Journal of Gerontology: MEDICAL SCIENCES
2001, Vol. 56A, No. 4, M200–M205

Copyright 2001 by The Gerontological Society of America

Flavor Enhancement of Food Improves Dietary Intake and Nutritional Status of Elderly Nursing Home Residents

Marie-Françoise A.M. Mathey, Els Siebelink, Cees de Graaf, and Wya A. Van Staveren

Division of Human Nutrition and Epidemiology, Wageningen University, The Netherlands.

Background. Taste and smell losses occur with aging. These changes may decrease the enjoyment of food and may subsequently reduce food consumption and negatively influence the nutritional status of elderly persons, especially those who are frail. The objective of this study was to determine if the addition of flavor enhancers to the cooked meals for elderly residents of a nursing home promotes food consumption and provides nutritional benefits.

Methods. We performed a 16-week parallel group intervention consisting of sprinkling flavor enhancers over the cooked meals of the "flavor" group ($n = 36$) and not over the meals of the control group ($n = 31$). Measurements of intake of the cooked meals were taken before and after 8 and 16 weeks of intervention. Appetite, daily dietary intake, and anthropometry were assessed before and after the intervention.

Results. On average, the body weight of the flavor group increased ($+1.1 \pm 1.3$ kg; $p < .05$) compared with that of the control group (-0.3 ± 1.6 kg; $p < .05$). Daily dietary intake decreased in the control group (-485 ± 1245 kJ; $p < .05$) but not in the flavor group (-208 ± 1115 kJ; $p = .28$). Intake of the cooked meal increased in the flavor group (133 ± 367 kJ; $p < .05$) but not in the control group (85 ± 392 kJ). A similar trend was observed for hunger feelings, which increased only in the flavor group.

Conclusion. Adding flavor enhancers to the cooked meals was an effective way to improve dietary intake and body weight in elderly nursing home residents.

INADEQUATE dietary intake is often observed in elderly nursing home residents (1,2). Accordingly, this population is highly at risk of developing undetected malnutrition and nutritional deficiencies. This malnutrition contributes to a reduced quality of life and leads to an impaired health status often called frailty (3–7).

Taste and smell losses occur with aging (8) and may influence the enjoyment of food and thereby affect the nutritional intake of older adults. Most studies on taste and aging have focused on taste acuity and sensitivity rather than on hedonic preference. Aging is associated with an increase in taste and smell thresholds, and elderly subjects when blindfolded had about one half the ability of young subjects to recognize blended foods (9). Many studies on preferences indicate that elderly subjects would prefer higher concentrations of stimuli for solutions of sucrose, sodium chloride, and citric acid than younger subjects do (10,11). The studies demonstrated that elderly subjects prefer a higher level of tastants but failed to associate this preference to a higher consumption of foods containing these tastants (12,13).

These age-related deficits in taste and smell may decrease food consumption and probably contribute to negative changes in eating behavior (14–17). Few studies have explored the relationship between sensory impairment, hedonic response, and altered food intake in elderly persons (12). Recently, de Jong and colleagues (18) demonstrated that a poor appetite is related to a loss of sensory perception, but they could not show an effect on intake. Also, Schiffman and Warwick (19) observed no changes in dietary intake of elderly subjects after 3 weeks of consuming flavor-enhanced foods, although they did observe an improved immune function and grip strength. Reasons for not finding an effect on dietary intake might be the reliability of the dietary methods and the short duration of the observation periods.

Our objective was to determine whether the addition of flavor enhancers to the cooked meals over 16 weeks would lead to an increase in food consumption and thereby provide nutritional benefits to elderly nursing home residents.

Methods

Subjects and Setting

The study was conducted at the nursing home "Rustenburg," Wageningen, The Netherlands. Participants were selected using the following criteria: being older than 65 years of age, having no known dementia or residing in a somatic ward (20), having no known depression, having no disease in terminal phase, having no allergy to monosodium glutamate (MSG), already residing in the nursing home for more than 3 months, and consuming the cooked meal provided by the nursing home kitchen at lunchtime at least 5 days per week. Seventy-one residents were enrolled in the study. The study protocol was approved by the Medical Ethical Committee of the Division of Human Nutrition & Epidemiology, Wageningen University.

