Aging & Appetite

Social and physiological approaches in the elderly

Marie-Françoise A.M. Mathey

Promotor: Dr. W. A. van Staveren
Hoogleraar in de voeding van oudere mens

Co-promotor: Dr. C de Graaf
Universitair docent

Afdeling Humane Voeding & Epidemiologie
Wageningen Universiteit

Aging & Appetite

Social and physiological approaches in the elderly

Marie-Françoise A.M. Mathey

Proefschrift
Ter verkrijging van de graad van doctor
op gezag van de Rector Magnificus
van Wageningen Universiteit,
Dr. Ir. L. Speelman,
in het openbaar te verdedigen
op woensdag 6 september 2000
des namiddags te vier uur in de Aula
van Wageningen Universiteit

The studies described in this thesis were partly funded by the 'Stichting Voeding Gezondheid en Ouderen', Wageningen, the Netherlands.
The studies were part of the research program of the graduate school VLAG.

Financial support for the publication of this thesis by the Wageningen University is gratefully acknowledged.

Mathey, Marie-Françoise A.M.

Aging & Appetite. Social and physiological approaches in the elderly.
Thesis Wageningen University- With ref.- With summary in Dutch and French.

ISBN 90-5808-270-9

Cover design: " et je dois encore penser a tout ca?!", Marie-Françoise Mathey

Printing: Grafisch Service Centrum Van Gils B.V., Wageningen, the Netherlands

Stellingen - Theorems - Théorèmes

1. Individualised nutritional care does improve nutritional status in institutionalised elderly residents and therefore should be a right for all care-depending elderly people *(o.a. dit proefschrift)*.

2. Ambience of food consumption is an important determinant of dietary intake in institutionalised elderly residents *(o.a. dit proefschrift)*.

3. Sufficient individualised care in elderly institutions is not a finance-related but a management-related issue *(o.a. dit proefschrift)*.

4. Monitoring body weight is a reliable indicator of nutritional status in institutionalised elderly and should be used as a screening tool to prevent weight loss *(o.a. dit proefschrift)*.

5. Scientific truth, which I formerly thought of as fixed, as though it could be weighed and measured, is changeable. Add a fact, change the outlook, and you have a new truth. Truth is a constant variable. We seek it, we find it, our viewpoint changes, and the truth changes to meet it
William J. Mayo (1861-1939).

6. How far you go in life depends on your being tender with the young, compassionate with the aged, sympathetic with the striving, and tolerant of the weak and strong, because someday in life, you will have been all of these things
George Washington Carver (1864-1943).

7. Colette avait raison : il est incroyable de constater que dans une société aisée il n'y a pas de nourriture pour ses personnes âgées et pas de travail pour ses apprentis.

8. Senescence begins, and middle age ends,
The day your descendants outnumber your friends
Odgen Nash (1964).

9. "Celui qui est toujours sage, mène une vie lamentable"
CANDIDE, Voltaire (1757).

10. Au bouquet on juge le vin ; à l'odeur, la fleur ; au langage, l'homme.

11. "Je me presse de rire de tout, de peur d'être oblige d'en pleurer"
Beaumarchais (1732-1799).

12. Werken met een buitenlandse taal is accepteren om niet honderd procent van je capaciteiten te kunnen gebruiken.

Stellingen behorende bij het proefschrift
Appetite & Aging
Social and physiological approaches in the elderly
Marie-Françoise A.M. Mathey. Wageningen, 6 september 2000

A la mémoire de Jean Mathey

Abstract

Aging & Appetite: Social and physiological approaches in the elderly

Ph.D.-thesis by Marie-Françoise A.M. Mathey, Division of Human Nutrition & Epidemiology, Wageningen University, the Netherlands. September 6, 2000.

Aging is often accompanied by anorexia of aging, described as a decline in appetite, a lower dietary intake and followed by unexplained weight loss. The present thesis describes research on anorexia of aging. Focus was given to social and physiological determinants of appetite and the relationship with dietary intake and/or body weight was examined in observation as well as in intervention studies.

Results showed first that appetite and the extent to which food is enjoyed, varied greatly between elderly people. These differences may be explained by differences in the health characteristics of the elderly groups studied. Second, social and environmental factors remained important determinants of appetite, more especially in elderly with an unstable or poor health condition. Further, the incapacity to adjust energy intake to physiological challenges on long-term seems to be a non-reversible process. In daily practice, this lack of regulation suggests that the consumption of energy and nutrient dense supplements between meal could help to prevent weight loss in older adults at risk.

In conclusion, the properties of foods and the context in which the foods are consumed remain important determinants of dietary intake in the elderly and are thereby major risk factors for anorexia of aging and its subsequent weight loss. From a public health perspective, the lack of regulation in appetite and dietary intake should encourage the use and consumption of nutritional interventions in elderly at risk.

Contents

Chapter 1	General introduction	11
Chapter 2	Assessing appetite in Dutch elderly with the Appetite, Hunger feelings and Sensory Perception (AHSP) questionnaire	23
Chapter 3	Social and physiological factors affecting food intake in elderly subjects: an experimental comparative study	33
Chapter 4	Health effect of improved meal ambiance in a Dutch nursing home: a one-year intervention study	47
Chapter 5	Effect of an evening supplement provided to nursing-home elderly on body weight and dietary intake	63
Chapter 6	Flavor enhancement of food improves dietary intake and nutritional status of nursing home elderly	75
Chapter 7	General discussion	89

Summary	105
Résumé	109
Samenvatting	113
Remerciements	117
About the author	120

1

General Introduction

The worldwide raising number of people aged of 65 and over is well documented (1;2). This growing number is the consequence of two phenomena, an increased absolute number and an average longer life expectancy (Table 1). As a consequence the elderly represent a substantial segment of the European population.

