subjects had hair zinc levels indicative of zinc deficiency (below 75 μg/gm). Hair zinc levels were significantly correlated to protein intake by men and were significantly lower in women taking medication for coronary heart disease. Approximately one-fifth of the subjects had decreased taste acuity as evidenced by an inability to detect a difference in deionized water and 48mM solutions of sodium chloride or sucrose. Neither dietary intake of zinc, hair zinc levels, nor smoking habits were correlated to taste acuity at the $p<0.05$ level.

ONE mineral of potential interest in nutrition surveys of the aged is zinc. The typical American diet is believed to contain 10 to 15 milligrams of zinc daily, which is 66% to 100% of the RDA (Sandstead, 1973). However, zinc is not universally abundant in all foods. Generally animal proteins contain more biologically available zinc than cereal or vegetable products (Murphy, Willis, & Watt, 1975; Reinhold, Faradji, Abadi, & Ismail-Beigi, 1976). Hence, among aged with low incomes and those residing in extended care facilities, which substitute vegetable products for animal proteins, the potential of low zinc intake is great. Moreover, in the last 10 years marginal zinc deficiency as manifested by stunted growth, decreased taste acuity, and slow wound healing has been described in several segments of the U.S. population (Hambidge, Hambidge, Jacobs, & Baum, 1972; Henkin, Schecter, Raff, Bonzert, & Friedewald, 1974; Pories, Henzel, Dob, & Strain, 1967). Both of the latter symptoms are degenerative changes commonly noted in the aged.

The purpose of this study was to determine dietary intake and the resulting nutritional status in regard to zinc of relatively healthy aged residing in an extended care facility. Zinc nutritional status was assessed by hair zinc levels and taste acuity for sweet and salty flavors.

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Method

Subjects. — The 150 members of a state-run institution for the aged who were classified by the administration of the facility as being "self sufficient" were invited to participate in this study; 65 individuals agreed to participate. No individual was included in the study who had not resided at the facility for at least 30 days.

The age and health status of participants is summarized in Table 1. Twenty-eight percent of the women and 19% of the men weighed more than 75% of the men and women of corresponding heights and ages surveyed in the Health and Nutrition Examination Survey (Roberts, 1966). Physicians had prescribed modified diets and medication for heart and cardiovascular disorders and hypertension for more women than men.

Survey procedure. — During a 10-day period, dietary intake, taste acuity, height, and weight of all subjects were measured. Hair samples and smoking histories were also obtained from all subjects. The drug and diet prescriptions of subjects were determined from their medical records.

Nutrient intake. — Sample meals with standard-sized servings were collected for 10

Table 1. Characteristics of Aged Subjects Residing in a State Facility for the Aged.

	Male	Female
Number of subjects	31	34
Age (years)	75.1 ± 10.1[a]	75.9 ± 5.7
Height (cm)	171 ± 8	159 ± 6
Weight (kg)	72 ± 12	87 ± 13
Current diet prescriptions		
Caloric restricted (%)	6	15
Sodium restricted (%)	6	21
Diabetic (%)	10	12
Drug prescriptions during last year		
For heart & cardiovascular disorders (%)	23	38
For hypertension (%)	10	26
For diabetes (%)	10	12

[a]Mean ± standard deviation.

days. Individual food items were weighed. Meals were also composited.

Homogenized food items and meal composites were prepared for mineral analyses by dry ashing as described by Osis, Kramer, Wiatrowski, & Spencer (1972). Samples and standards were diluted with a lanthanum solution to a final concentration of 0.1% (w/v) lanthanum and were read with an atomic absorption spectrophotometer for zinc and magnesium.

The amount of foods consumed in 1 day by each subject was measured. Survey aides observed the subjects throughout meals and recorded the type and quantity of menu items that subjects selected and the quantity of foods that were removed from their plates but did not consume during the mealtime. At the end of the meal all food remaining on the plates was weighed.

Intake of snacks was determined by diet recalls, which were crosschecked with diet histories.