Downloaded from http://biomedgerontology.oxfordjournals.org/ at Oxford Journals on September 22, 2015

Design and Procedure

A parallel group-intervention design was applied. The intervention consisted of adding flavor enhancers to the main dish of the cooked meals of the flavor group but not to the meals of the control group. The study was conducted for a period of 17 weeks: a week of run-in period and an experimental period of 16 weeks. After the baseline measurements, subjects were randomly assigned to be in the control group ($n = 34$) or the flavor group ($n = 37$).

Anthropometry and appetite data were assessed before and at the end of the intervention period. Dietary intake data were collected before the trial, after 8 weeks, and at the end of the trial. Compliance (i.e., consumption of the served meal) was checked daily during the 16 weeks by keeping records of meal orders and deliveries (Table 1).

Flavor Enhancers

Four flavor powders were available to enhance the cooked meal (Table 2): chicken flavor, beef bouillon flavor, turkey flavor, and lemon butter (fish) flavor (IFF BV, Hilversum, The Netherlands). The choice of the added flavor was determined by the nature of the protein-rich meal component and by the cooking process. Flavors were sprinkled just before meal delivery with a spice shaker over the whole main dish including the carbohydrate-rich components and the vegetables. The amount sprinkled per dish was 1 ± 0.2 g of flavor powder.

MEASUREMENTS

Anthropometry

Body weight.—Patients' body weight, as an index of the nutritional status before and after the study, was measured before breakfast and after voiding to the nearest 0.5 kg (Seca weighing scale, Hamburg, Germany), with subjects dressed in lightweight clothing and without shoes.

Knee height.—The knee-to-floor height (KFH) was measured twice by a single trained observer with a stadiometer in a sitting position, from the anterior surface of the thigh to the floor with the ankle and the knee each flexed at a 90° angle against the metallic help. Body height was derived using the formula height (in cm) = $3.16 \times$ KFH (in cm).

Dietary Intake

Total daily dietary intake data were collected using a combination of a 3-day record and weighing-back methods before and at the end of the intervention. Bread-based meal, snack, and beverage consumption was recorded in individual food diaries and checked by interviews with a trained dietician. Portion sizes were derived from a Dutch table of regular food portion sizes and household units (22).

Dietary intake at the cooked meal was assessed with a 3-day weighing-back method before the intervention. On the basis of the information on the day-to-day variation, a 7-day weighing-back method was used after 8 and 16 weeks (23). This enabled us to detect a mean difference of at least 70 kJ. Individual menus and recipes for the measurement days were obtained from the kitchen. Food consumption was then registered by keeping records of amounts served and weighing waste after the meal.

Dietary data were converted into nutrients using the Dutch food composition table (24).

Appetite, Hunger Feelings, and Sensory Perception Questionnaire

Subjects responded to a 29-item questionnaire about their feelings of hunger, appetite, and their taste and smell perception (18). After reading the questions together with an interviewer, subjects responded to the questions using a 5-point scale. A higher score corresponded to a more positive feeling of their sensory perception, a better appetite, and more feelings of hunger. Five variables were calculated: present taste perception, 8 items; present smell perception, 3 items; present smell perception compared with the past, 3 items; appetite, 6 items; and daily feelings of hunger, 9 items.

Geriatric Depression Scale

The geriatric depression scale (GDS) (25), used to assess the depression status of the subjects, consisted of 15 items to be answered "yes" (1) or "no" (0). The answers of each participant were summed to obtain a score, with each score above 5 indicating a depressive status.