Table1: Evolution of the European elderly population in the last 10 years

	Life expectancy at birth (y)				% of the population aged ≥65 y old	
	In 1990		In 1999		In 1990	In 1999
Country	M	F	M	F	M+F	M+F
France	72.7	80.9	74.6	82.3	14	15.4
The Netherlands	73.8	80.1	74.6	80.4	13	13.4
European Union	73.0	80.0	74.0	81.0	14	15.8

Based on references (1;2) (M=male, F=female)

Aging is known as "a process that converts healthy individuals into frail ones, with diminished reserves in most physical systems and an exponentially increasing vulnerability to most diseases and death"(3). Thus the growing number of elderly inevitably leads to an increased demand of health care and attention for this group of the population.

The elderly population

Different human beings age at a different rate, implying that a so chronological age is not necessarily equal to biological age. Aging has been described as a complex system (3) influenced by a large number of internal and external factors (Fig 1).
Therefore apart from a chronological description the elderly population has often been classified according to their health status (4-7):
-*successful agers* are independently living and present little or almost no loss of functioning that could defined as aging *per se*,
-*usual agers* are independently living with a variety of medical conditions and
-*accelerated agers* carrying an heavy burden of chronic diseases and disabilities most of them residing in institutions. This classification highlights the heterogeneity of the elderly population.

In all agers an adequate dietary intake has well been recognized as a necessary factor in improving longevity (8), maintaining good health (9) and quality of life (10). Aging is associated with many social and physiological changes (11;12), which may negatively influence energy and nutrient use. Besides, simply consuming enough food may become a major issue for older people (13).

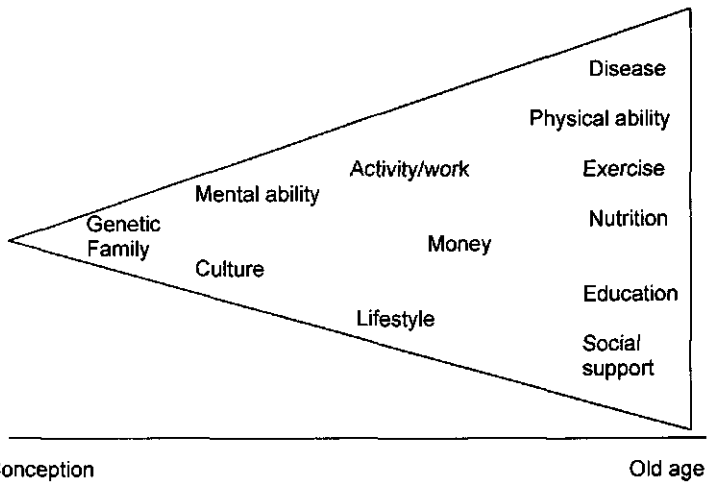

Figure 1: Diversity of factors influencing aging from young to old age

Both European and American health surveys showed that at the age of 65-70 y and beyond body weight tends to decrease, even in healthy individuals (5;14-18). This involuntary unexplained weight loss in later life increases the risk of protein-energy malnutrition, micronutrient deficiencies and nutrition-related illnesses and is associated with frailty and increased morbidity (19).
Intervention studies in the elderly showed that this loss of body weight would result from a dysrégulation of the ability to regulate food intake i.e., a decline in appetite control (20-22) and energy balance (23). This loss of ability makes it difficult to compensate for the day to day fluctuation in dietary intake and subsequently may lead to malnutrition and unintentional weight loss.

Appetite

Appetite is defined as the process, which directs eating and guides the moment-to-moment selection and intake of foods (24). The control of food intake also occurs at different levels: -social, psychological and physiological.

Eating is not only a biological action; it has also social, cultural and symbolic meanings (25). Therefore social, physical and environmental (=non-physiological) factors are also important determinants of appetite and food intake. As an example, physical and sensory aspects of food such as color, form, texture, crispiness, smell are relevant parameters for food choice and consumption (26). These parameters promote signals preceding the ingestion of food and will stimulate the 'cephalic phase of appetite'. The cephalic phase generates responses in the gastro-intestinal tract to anticipate the ingestion and digestion of food (27).

Meals may often be the only time when a family is together. Eating with family and/or friends has been found to have a positive effect on appetite (28-30). Studies showed that social facilitation i.e., eating more in the presence of others occurs in the presence of family and friends but not with strangers and is mainly mediated by meal duration (31).

During and immediately after eating, afferent information from the ingested food provides the major control on appetite. Several physiological determinants intervene in the process of energy and nutrient intake. They primarily provide positive feedback for eating when food is acting in the mouth (sensory and cognitive phases). Secondly they provide negative feedback information when food reaches the stomach, the small intestine and the blood flow (postprandial and post-absorptive phases) leading first to satiation, the process which terminates eating within a meal and then to satiety, the state which inhibits further eating (24; 32).

As an example, taste and smell perception is a key determinant of the palatability of foods (33) and represents a major factor of the sensory-specific satiety. The latter has been defined as a progressive decrease in pleasantness of a particular food following consumption (34). Sensory-specific satiety is associated with a decrease in consumption of the previously eaten food and a shift to other foods hereby promoting intake of a wider variety of foods and a nutritionally balanced diet (33; 35).

The gastro-intestinal tract has chemo-and mechano-receptors, which will monitor the physiological activity following the food intake and then pass the information to the brain through the vagus nerve (24). This information is translated into brain neurochemical activity and forms part of the post-ingestive control of appetite.

The resulting brain activity involving a large number of neurotransmitters, neuromodulators, pathways and receptors determines the strength of motivation, the pattern of behavioral events (36-38) and the willingness to start or stop eating (24).

With aging, this complex system may be affected, leading to an appetite dysrégulation, which would promote an inadequate dietary intake and subsequent involuntary weight loss.