The zinc and magnesium intake of the subjects was computed by using the values obtained from analyzing all the foodstuffs served at the facility during the 10-day period. Dietary intake of protein, fat, carbohydrate, thiamin, riboflavin, niacin, ascorbic acid, vitamin A, calcium, and iron were calculated by computer using USDA food compostition tables (Watt & Merrill, 1963).

Hair analyses. — Samples of newly grown hair were cut with forged stainless steel scissors from the nape of the neck. Hair samples were washed, wet ashed, and analyzed by atomic absorption spectrophotometry for zinc as described previously (Greger & Sciscoe, 1977).

Taste acuity. — To avoid taste fatigue, taste acuity for only two flavor modalities (salty and sweet) was tested. Taste acuity for salt was of special interest because McConnell and Henkin (1974) have noted an increase in sodium chloride preference in zinc-deficient rats. Also Schechter, Horwitz, and Henkin (1974) have found that hypertensive patients had an increased preference for sodium chloride. Subjects were asked to differentiate between deionized water and three concentrations (12, 24, 48 mm) of sodium chloride and of sucrose in forced choice triangle tests (American Society for Testing and Materials, 1969). No subject had eaten in the hour prior to the test. The solutions within a test and the tests themselves were presented in a random order to subjects. Retests were made around the transition point where subjects no longer consistently recognized a difference between the solutions and deionized water. The level of sodium chloride and sucrose consistently and correctly identified as different from deionized water was considered the subject's detection threshold for the compound.

Previously 11 young adult women (22 to 35 years of age) were also tested for taste acuity in this manner on 5 different days in both the morning and afternoon. Each time the solutions were presented in a different order. No significant differences were found in these women's ability to detect sodium chloride or sucrose in the morning and in the afternoon. The order that the solutions were presented did not significantly affect the detection thresholds.

Statistical treatment. — Correlations were calculated by computer using the Statistical Package for Social Science (Nie, Hull, Jenkins, Steinbrenner, Bent, 1975). Student's t and paired t tests were applied when applicable.

Results and Discussion

Complete dietary information was collected on 65 subjects. Hair samples were collected and taste acuity was measured on 62 subjects.

Table 2. Mean Nutrient Intake for One Day and Amounts Provided by the Facility's General Diet.

			Mean Intake				
	R.D.A.		Males (n = 31)		Females (n = 34)		Amounts Provided by General Diet (n = 10 Days)
Nutrient	51+ Male	51+ Female	at Meals	at Snacks and Meals	at Meals	at Snacks and Meals	
Energy (kcal)	2400	1800	1669 ± 543[a*†]	1839 ± 540[a]	1347 ± 378[†]	1527 ± 377	2435 ± 267
Protein (gm)	56	46	71 ± 24[†]	76 ± 25	65 ± 22[†]	72 ± 23	122 ± 14
Fat (gm)	—	—	59 ± 21[†]	64 ± 21	52 ± 21[†]	57 ± 20	91 ± 18
Carbohydrate (gm)	—	—	217 ± 82[*†]	245 ± 86[a]	160 ± 47[†]	188 ± 51	298 ± 46
Vitamin A (IU)	5000	4000	9797 ± 13617[†]	9934 ± 13614	8230 ± 11298[†]	8460 ± 11296	14842 ± 14591
Ascorbic acid (mg)	45	45	84 ± 47[†]	89 ± 50	94 ± 45[†]	98 ± 47	127 ± 15
Thiamin (mg)	1.2	1.0	1.3 ± 0.6[*†]	1.4 ± 0.6[a]	1.0 ± 0.3[†]	1.1 ± 0.4	1.7 ± 0.3
Riboflavin (mg)	1.5	1.1	2.3 ± 1.5[†]	2.5 ± 1.4[a]	1.9 ± 1.1[†]	2.2 ± 1.2	3.2 ± 1.2
Niacin (mg)	16	12	17.2 ± 9.7[*†]	17.8 ± 9.7	13.4 ± 4.8[†]	14.1 ± 4.8	19.2 ± 5.4
Calcium (mg)	800	800	1035 ± 536[†]	1150 ± 531	844 ± 411[†]	1028 ± 481	1620 ± 241
Iron (mg)	10	10	16.3 ± 9.4[*†]	17.1 ± 4.9[a]	12.5 ± 5.0[†]	13.5 ± 5.0	19.4 ± 6.2
Magnesium (mg)	350	300	231 ± 63[†]	251 ± 61	254 ± 128[†]	283 ± 121	324 ± 37
Zinc (mg)	15	15	7.5 ± 2.1[†]	8.0 ± 2.0	7.9 ± 2.8[†]	8.6 ± 2.8	18.7 ± 11.0