Data Analyses

Only data of subjects completing the study were analyzed. Means ± standard deviations (*SD*) of baseline and absolute changes were calculated for the outcome variables

Table 1. Experimental Schedule Followed During the Study

	Week																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Experimental periods	Run in	Intervention: Control group (no flavors) and flavor group (with added flavors)															
Measurements																	
Dietary intake at the cooked meal	X								X								X
Total daily dietary intake	X																X
Anthropometry	X																X
AHSP questionnaire	X																X
GDS	X																
Compliance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Note: AHSP = appetite, hunger, and sensory perception; GDS = geriatric depression scale.

Downloaded from http://biomedgerontology.oxfordjournals.org/ at Oxford Journals on September 22, 2015

Table 2. Ingredients for 100 g of Ready-to-Use Flavor Product

	Chicken Flavor	Beef Bouillon Flavor	Turkey Flavor	Lemon Butter (Fish) Flavor
Protein	1	1	1	2
Fat	8	4	10	7
Sugars/starch	58	61	58	59
Salt	<1	<1	<1	<1
MSG	30	30	28	31
Others	<2	<3	<2	<1

Notes: Values are grams. MSG = monosodium glutamate. Sugars/starch is mainly lactose; others refers to free-flowing agents and acids.

per group. Changes were compared with an unpaired *t* test for differences between groups or with a paired *t* test for differences within groups. A p value $\leq .05$ was considered statistically significant. Data were analyzed using the SAS program (26).

Results

Subjects

Sixty-seven out of seventy-one subjects completed the study. Dropouts were patients who failed in completing the study because of death (1 subject), relocation (1 subject), or personal reasons (2 subjects). Data on dietary intake and body weight could be obtained from all subjects. We also had results on appetite feelings and depression from 42 subjects who were capable of understanding and answering the different questionnaires.

Resident characteristics were similar for both groups at the start of the study (Table 3). Groups were comparable with respect to diseases and treatments and used medications mainly prescribed for cardiovascular disorders, pain, or digestive track disorders. No differences in depression status were observed at baseline between the two groups, with a mean score of 3.2 indicating that participants were not depressed. Compliance was high with, on average, 111 of 114 days (98%) of consumption of the cooked meal.

Anthropometry

Groups were comparable with respect of mean body weight, body mass index (BMI), and energy intake before the study (Table 4). As shown in Table 4, mean body weight increased during the intervention in the experimental group (1.1 ± 1.3 kg; $p < .001$) but remained stable in the control group (-0.4 ± 1.6 kg; $p = .37$). Changes between groups differed significantly ($p < .001$). Figure 1 shows the percentage of subjects with stable body weight or losing or gaining weight over the 16-week period.

Daily Dietary Intake

Table 4 presents the daily dietary intake at baseline and absolute changes after 16 weeks of intervention. In both groups energy intake, on average, was low (5969 ± 1641 kJ for the control group and 5821 ± 1449 kJ for the flavor group) and below the mean Dutch requirement for elderly persons (7.8 MJ/d). As expressed per unit of body weight, dietary intake was also lower than the recommended intake (120 kJ/kg body weight) with 91 ± 31 kJ/kg body weight for the control group and 86 ± 3.0 kJ/kg body weight for the flavor group. Percentage of energy provided by fat, carbohydrates, and protein were similar in both groups with 36%, 46%, 17%, and 1% for fat, carbohydrate, protein, and alcohol, respectively.

After the 16-week intervention, energy intake of the control group declined (-485 ± 1245 kJ; $p = .03$), whereas it remained relatively stable (-208 ± 1115 kJ; $p = .28$) in the flavor group. A similar trend was observed for intake expressed per unit of body weight. Percentage of daily energy intake provided by fat (-2%; $p < .05$) declined in the control group, whereas the energy provided by other macronutrients remained unchanged. No changes occurred in the flavor group regarding the contribution of macronutrient to the daily energy intake.