Appetite dysrégulation: Anorexia of aging

The loss of appetite occurring with age or so-called anorexia of aging has been defined by Morley and Silver (39) as "the physiological decrease in food intake occurring to counterbalance reduced physical activity and lower metabolic rate, not compensated in the long term". The main consequence of this loss of appetite is unintentional weight loss, which is an important predictor for mortality (14; 17; 40-42). Anorexia of aging has many potential causative parameters that may be divided in three groups: social and environmental, psychological, and physiological and medical parameters.

Social and environmental parameters

Retirement leads to changes in life habits and daily rhythm but also to a reduced household income. Poverty or low income has been cited as one of the major social causes for a lower food intake (43).

With advancing age, remarkable loss of functioning such as decreased physical ability, visual and hearing impairments occurred (44). Consequently it becomes more difficult for an elderly person to perform basic daily activities such as shopping/ buying the desired food, cooking and feeding oneself (45). Besides, limited physical ability and/or the need of assistance for daily activities may restrain the social network. The latter may result hereby resulting in isolation within a neighborhood and no company during meals (46; 47).

Psychological parameters

Mental disorders have been estimated to be responsible for the major parts of psychological causes of anorexia of aging and unintentional weight loss, especially in nursing home elderly (48).

An important psychological parameter, bereavement is induced by the loss of spouse or widowhood, which often eventuates in social isolation and loneliness (43; 49). This latter may eventually make the elderly person feel an overwhelming burden of life (43) and lead to depression.

Depression has been found to be the most common cause of weight loss in medical outpatients and nursing home elderly residents (50). In this regard food might be used as a weapon, a kind of subconscious wish of death (44; 51).
Dementia or cognitive impairment is also a frequent cause of decline in dietary intake and weight loss since subjects can simply forget to eat (49; 52). It seems difficult to determine the reasons for a decrease in appetite. Potentially it may be caused by indifference or lack of concern about eating, memory loss and impairment of judgment i.e., inability to recognize the need to eat. Recently it has been suggested that dementia might also be paired with an increased hunger and absence of satiation. This disturbance of the internal appetite regulation might result in hypo- or hyperphagia (53; 54).

Physiological and medical parameters
Aging is paired with the occurrence of pathological and physiological variations.
Age-related physiological changes influencing food intake are a decreased basal metabolic rate due to a decline in fat free mass or sarcopenia (55) and a variation in gut hormonal responses and secretion (11; 12; 21). These changes may lower gastric emptying and appetite response to meal intake challenges resulting in an early satiety and a subsequent overall decline of food intake.
Dysfunction of taste and smell senses, caused by normal aging as well as certain disease state may affect the palatability and hedonic responses to foods (56-62). This loss of sensory perception paired with a diminished sensory-specific satiety may limit both variety and quantity of foods consumed.
Numerous infections and medical disorders, both acute and chronic can produce anorexia (49; 63). A number of these disorders lead to inflammation and cytokines production resulting in a lower appetite (64). Cancer, AIDS, cardiac and geriatric cachexia are related to severe loss of appetite and food aversions generally resulting in excessive wasting (43; 49).
Disease-related changes such as decreased mobility secondary to cerebrovascular disorders or meal-induced dyspnea in chronic obstructive pulmonary disease also promote loss of appetite(44).
Intake of medication may influence the endogenous opiate regulation of appetite anorexigenic effect. Drug intake can also adversely affect appetite and dietary intake by causing nausea and vomiting as well as altering taste and smell senses (43; 59).

Anorexia of aging makes it difficult for an elderly person to respond to environmental changes and maintaining an internal state. It therefore contributes to unintentional weight loss.

Involuntary weight loss

At the age of 65-70 and beyond, both loss of lean body mass (sarcopenia), and decline of fat body mass result in a decline in total body mass (40). These changes have been documented in both cross-sectional and longitudinal surveys (14; 17; 40; 65). Unintentional weight loss has been found to happen in both institutionalized and non-institutionalized elderly and is associated with physiological, psychological and immunologic consequences, regardless of the underlying causes (48; 64; 66-68). This weight loss increases the risk of protein-energy malnutrition and dangerous underweight in the elderly, more especially in nursing home residents. Among free-living frail elders, weight loss was shown to be a predictor of early mortality after controlling for smoking, and functional and health status indicators (69). These findings confirmed the important role of losing weight as a major risk factor for the downward spiral leading to frailty and mortality. Involuntary weight loss of 4-10 % of original body weight has been found to be an important predictor of morbidity and mortality (41; 42; 70; 71).

Rationale

The etiology of weight loss occurring with old age is, as explained above, multifactorial and in this regard, anorexia of aging seems to be a key issue. Therefore the aim of this thesis is to examine the potential link existing between the determinants of appetite, dietary intake and body weight in older adults.

Outline of the thesis

In the present thesis both social and physiological factors were investigated as major determinants of the regulation of appetite. This was realized in both short-term and long-term studies in elderly subjects.

Chapter 2 presents an in depth cross-sectional observation study on possible differences in self -assessment of appetite feelings in three health categories of elderly.

Chapter 3 presents a study on short-term regulation of appetite and dietary intake in free-living elderly. In this study a social (environmental) manipulation was combined

with a physiological manipulation consisting of preload-test meal design in order to investigate the role of social facilitation and of energetic and nutrient challenges on appetite control and food intake.

Long-term regulation of appetite i.e. body weight maintenance (or weight loss prevention) was assessed in three intervention studies conducted in nursing home. This category of people was chosen for these three studies since we expected that the dietary intake of these people would be low as a consequence of a poor appetite. In *Chapter 4*, the long-term effects of a changed environment and atmosphere on appetite and health were explored in a Dutch nursing home. Since social support and physical environment have been reported as some of the major reasons for a decrease in dietary intake in nursing home residents, a one-year intervention with an improved ambiance of food consumption was conducted.