[a]Mean ± standard deviation.
[*]Significant difference ($p<0.05$ level) between males and females.
[†]Significant difference ($p<0.05$ level) between intake at meals verses intake at meals and snacks.

Nutrient intake. — The facility's general diets provided calories, protein, vitamins, and minerals, except for magnesium, in excess of the Recommended Dietary Allowance (RDA) for men over 51 years of age (Food & Nutrition Board, 1974). Dietary intake of protein, vitamins, calcium, and iron by both men and women exceeded the RDA (Table 2). The mean intake of magnesium by the women almost equalled the RDA, while the mean intake of magnesium by the men was below three-fourths of the RDA. Dietary intake of zinc by both men and women was below two-thirds of the RDA.

The dietary intake of these aged was comparable to the dietary intake of noninstitutionalized aged (Greger & Sciscoe, 1977; Jordan, 1976) but was somewhat higher than the dietary intake of institutionalized aged (Clarke & Wakefield, 1975; Justice, Howe, & Clark, 1974). This may reflect the fact that, while the aged in this study were institutionalized, they were still mobile and self-sufficient.

Snacks added on the average 175 calories per day to the subjects' diets. The snacks contributed significantly to the intake of protein, vitamins, and minerals by these aged subjects (Table 2).

The meal and snack patterns of subjects on the days recorded were not significantly different from their usual eating habits as determined through the diet histories. Snacks were consumed at least three times a week in the morning, afternoon, and evening by 21%, 33%, and 55% of the subjects, respectively. The types of foods that were most frequently consumed as snacks were candies and pastries (49%), fruits (49%), breadstuffs (32%), and milk (27%). The percentages in parentheses indicate the number of subjects who said that they consumed these foods as snacks at least three times per week.

Nineteen percent of the men and 53% of the women took nutritional supplements. None of these supplements were fortified with magnesium or zinc.

Hair zinc levels. — The mean hair zinc concentration of men was 176 ± 40 μg/gm and of women was 170 ± 75 μg/gm. This is similar to values noted by other investigators among adults (Greger & Sciscoe, 1977; Klevay, 1970; Petering, Yaeger, & Witherup, 1971; Schroeder & Nason, 1969). Five percent of the subjects had hair zinc levels below 75 μg/gm. Strain, Steadman, Lankov, Berlinger, and Pories (1966) have suggested that

hair zinc levels below 70 μg/gm are an indication of zinc deficiency. All subjects with hair zinc levels below 100 μg/gm were women in this study. Hair zinc levels were not significantly correlated with dietary zinc intake in either men or women, but they were correlated to total dietary protein intake among the men ($r=0.4166$, $p<0.025$). Women, who were diagnosed by a physician as having cardiovascular disease and were receiving medication for these conditions, had significantly ($p<0.02$) lower levels of zinc in their hair than the other women. The medications prescribed included Lanoxin, Parabid, and nitroglycerine. Hair zinc levels were not significantly correlated to age.

Taste acuity. — The taste detection threshold for sucrose was greater than 48mM for 21% of the aged men and 6% of the aged women (Table 3). All the young adult women had taste detection thresholds for sucrose of 24mM or less. Henkin, Schecter, Hoye, and Mattern (1971) and Pangborn (1959) have estimated the typical taste threshold for adults is 4 to 12mM sucrose. However, Langan and Yearick (1976) noted the mean detection threshold in aged individuals to be 16.6mM sucrose.