Table 3. General Baseline Characteristics of the Elderly Subjects Who Completed the Study

Variable	Control Group ($n = 31$)	Flavor Group ($n = 36$)
Age[†]	83.0 (5.5)	84.6 (6.1)
Gender (male/female)	6/25	7/29
Living with spouse	4	10
Dentures, %		
Complete	13	9
Partial	74	83
None	13	8
Smoking behavior, %		
No smoking	84	92
Smoking	16	8
Medicine uses, mean number/day[†]	2.1 (1.6)	2.1 (1.8)
Restrained physical mobility, % use		
Wheel chair	7	11
Walking frame	42	36
GDS score[†]	3.2 (2.8)[‡]	3.2 (2.4)[§]

Note: GDS = geriatric depression scale.
[†]Mean (*SD*).
[‡]$n = 18$.
[§]$n = 24$.

Table 4. Anthropometry and Daily Dietary Intake Characteristics and Changes after the Intervention

Variable	Control Group ($n = 31$)	Flavor Group ($n = 36$)
Body weight (kg) at baseline	69.0 (17.0)	72.0 (17.5)
Absolute changes[‡]	−0.3 (1.6)	1.1 (1.3)*,†
Calculated height, cm[§]	160.0 (10.6)	157.6 (12.1)
BMI, kg/m^2	28.1 (7.0)	28.4 (7.1)
Daily energy intake at baseline, kJ	5969 (1641)	5821 (1449)
Absolute changes[‡,‖]	−485 (1245)*	−208 (1115)
Energy (kJ)/weight (kg) at baseline	91 (31)	86 (30)
Absolute changes[‡,‖]	−8 (4)*	−5 (17)

Note: BMI = body mass index.
*Significant difference in changes within one group between the start and end of the intervention period ($p \leq .05$).
[†]Significant difference in changes between groups between the start and end of the intervention period ($p < .05$).
[‡]Absolute changes after 16 weeks of intervention.
[§]Derived from Berkhout (21).
[‖]Control ($n = 29$) and intervention ($n = 35$).

Downloaded from http://biomedgerontology.oxfordjournals.org/ at Oxford Journals on September 22, 2015

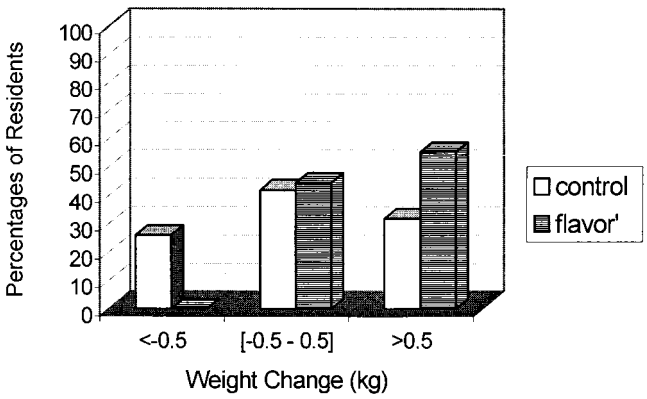

Figure 1. Distribution (%) of elderly nursing home elderly losing or gaining weight over the 16-week period (control [□] $n = 31$ and flavor [▤] $n = 36$).

When body weight variation after 16 weeks was related to changes in daily dietary intake, positive associations were found for changes in daily energy (Pearson $r = .345$, $p = .04$) and fat intake (Pearson $r = .407$, $p = .01$) in the flavor group. Such correlations were not found in the control group.

Dietary Intake of the Cooked Meal

Dietary intake of the cooked meal and absolute changes after 8 and 16 weeks of intervention are shown in Table 5. Intake of energy, carbohydrate, and fat increased in the flavor group after the 16-week intervention. In the control group, little change was also observed for the carbohydrate intake. In both groups, intake of vitamins and minerals remained stable (data not shown).

Appetite, Hunger Feelings, and Sensory Perception Questionnaire

Table 6 presents mean scores and absolute changes of the Appetite, Hunger Feelings, and Sensory Perception questionnaire. No differences were observed between the scores at baseline. After 16 weeks of intervention, higher scores were observed in the flavor group for daily feelings of hunger and present smell perception. Changes in daily feelings of hunger in the flavor group differed from those in the control group.