Chapter 5 describes the effects of a 4-week supplementation with an evening energy rich drink on the dietary intake and body weight of nursing home elderly residents.

In *chapter 6*, the influence of a 16-week intervention with or without added flavor enhancers on appetite, dietary intake and body weight is presented.

Finally, in *chapter 7*, the main findings are summarized; methodological problems, conclusions and implications are discussed.

References

1. INED. Population & sociétés. bulletin mensuel d'information de l'INED (282). 1993.

2. INED. population & sociétés. bulletin mensuel d'information de l'INED (348). 1999.

3. Miller R. The biology of aging and longevity. In: Hazzard W, Bierman E, Blass J, Ettinger W, Halter J, Andres R, eds. Principles of geriatric medicine and gerontology. 3rd Ed. New York: Mc Graw-Hill, Inc., 1994:3-18.

4. Rowe JW, Kahn RL. Human aging: usual and successful. Science 1987;237:143-149.

5. Diehr P, Bild DE, Harris TB, Duxbury A, Siscovick D, Rossi M. Body mass index and mortality in nonsmoking older adults: the Cardiovascular Health Study. Am.J.Public Health 1998;88:623-629.

6. van der Wielen, RPJ. Vitamin intake and status in elderly Europeans. 1-167. 1995. Department of Human Nutrition, Wageningen Agricultural University, the Netherlands .

7. de Jong, N. Sensible aging, nutrient dense foods and physical exercise for the vulnerable elderly. 1-191. 1999. Department of Human Nutrition & Epidemiology, Wageningen University, The Netherlands.

8. de Groot L, Van Staveren W, Burema J. Survival beyond age 70 in relation to diet. Nutr Rev 1996;54:211-212.

9. Sullivan DH. Impact of nutritional status on health outcomes of nursing home residents. J Am Geriatr.Soc 1995;43:195-196.

10. Vetta F, Ronzoni S, Taglieri G, Bollea MR. The impact of malnutrition on the quality of life in the elderly. Clin.Nutr. 1999;18:259-267.

11. Cook CG, Andrews JM, Jones KL, et al. Effects of small intestinal nutrient infusion on appetite and pyloric motility are modified by age. Am J Physiol. 1997;273:R755-R761

12. Lovat LB. Age related changes in gut physiology and nutritional status. Gut 1996;38:306-309.

13. Stitt S, O'Connell C, Grant D. Old, poor & malnourished. Nutr Health 1995;10:135-154.

14. Cornoni-Huntley JC, Harris TB, Everett DF, et al. An overview of body weight of older persons, including the impact on mortality. The National Health and Nutrition Examination Survey I--Epidemiologic Follow-up Study. J.Clin.Epidemiol. 1991;44:743-753.

15. Allison DB, Gallagher D , Heo M, Pi SF, Heymsfield SB. Body mass index and all-cause mortality among people age 70 and over: the Longitudinal Study of Aging. Int J Obes.Relat.Metab Disord. 1997;21:424-431.

16. 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:S9-15.

17. Lehmann AB, Bassey EJ. Longitudinal weight changes over four years and associated health factors in 629 men and women aged over 65. Eur J Clin Nutr 1996;50:6-11.

18. Fischer J, Johnson MA. Low body weight and weight loss in the aged. J Am Diet Assoc. 1990;90:1697-1706.

19. Mowe M, Bohmer T. Nutrition problems among home-living elderly people may lead to disease and hospitalization. Nutr Rev 1996; 54:S22-S24

20. Rolls BJ, Dimeo KA, Shide DJ. Age-related impairments in the regulation of food intake. Am J Clin Nutr 1995;62:923-931.

21. Clarkston WK, Pantano MM, Morley JE, Horowitz M, Littlefield JM, Burton FR. Evidence for the anorexia of aging: gastrointestinal transit and hunger in healthy elderly vs. young adults. Am J Physiol. 1997;272:R243-R248

22. Zandstra E, Mathey M-F, de Graaf C, Van Staveren W. Short-term regulation of food intake in children, young adults and the elderly. European Journal of Clinical Nutrition 2000;54:239-246.

23. Roberts SB, Fuss P, Heyman MB, et al. Control of food intake in older men. JAMA 1994;272:1601-1606.

24. Blundell JE. the biology of appetite. Clin Appl Nutr 1991;1:21-31.

25. Rogers PJ. Eating habits and appetite control: a psychobiological perspective. Proc.Nutr.Soc. 1999;58:59-67.

26. Drewnowski A. Taste preferences and food intake. Annu.Rev.Nutr. 1997; 17:237-253.

27. Blundell JE, Halford JC . Regulation of nutrient supply: the brain and appetite control. Proc Nutr Soc 1994;53:407-418.

28. De Castro JM. Social facilitation of the spontaneous meal size of humans occurs on both weekdays and weekends. Physiol.Behav. 1991;49:1289-1291.

29. De Castro JM, Brewer EM . The amount eaten in meals by humans is a power function of the number of people present. Physiol.Behav. 1992;51:121-125.

30. De Castro JM. Family and friends produce greater social facilitation of food intake than other companions. Physiol.Behav. 1994;56:445-445.

31. Feunekes GI, De Graaf C., Van Staveren WA. Social facilitation of food intake is mediated by meal duration. Physiol.Behav. 1995;58:551-558.

32. Stubbs RJ. Nutrition Society Medal Lecture. Appetite, feeding behaviour and energy balance in human subjects. Proc Nutr Soc 1998;57:341-356.