The taste detection threshold for sodium choloride was greater than 48mM for 17% of the aged men and 18% of the aged women (Table 3). Similarly 16% of another group of elderly could not detect sodium chloride at this concentration (Greger & Sciscoe, 1977).

Table 3. Taste Detection Thresholds of Sucrose and Sodium Chloride by Aged and Young Adults.

Lowest level of chemical detected consistently	Aged males %	Aged females %	Young adult female %
12mM sucrose	14	12	91
24mM sucrose	14	30	9
48mM sucrose	52	52	0
Unable to identify any of 3 levels of sucrose	21	6	0
12mM NaCl	7	24	73
24mM NaCl	28	36	27
48mM NaCl	48	21	0
Unable to identify any of 3 levels of NaCl	17	18	0

Langan and Yearick (1976) noted the mean detection threshold for 23 aged individuals to be 15.5mM sodium chloride. The typical adult taste threshold for sodium chloride has been estimated to be between 3 and 6mM (Greger & Sciscoe, 1977; Henkin et al., 1963; Pangborn 1959). The young adult women in this study were all able to detect sodium chloride at concentrations of 24mM or less.

Taste acuity for sweet and salty flavors was not correlated at a $p<0.05$ level to dietary intake of any nutrient, including zinc. The correlation between taste acuity for sugar and the men's hair zinc levels ($r=0.3560$) was significant at $p<0.058$ level. Hair zinc levels were not correlated even at a $p<0.10$ level to the men's taste acuity for salt or the women's taste acuity for salt or sugar. Taste acuity for salt of females, but not males, decreased with age ($r=0.3526$, $p<0.044$). Taste acuity for sugar was not correlated to the age of subjects. Taste acuity for salt and sugar were correlated among females ($r=0.3864$, $p<0.026$), but not among males ($r=0.3454$, $p<0.067$). There was no difference in taste acuity between subjects who wore dentures and those who did not.

Sixty percent of the women but only 35% of the men could detect a difference between a 24mM sodium chloride solution and deionized water (Table 3). This difference was statistically significant ($p<0.04$). In previous studies women have also demonstrated significantly greater taste acuity for salt than men (Greger & Sciscoe, 1977; Pangborn, 1959). A significantly ($p<0.02$) larger number of men could not detect the 48mM concentration of sucrose than women. Another factor that might be expected to influence taste acuity is smoking. Only 6% of the women had smoked in the last year; 66% of the men smoked or chewed tobacco regularly. However, there was no significant correlation between smoking and taste acuity.

Presently studies are being conducted to determine if zinc supplementation of the diet will alter the concentration of zinc in hair or taste acuity of aged individuals.

Summary

Dietary intake and nutritional status in regard to zinc were assessed in 31 men and 34 women. The mean age of the subjects was 75 years. All were mobile even though they were institutionalized. Dietary intake of protein, thiamin, riboflavin, niacin, vitamin A, ascorbic acid, calcium, and iron exceeded the RDA. The magnesium and especially the zinc content of the diets was below recommended levels. The consumption of snacks contributed significantly to the daily nutrient intake of these aged.

The nutritional significance of these apparently low intakes of zinc is not clear. Five percent of the subjects had hair zinc levels less than 75 μg/gm, which is indicative of zinc deficiency. The subjects with low hair zinc levels were all women. Women taking medication for coronary heart disease had significantly lower hair zinc levels than other women.

Taste acuity of these aged subjects was less than that of younger adults. Approximately one-fifth of the subjects had very depressed taste acuity and could not detect a difference between deionized water and a 48mM solution of sodium chloride or of sucrose. The taste acuity of males tended to be less than that of females. Levels of zinc in hair samples were not correlated to taste acuity at $p<0.05$ level. Neither smoking nor dietary habits were implicated as the cause for the depression to taste acuity among these aged.

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