Discussion

Results of this intervention study showed three major findings after 16 weeks: (i) Repeated consumption of a flavor-enhanced cooked meal led to an increase in dietary intake at this meal and a stable daily dietary intake; (ii) increased body weight was noticeable after consumption of a flavor-enhanced cooked meal; and (iii) repeated consumption of flavor-enhanced foods resulted in increased daily feelings of hunger.

These findings are in agreement with previous studies (9,19,27,28), suggesting that adding flavor enhancers might improve appetite and dietary intake in an elderly population. Until now no study has shown an increase in actual food intake. We assume that the 16-week intervention was long enough to establish acceptance and preferences for the flavor-enhanced foods and that these preferences would be reflected by a rise in energy intake. This might not have been the case in shorter studies.

Daily energy intake was relatively stable in the flavor group, whereas a decrease of about 0.4 MJ occurred in the control group. At first sight, this finding is not in line with the observed increase in body weight in the experimental group and the relatively stable weight in the control group. However, from other studies it is well known that the assessment of food intake gives lower intake values with repeated measurements (29). Therefore, we believe that the values obtained at the end of the experiment are underestimates. Besides, a significant correlation between changes in daily intake and body weight variation was observed and implies that energy intake actually increased in the flavor group. We assume that measured differences in mean body weight give a better assessment of the overall changes in cumulative differences in energy intake over a 16-week period.

Changes in dietary intake at the cooked meal are likely to be the result of an increased enjoyment of food. This hypothesis was confirmed by an increase in energy intake of the cooked meal in the flavor group. Because intake data of the cooked meal are derived from repeated measures for 7 days, we believe that we have a good picture of intake of the cooked meal.

The rather high BMI suggests a well-nourished population (30). However, interpretation of BMI in elderly persons should be more liberal than in younger adults. First, elderly persons shrink, so their measured body height is somewhat underestimated (31). Second, BMI is not related to the presence of diseases. On the contrary, attention should be paid to weight because it is one of the major risk factors for morbidity in this population considered as accelerated agers (2,3). Our results indicate that consumption of food with enhanced chemosensory properties could provide nutritional

Table 5. Energy and Macronutrient Intake of Elderly Nursing Home Residents at the Cooked Meal

	Control Group ($n = 31$)			Flavor Group ($n = 36$)		
Variable	Before	Change 0–8† ($n = 30$)	Change 0–16‡	Before	Change 0–8†	Change 0–16‡
Energy, kJ	1880 ± 657	124 ± 366	85 ± 392	1907 ± 560	87 ± 380	133 ± 367*
Protein, g	25 ± 8	2 ± 6	1 ± 6	27 ± 8	0 ± 6	0 ± 5
Carbohydrate, g	41 ± 15	3 ± 10	3 ± 10*	43 ± 13	0 ± 11	3 ± 9*
Total fat, g	20 ± 9	1 ± 6	0 ± 7	19 ± 7	2 ± 6*	2 ± 7*

*Significant difference in changes within group as compared to a given time ($p \leq .05$).
†Changes observed after 8 weeks as compared with baseline.
‡Changes observed after 16 weeks as compared with baseline.

Downloaded from http://biomedgerontology.oxfordjournals.org/ at Oxford Journals on September 22, 2015

Table 6. Mean Score (*SD*) of the Appetite, Hunger Feelings, and Sensory Perception Questionnaire and Absolute Changes After 16 Weeks of Intervention in Elderly Nursing Home Residents

		Control Group ($n = 18$)		Flavor Group ($n = 24$)	
Variable	Possible Range	Baseline	Absolute Changes	Baseline	Absolute Changes
Appetite	6–30	17.4 (6.7)	1.2 (3.1)	18.8 (5.3)	0.5 (2.7)
Daily feeling of hunger	9–45	33.2 (7.4)	−0.3 (5.8)	29.3 (7.5)	3.0 (4.3)*,†
Subjective feeling of present taste perception	8–40	20.7 (7.0)	0.8 (3.5)	23.0 (6.1)	−0.0 (3.0)
Subjective feeling of present smell perception	3–15	11.2 (1.6)	0.8 (2.1)	9.8 (2.4)†	1.3 (2.7)*
Present smell perception compared with the past	3–15	8.2 (1.6)	0.3 (3.2)	7.5 (2.3)	0.8 (2.7)

*Significant difference in changes within one group between the start and end of the intervention period; $p < .05$.
†Significant difference between groups; $p < .05$.

benefits in this population and help to prevent weight loss. These observations should be further confirmed with data on body composition and biochemical indices. A long-term assessment of body weight would be necessary to verify that the gain in body weight remains stable and does not decrease as soon as the intervention is stopped.