33. Guinard JX, Brun P. Sensory-specific satiety: comparison of taste and texture effects. Appetite. 1998;31:141-157.

34. Rolls BJ. Sensory-specific satiety. Nutr Rev 1986;44:93-101.

35. Lozano DI, Crites SL, Aikman SN. Changes in food attitudes as a function of hunger. Appetite 1999;32:207-218.

36. Westerterp-Plantenga M. Eating behavior in humans, characterized by cumulative food intake curves - a review. Neurosci.Biobehav.Rev 2000;24:239-248.

37. James WP, McNeill G, Ralph A. Metabolism and nutritional adaptation to altered intakes of energy substrates. Am.J.Clin.Nutr. 1990;51:264-269.

38. Hirsch J, Hudgins LC, Leibel RL, Rosenbaum M. Diet composition and energy balance in humans. Am.J.Clin.Nutr. 1998;67:551S-555S.

39. Morley JE, Silver AJ. Anorexia in the elderly. Neurobiol.Aging 1988;9:9-16.

40. Mattila K, Haavisto M, Rajala S. Body mass index and mortality in the elderly. Br.Med.J.Clin.Res.Ed. 1986;292:867-868.

41. Murden RA, Ainslie NK. Recent weight loss is related to short-term mortality in nursing homes. J Gen.Intern Med 1994;9:648-650.

42. Berkhout AM, van HJ, Cools HJ. [Increased chance of dying among nursing home patients with lower body weight](in Dutch). Ned Tijdschr Geneeskd 1997;141:2184-2188.

43. Morley JE. Anorexia in older persons: epidemiology and optimal treatment. Drugs Aging 1996;8:134-155.

44. Morley JE, Silver AJ, Fiatarone M, Mooradian AD. Geriatric grand rounds: nutrition and the elderly. University of California, Los Angeles [clinical conference]. J Am Geriatr.Soc 1986;34:823-832.

45. Keller HH, Ostbye T, Bright SE. Dietary habits of seniors with some activity limitations. Can J Diet Pract Res. 1999;60:214-221.

46. Goodwin JS. Geriatric ideology: the myth of the myth of senility. J Am Geriatr.Soc 1991;39:627-631.

47. Goodwin JS. social, psychological and physical factors affecting the nutritional status of elderly subjects: separating cause and effect. Am J Clin Nutr 1989;50:1201-1209.

48. Morley JE, Kraenzle D. Causes of weight loss in a community nursing home. J Am Geriatr.Soc 1994;42:583-585.

49. Morley JE. Anorexia of aging: physiologic and pathologic. Am J Clin Nutr 1997;66:760-773.

50. Wilson MM, Vaswani S, Liu D, Morley JE, Miller DK. Prevalence and causes of undernutrition in medical outpatients. Am.J.Med. 1998;104:56-63.

51. Silver AJ, Morley JE, Strome LS, Jones D, Vickers L. Nutritional status in an academic nursing home. J Am Geriatr.Soc 1988;36:487-491.

52. Marcus EL, Berry EM. Refusal to eat in the elderly. Nutr Rev 1998;56:163-171.

53. Keene J, Hope T, Rogers PJ, Elliman NA. An investigation of satiety in ageing, dementia, and hyperphagia. Int J Eat.Disord. 1998;23:409-418.

54. Keene JM, Hope T. Hyperphagia in dementia: 2. Food choices and their macronutrient contents in hyperphagia, dementia and ageing. Appetite 1997;28:167-175.

55. Visser, M. body composition and energy metabolism in elderly people. 6-9-1995. Department of Human Nutrition, Wageningen Agricultural University, the Netherlands .

56. Wysocki CJ, Pelchat ML. The effects of aging on the human sense of smell and its relationship to food choice. Crit.Rev Food Sci Nutr 1993;33:63-82.

57. Clydesdale FM. Changes in color and flavor and their effect on sensory perception in the elderly. Nutr Rev 1994;52:S19-S20

58. Schiffman SS. Perception of taste and smell in elderly persons. Crit.Rev.Food Sci.Nutr. 1993;33:17-26.

59. Schiffman SS. Taste and smell losses in normal aging and disease. JAMA 1997;278:1357-1362.

60. Rolls BJ, McDermott TM. Effects of age on sensory-specific satiety. Am J Clin Nutr 1991;54:988-996.

61. Rolls BJ. Do chemosensory changes influence food intake in the elderly? Physiol.Behav. 1999;66:193-197.

62. De Graaf C, Polet P, Van Staveren W. Sensory perception and pleasantness of food flavors in elderly subjects. J Gerontol 1994;49:93-99.

63. Lesourd B. Protein undernutrition as the major cause of decreased immune function in the elderly: clinical and functional implications. Nutr Rev 1995;53:S86-S91

64. Yeh SS, Schuster MW. Geriatric cachexia: the role of cytokines. Am.J.Clin.Nutr. 1999;70:183-197.

65. Matthews LE. Monitoring weight changes in nursing home residents. J Nutr Elder. 1989;9:67-72.

66. Blaum CS, Fries BE, Fiatarone MA. Factors associated with low body mass index and weight loss in nursing home residents. J Gerontol A Biol Sci Med Sci 1995;50:M162-M168

67. Fabiny AR, Kiel DP. Assessing and treating weight loss in nursing home patients. Clin Geriatr.Med 1997;13:737-751.

68. Morley JE, Silver AJ. Nutritional issues in nursing home care. Ann.Intern Med 1995;123:850-859.

69. Payette H, Coulombe C, Boutier V, Gray-Donald K. weight loss and mortality among frail living elders: a prospective study. J Gerontol A Biol Sci Med Sci 1999;54:M440-M445

70. Allison DB, Zannolli R, Faith MS, et al. Weight loss increases and fat loss decreases all-cause mortality rate: results from two independent cohort studies. Int J Obes 1999;23:603-611.

71. Wallace JI, Schwartz RS , LaCroix AZ, Uhlmann RF, Pearlman RA. Involuntary weight loss in older outpatients: incidence and clinical significance. J.Am.Geriatr.Soc. 1995;43:329-337.

2

Assessing appetite in Dutch elderly with the Appetite, Hunger and Sensory Perception (AHSP) questionnaire*

Marie-Françoise A.M. Mathey, Nynke de Jong, Lisette C.P.G.M. de Groot,
Cees de Graaf and Wija A. van Staveren

Abstract

Background: In investigating anorexia of ageing attention is often given to physical and psychological determinants of appetite in elderly but little has been done to provide information on self-assessment of appetite and sensory perceptions in the elderly.

Objectives: to provide data and detect possible differences in self-assessment of appetite, hunger feelings and sensory perception in different health group of elderly using the Appetite, Hunger feelings and Sensory Perception (AHSP) questionnaire.

Methods: three health categories of elderly subjects were used for the present study: free-living with no help, free-living with help and nursing home elderly. For each group, collected data were general characteristics, anthropometry and answers to the AHSP. The AHSP questionnaire includes 29-items focusing on feelings of hunger and appetite as well as taste and smell perception addressing both the present situation and the period before retirement.

Results: Significant differences were observed between the 3 health groups for appetite, hunger feelings, present taste perception and present smell perception ($P<0.05$). Appetite and hunger were found to be related to body weight in the healthiest but not in the others.

Conclusion: A decline in health status is paired with a decrease in appetite, hunger feelings and sensory perceptions of elderly subjects.

*submitted

Introduction

Poor dietary intake and weight loss as well as nutrition-related acute or chronic illnesses in elderly people have been described in many cross-sectional as well as longitudinal studies (1-6). Still the question remains what comes first: either the disease or inadequate nutrition. Loss of appetite may be an early indicator of 'anorexia of ageing' leading to malnourishment, especially in the frail elderly (7) (8). Therefore it seems important to have a good tool to assess appetite in the elderly.

In investigating this 'anorexia of ageing' attention is often given to physical and psychological determinants of appetite in elderly subjects (7) but only a few studies have focused on the validity and reliability of the elderly 'self-assessment of appetite and sensory perceptions (9;10). Different questionnaires have been developed but they mainly focused on eating pattern or attitude and frequency of eating rather than on feelings of hunger and appetite combined with sensory perception (11). Until now only the Mini Nutritional Assessment gave slightly insight in appetite feelings (10). However its major aim was to determine nutritional risks rather than self-evaluation of hunger and appetite.

De Jong (12) developed a survey-convenient tool for estimating appetite and hunger feelings as well as taste and smell perception in the elderly: the Appetite, Hunger and Sensory Perception (AHSP) questionnaire. This tool was firstly tested against a taste Perception test and a smell identification test based on the Connecticut Chemosensory Clinical research center (CCCRC) test (13) and secondly more in depth against energy intake (9). Results showed a relatively high internal validity and a good reliability of this tool compared to the other outcome measures and provided accurate descriptive data on elderly self-assessment of appetite.

In the present study we further examined this newly developed tool: the Appetite, Hunger and Sensory Perception (AHSP) questionnaire. The objective of the present study was to determine whether or not this questionnaire would be able to distinguish differences of feelings of appetite and hunger and sensory perception between three elderly categories differing in health status: -healthy independently living, -frail independently living and -nursing home residents.

Methods

Study population

Data used for the present analyses were derived from three different studies: two intervention studies and one observational study. For all subjects, general characteristics were collected on age, gender, number of diseases, and dental status.

SENECA population: free-living without help

In 1999, the final part of the Survey in Europe on Nutrition and the Elderly, a Concerted Action (SENECA) study took place (14). In 7 countries participating in the final study, the protocol included the AHSP questionnaire to give indications on appetite self-assessment in successful agers. Data for the current analyses were collected from a random age-stratified population of elderly men and women including 84 Dutch subjects. All subjects were recruited in 1988-89 using the following criteria: born between 1913 and 1918, free living in a traditional town with a stable population of 10 000 to 20000 inhabitants. From the results of the first and the second Seneca study it appears that these subjects could be considered as 'healthy' elderly (2;14-16).

Frail elderly population: free-living with help

For the frail elderly group, baseline data of 190 elderly subjects who started a randomised placebo controlled intervention trial described elsewhere were used in the present study(17;18). Frailty selection criteria to recruit these subjects were partly based on criteria defined by (19)) i.e., including the need of requirement of help services at home such as home care and meals on wheels, a BMI (body mass index)$\leq$25kg/m^2 or presenting recent involuntary weight loss, no regular practise of physical activities of moderate to high intensity, no use of vitamins and mineral supplements and no dementia. Subjects were recruited in Wageningen and surrounding municipalities.

Nursing home elderly residents: nursing home

For the nursing home elderly, subjects included were recruited for a nutritional intervention study at the nursing home Rustenburg, Wageningen, the Netherlands. Dutch elderly people are referred to a somatic ward of a nursing home when, because of diseases, a person cannot take care of his/herself and is thereby unable to function at home (20;21). Selection criteria were: being older than 65 y of age, no known dementia, no known depression (assessed with a score below 5 on the Geriatric Depression Scale (22)), no disease in terminal phase.

Anthropometry

Body weight:

For all subjects' body weight, as index of the nutritional status, and height were measured in the early morning after voiding with subjects dressed in light clothing and without shoes. For SENECA and nursing home subjects, it was realized to the nearest 0.5 kg using a calibrated mechanical weighing scale (Seca, Hamburg,

Germany). Body weight of the frail free-living elderly was measured to the nearest 0.01kg using a calibrated digital weighing scale (ED6-T; Berkel, Rotterdam, The Netherlands).