The use of flavor enhancers has been suggested to compensate for diminished chemosensory functioning that contributes to impaired control of appetite in elderly persons, or the so-called anorexia of aging (32,33,39). Flavor enhancement could restore the hedonic functions of food and thereby promote a partial reestablishment of the original attitude and behavioral response of this population toward food intake (28,34).

Previous studies suggest that the consumption of flavor-enhanced foods would stimulate the limbic system and the endogenous opioid activity (19,34). The positive effect on body weight and the increased daily feelings of hunger observed in our study strengthen this possible path and suggest that the opioid activity arising from the consumption of more palatable foods may promote nutritional and physiological benefits in elderly persons.

In the present study we were in favor of stimulating both olfactory and gustative functions. This could be realized by using flavor enhancers containing MSG. We were confronted by an arguable issue regarding the repeated exposure to flavor enhancers containing about 30% MSG: Because sodium intake remains a sensible matter in elderly persons with slower renal function, a possible increase in daily sodium intake through the use of flavor enhancers rich in MSG could initially seem to be inadvisable. Considering a mean daily sodium intake of 9 g in this population (35), an additional daily dose of about 30 to 45 mg of sodium (i.e., 3.9 g to 5.4 g for a 16-week period) will most likely have very little influence on sodium metabolism, renal excretion, and water retention.

Sensory studies in elderly subjects showed that the concentration of MSG needed to influence preference was lower than the detection threshold in that food (27,36,37). This finding suggests that the flavor-enhancing effect of MSG occurs even if its concentration is too low to be detected by the elderly consumer. Furthermore, the sodium content of MSG is one third that of table salt (NaCl) (38). From a health point of view, these findings, together with our results, suggest that the use of flavor enhancers containing MSG could allow the elderly population to decrease their sodium intake from table salt while maintaining palatability and, therefore, the hedonic function of foods.

Adding ready-to-use flavor enhancers to the cooked meal is a simple but effective way to improve daily feelings of hunger, actual dietary intake, and body weight in a nursing home population with a stable health status.

Acknowledgments

We gratefully acknowledge IFF BV (Hilversum, The Netherlands) for their donation of flavors. We also would like to thank Friesland Coberco Research and the Suikerstichting for their sponsorship. We are grateful to Alma van der Greft, Jill Idzinga, Marieke Spaan, and Marjolein Homs for their help during data collection. We also thank the participants and the nurses as well as the kitchen staff, especially Mr. Pinkster and Mr. Hardeman of the nursing home Rustenburg for their cooperation in this study.

Address correspondence to Cees de Graaf, Division of Human Nutrition and Epidemiology, Wageningen University, Dreijenlaan 1, 6703 HA Wageningen, The Netherlands. E-mail: Kees.deGraaf@staff.nutepi.wau.nl