Body height

Standing height was measured for all free-living subjects to the nearest 1mm using a wall mounted stadiometer. For nursing home subjects body height was estimated from knee - to -floor 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 following formula (23):

Height (in cm) =3.16*KFH (in cm)

Appetite, Hunger and Sensory Perception questionnaire (AHSP)

The AHSP questionnaire includes 29-items focusing on the main determinants of energy and macronutrient intake: feelings of hunger and appetite as well as taste and smell perception addressing both the present situation and the period before retirement. After reading each item together with a trained interviewer, subjects had to score on a 5-point Likert scale with verbally labelled categories (see appendix). Five variables were initially calculated:

- Present taste perception: 8 items, range 8-40
- Present smell perception: 3 items, range 3-15
- Present smell perception compared to the past: 3 items, range 3-15
- Appetite: 6 items, range 6-30
- Daily feelings of hunger: 9 items range 9-45

The lower scores on these variables indicated a low self-perception i.e. deterioration of the item being judged. For the variable appetite, present taste perception and present smell perception compared to the past a lower score also indicated that these items had deteriorated compared with the time before retirement. A higher score corresponded to a positive self-perception of these attributes such as for instance a better appetite or more feelings of hunger.

Data analyses

To determine if health would be a major influencing factor, subjects were grouped in 3 health categories according to residence and requirement of health care: nursing home, free-living with help and free-living without help. Means ± standard deviations (SD) were calculated per group for the main outcome variables.

Differences in general characteristics between the three groups were assessed using a general linear model procedure

The internal validity and consistency of the AHSP questionnaire was tested through the use of Cronbach's α.

To evaluate the effect of health on the AHSP variables a multiple analysis of variance was conducted using a model in which health was adjusted for age and gender.

Spearman correlation coefficients were calculated to quantify the association between body weight as main indicator of nutritional status and the variables of the AHSP questionnaire. Gender differences in the AHSP variables were assessed in the combined groups by using an unpaired t-test.

A p-value ≤ 0.05 was considered statistically significant. Data were analyzed using the SAS program (24).

Results

General characteristics of the study population

Table 1 shows the general characteristics of the study population. Age, disease and body weight differed per group ($P< 0.05$) while use of dentures was similar. Gender distribution also differed between groups ($P=0.001$). Percentages of men were 47%, 25% and 20% of men for the 'free living without help', the 'free-living with help' and the nursing home categories, respectively.

Table 1: General characteristics of the 3 categories of Dutch elderly subjects

Variable	Total population (n=316)	Free-living without help (n=60)	Free-living with help (n=190)	Nursing home (n=66)
Age [mean (SD) y]	80.2(5.3)	83.1(1.6)	78.3(5.5)	83.0(4.5)
Gender [men/women]	88/228	28/32	47/143	13/53
Body weight [mean (SD) kg]	68.2(11.2)	72.8(11.3)	66.2(9.6)	70.1(13.8)
Disease (%)	89	79	91	100
Denture: Partial or complete[1]	87	-	85	92
None	13	-	15	8

[1]. Data not available for the SENECA study

AHSP questionnaire results

The internal consistency of the questionnaire was relatively high with Cronbach's α varying from 0.71 for the variable appetite and present taste perception to 0.76 for both smell perceptions (Table 2).

Results of the multiple analyse of variance showed significant different health effects for the present taste perception [F (315,30)=1.8, P=0.008], daily feelings of hunger [F (315,30)=1.93, P=0.003], appetite [F (315,30)=1.59, P=0.03] but not for the present smell perception compared to the past [F (315,30)=1.03, P=0.43], nor for the present smell perception [F (315,30)=1.30, P=0.14].

Table 2: Mean scores of the Appetite, Hunger and Sensory Perception questionnaire in the three categories of elderly subjects

Variable (Possible Range)	Cronbach coefficient α	Total population (n=316)	Free-living without help (n=60)	Free-living with help (n=190)	Nursing home (n=66)
Appetite	0.71	20.7±4.6	22.1±3.9^{A}	20.7±4.3^{B}	19.4±5.6^{B}
Daily feeling of hunger	0.75	34.3±6.1	36.1±5.8^{A}	34.2±5.7^{A,B}	33.2±7.2^{B}
Present taste perception	0.71	26.0±5.0	27.4±4.5^{A}	26.3±4.4^{A}	24.0±6.4^{B}
Present smell perception	0.76	11.5±2.4	12.2±2.5^{A}	11.4±2.4^{B}	11.3±2.3^{B}
Present smell perception compared to the past	0.76	8.5±2.2	9.0±2.3^{A}	8.3±2.2^{A}	8.5±2.2^{A}

Different letters (A, B) represent significant difference between groups assessed with a multiple analysis of variance, P<0.05.

Table 3 shows the association between body weight as indicator of the nutritional status and the variables of the AHSP questionnaire. These associations differed per group. Relatively high correlation coefficients were observed in the free-living group without help for appetite, daily feelings of hunger and present taste perception.

Table 3: Spearman correlation coefficients between body weight as indicator of nutritional status and the AHSP variables for the 3 categories of elderly subjects

Variable	Total population (n=316)		Free-living receiving no help (n=55)		Free-living receiving help (n=190)		Nursing home (n=63)	
	r	p	r	p	r	p	r	p
Appetite	0.157	0.006	0.409	0.002	0.143	0.04	-0.078	0.54
Daily feeling of hunger	0.134	0.01	0.315	0.02	0.031	0.67	0.103	0.42
Present taste perception	0.158	0.005	0.351	0.008	0.221	0.002	-0.135	0.29
Present smell perception	0.145	0.01	0.151	0.27	0.110	0.13	0.147	0.25
Present smell perception compared to the past	0.066	0.25	0.146	0.28	0.079	0.27	-0.118	0.35

In the free-living group with help lower correlation coefficients were found. Only appetite and present taste perception had a significant correlation with body weight. No significant correlation was found in the nursing home category.
Women generally scored lower ($P<0.05$) than men for appetite, present taste perception and daily feelings of hunger but scored similarly for smell perception.