References

1. Lowik MR, van den Berg H, Schrijver J, Odink J, Wedel M, Van Houten P. Marginal nutritional status among institutionalized elderly women as compared to those living more independently (Dutch Nutrition Surveillance System). *J Am Coll Nutr.* 1992;11:673–681.
2. van der Wielen RP, van Heereveld HA, de Groot CP, Van Staveren WA. Nutritional status of elderly female nursing home residents: the effect of supplementation with a physiological dose of water-soluble vitamins. *Eur J Clin Nutr.* 1995;49:665–674.
3. Murden RA, Ainslie NK. Recent weight loss is related to short-term mortality in nursing homes. *J Gen Intern Med.* 1994;9:648–650.
4. Blaum CS, Fries BE, Fiatarone MA. Factors associated with low body mass index and weight loss in nursing home residents. *J Gerontol Med Sci.* 1995;50A:M162–M168.
5. Sullivan DH. Impact of nutritional status on health outcomes of nursing home residents. *J Am Geriatr Soc.* 1995;43:195–196.
6. Morley JE, Silver AJ. Nutritional issues in nursing home care. *Ann Intern Med.* 1995;123:850–859.
7. Marcus EL, Berry EM. Refusal to eat in the elderly. *Nutr Rev.* 1998; 56:163–171.
8. Hetherington MM. Taste and appetite regulation in the elderly. *Proc Nutr Soc.* 1998;57:625–631.
9. Schiffman SS. Perception of taste and smell in elderly persons. *Crit Rev Food Sci Nutr.* 1993;33:17–26.
10. Zandstra EH, de Graaf C. Sensory perception and pleasantness of orange beverages from childhood to old age. *Food Quality Preference*. 1998;35:7–12.
11. Griep MI, Mets TF, Vercruysse A, et al. Food odor thresholds in relation to age, nutritional, and health status. *J Gerontol Biol Sci.* 1995; 50A:B407–B414.
12. Griep MI, Verleye G, Franck AH, Collys K, Mets TF, Massart DL. Variation in nutrient intake with dental status, age and odour perception. *Eur J Clin Nutr.* 1996;50:816–825.

Downloaded from http://biomedgerontology.oxfordjournals.org/ at Oxford Journals on September 22, 2015

13. de Jong N, de Graaf C, Van Staveren W. Effect of sucrose in breakfast items on pleasantness and food intake in the elderly. *Physiol Behav.* 1996;60:1453–1462.
14. Rolls BJ. Appetite and satiety in the elderly. *Nutr Rev.* 1994;52:S9–S10.
15. Rolls BJ. Do chemosensory changes influence food intake in the elderly? *Physiol Behav.* 1999;66:193–197.
16. Drewnowski A. Taste preferences and food intake. *Annu Rev Nutr.* 1997;17:237–253.
17. Drewnowski A, Henderson SA, Driscoll A, Rolls BJ. The Dietary Variety Score: assessing diet quality in healthy young and older adults. *J Am Diet Assoc.* 1997;97:266–271.
18. de Jong N, Mulder I, de Graaf C, Van Staveren WA. Impaired sensory functioning in elders: the relation with its potential determinants and nutritional intake. *J Gerontol Biol Sci.* 1999;54A:B324–B331.
19. Schiffman SS, Warwick ZS. Effect of flavor enhancement of foods for the elderly on nutritional status: food intake, biochemical indices, and anthropometric measures. *Physiol Behav.* 1993;53:395–402.
20. Ribbe MW, van-Mens JT, Frijters DH. [Characteristics of patients during their stay in a nursing home and at discharge.] *Ned Tijdschr Geneeskd.* 1995;139:123–127.
21. Berkhout AM, Cools HJ, Mulder JD. [Measurement or estimation of body length in older nursing home patients.] *Tijdschr Gerontol Geriatr.* 1989;20:211–214.
22. Donders-Engelen MR, Van Der Heijden L. Hulshof KFAM R. Maten, gewichten and codenummers 1997 [Food portion sizes and coding instructions 1997]. 1997 ed. Zeist, The Netherlands: TNO, 1997.
23. Cameron M, Van Staveren W. Manual on the methodology of food consumption studies. Oxford, England: Oxford University Press, 1988.
24. Anonymous. NEVO 1997. Stichting Nederlands voedingsstoffenbestand. Dutch Nutrient Database 1997. The Hague, The Netherlands: Voorlichtingsbureau voor de voeding; 1997.
25. Yesavage JA. Geriatric Depression Scale. *Psychopharmacol Bull.* 1988;24:709–711.
26. SAS Institute Inc. SAS/Stat User's Guide. Version 6. 4th ed. Cary, NC: SAS Institute; 1989.
27. Bellisle F, Monneuse MO, Chabert M, Larue AC, Lanteaume MT, Louis SJ. Monosodium glutamate as a palatability enhancer in the European diet. *Physiol Behav.* 1991;49:869–873.
28. Schiffman SS, Warwick ZS. Flavor enhancement of foods for the elderly can reverse anorexia. *Neurobiol Aging.* 1988;9:24–26.
29. de Jong N, Chin a Paw J, de Groot LC, de Graaf C, Kok FJ, Van Staveren WA. Functional biochemical and nutrient indices in frail elderly people are partly affected by dietary supplements but not by exercise. *J Nutr.* 1999;129:2028–2036.
30. Berkhout AM. [Limitations in feeding behavior in nursing home patients] (in Dutch). *Tijdschr Gerontol Geriatr.* 1996;27:62–66.
31. de Groot C, Perdigao AL, Deurenberg P. Longitudinal changes in anthropometric characteristics of elderly Europeans. SENECA Investigators. *Eur J Clin Nutr.* 1996;50(suppl 2):S9–S15.
32. Blundell JE. Understanding anorexia in the elderly: formulating biopsychological research strategies. *Neurobiol Aging.* 1988;9:18–20.
33. Morley JE. Anorexia of aging: physiologic and pathologic. *Am J Clin Nutr.* 1997;66:760–773.
34. Schiffman SS, Warwick ZS. Use of flavor-amplified foods to improve nutritional status in elderly patients. *Ann NY Acad Sci.* 1989;561:267–276.
35. Anonymous. NEVO 1998. Stichting Nederlands voedingsstoffenbestand. Dutch Nutrient Database 1998. The Hague, The Netherlands: Voorlichtingsbureau voor de voeding; 1998.
36. Schiffman SS, Sattely ME, Zimmerman IA, Graham BG, Erickson RP. Taste perception of monosodium glutamate (MSG) in foods in young and elderly subjects. *Physiol Behav.* 1994;56:265–275.
37. Bellisle F. Effects of monosodium glutamate on human food palatability. *Ann NY Acad Sci.* 1998;855:438–441.
38. Bellisle F. Glutamate and the UMAMI taste: sensory, metabolic, nutritional and behavioural considerations: a review of the literature published in the last 10 years. *Neurosci Biobehav Rev.* 1999;23:423–438.
39. Schiffman SS, Warwick ZS. Flavor enhancement of foods for the elderly can reverse anorexia. *Neurobiol Aging.* 1988;9: 24–26.

Received September 1, 2000
Accepted September 8, 2000
Decision Editor: John E. Morley, MB, BCh

KRONOS INSTITUTE SYMPOSIUM
July 18-21, 2001
Bar Harbor, ME

Leading investigators discussing recent developments in aging and age-related diseases

Themes

Estrogen Effects On The Brain

Phyllis Wise, Ph.D.
Professor & Chair
Department Physiology
U. Kentucky School of Medicine

James Simpkins, Ph.D.
Professor & Chair
Dept. Pharmacology & Neuroscience
U. of N. Texas Health Science Center

J. Galen Buckwalter, Ph.D.
Senior Research Scientist
California Kaiser Permanente
University of Southern California

Pauline Maki, Ph.D.
Senior Staff Fellow
Personality & Cognition Lab, IRP
National Institute on Aging, NIH

Cardiovascular Risk And Metabolism

Gerald Reaven, M.D.
Professor of Medicine
Division Cardiovascular Medicine
Stanford Medical Center

Peter Reaven, M.D.
Director, Diabetes Research
Endocrine, Metabolism & Nutrition
Carl T. Hayden VA Hospital

David Herrington, M.D.
Associate Professor
Internal Medicine/Cardiology
Wake Forest U. School of Medicine

For more information contact:
M. Carol Jackson
Kronos Longevity Research Institute
Tel: 602-778-7499 Email: jackson@kronosinstitute.org

Downloaded from http://biomedgerontology.oxfordjournals.org/ at Oxford Journals on September 22, 2015