Discussion

Results of the present study revealed that health status influences self-assessment of appetite, hunger feelings and sensory perception in Dutch elderly.
The internal consistency of the AHSP questionnaire explored by Crohnbach's alpha was satisfactory and similar to that previously observed (9). Due to the lack of biological markers for appetite in the elderly, external validity of this questionnaire could only be performed against external measures such as taste score or dietary intake (9;12). In the present study, none of the subjects had difficulties to understand and answer the questions. In general, the time needed to complete the questionnaire was much less than ten minutes, which was acceptable in all categories of subjects. Results of the present study show that the AHSP questionnaire, especially developed for elderly subjects has a good feasibility and reliability to detect differences in feelings of hunger and appetite in elderly subjects with different health status included in our studies.
According to the cross-sectional findings obtained in 1989, SENECA participants were considered to be in a better health status than average (14). Longitudinal data collected in 1993 confirmed that the surviving sample of the population was relatively healthy (15;25). In this paper their results on the AHSP questionnaire have been used as a reference. These results show that in a healthy Dutch elderly population appetite and hunger feelings are still indicators of body weight, one of the principal 'markers' of elderly dietary intake. However their olfactory perception was not related to body weight. Since it is known that a poor smell perception (12) is related to a poor appetite, a poorer smell perception could be one of the first indicators predicting decline in pleasantness of food and perhaps subsequent alteration in dietary intake.
Scores of the frail free-living group requiring health care were intermediate between the other two groups. Data of this group 'at risk' selected for its (unconscious) frailty i.e. diminished physiological reserves and sub-optimal health status but no obvious signs of malnutrition showed no clear relationship between appetite and body weight. One of the possible explanations might be that, in this group, feelings of hunger and appetite were less important than symptoms of disease as determinants of body weight and may be nutritional status.

In the nursing home group no association could be established between feelings of hunger or appetite and nutritional status. Nursing home subjects, known as accelerated agers (26), have a low dietary intake, a low physical activity level and a relative poor health putting them highly at risk for malnutrition. Since depression has been cited as one of the major cause of failure to thrive and weight loss in nursing home (27), we selected a population who did not have depression in order not to bias our results. Still the discrepancy between appetite and body weight confirmed the fact that a poor health together with a lack of autonomy would negatively influence appetite and thereby dietary intake. Another possible explanation is that in this population health /disease conditions more than appetite is an indicator of body weight. Besides, the rhythm of a nursing home day is often based on the meal service. In this situation, this elderly group highly probably eats because they are served but not because they are hungry or enjoy it anymore. This points out the importance of non-physiologic parameters such as environment, meal ambience for appetite and hunger feelings and subsequent dietary intake in this elderly population (28).

Until this study, it was often postulated, but actually never determined, that nursing home elderly residents or frail elderly would have a more reduced appetite than healthy free-living would. In this regard the present study confirmed the findings of De Jong (1999) in a Dutch elderly population as well as those of Hininger (2000) (29) observed in a French elderly population that a deteriorating health together with a reduced autonomy negatively affect self-assessment of appetite and hunger feelings. Further long-term studies are now required to confirm and further explore this loss of appetite feelings in relation to body weight changes and specific markers of nutritional status.

In summary, our results show that appetite is related to the health status of elderly subjects. In case of a good health, appetite was shown to be an indicator of body weight while with a weakening health status, the state of disease rather than appetite influences body weight.

References

1. Lehmann AB, Bassey EJ. Longitudinal weight changes over four years and associated health factors in 629 men and women aged over 65. Eur J Clin Nutr 1996;50:6-11.

2. de Groot LC, Hautvast JG , Van-Staveren WA. Nutrition and health of elderly people in Europe: the EURONUT-SENECA Study. Nutr.Rev. 1992;50:185-194.

3. Moreiras O, Van Staveren W, Cruz JA, Nes M, Lund-Larsen K. Intake of energy and nutrients. Euronut SENECA investigators. Eur J Clin Nutr 1991;45 Suppl 3:105-119.

4. Payette H, Gray DK, Cyr R, Boutier V. Predictors of dietary intake in a functionally dependent elderly population in the community. Am J Public Health 1995;85:677-683.

5. Roberts SB, Fuss P, Heyman MB, et al. Control of food intake in older men. JAMA 1994;272:1601-1606.

6. Mattila K, Haavisto M, Rajala S. Body mass index and mortality in the elderly. Br.Med.J.Clin.Res.Ed. 1986; 292:867-868.

7. Morley JE. Anorexia of aging: physiologic and pathologic. Am J Clin Nutr 1997;66:760-773.

8. Mowe M, Bohmer T. Nutrition problems among home-living elderly people may lead to disease and hospitalization. Nutr Rev 1996;54:S22-S24

9. de Jong N, Chin a Paw J, de Graaf C, Van Staveren W. Effect of dietary supplements and physical exercise on sensory perception, appetite, intake and body weight in frail elderly? Br J Nutr 2000;(in Press)

10. Vellas B, Garry P, Guigoz Y. Mini nutritional assessment (MNA): research and practice in the elderly. 1 ed. Karger, 1999.

11. Shahar D, Shahar A. CEBQ: Composite eating behavior questionnaire -development and performance. J Nutrition, Health & Aging . 1999;3:11-18.

12. 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 [see comments]. J.Gerontol.A.Biol.Sci.Med.Sci. 1999;54:B324-B331

13. Cain WS, Gent JF, Goodspeed RB, Leonard G. Evaluation of olfactory dysfunction in the Connecticut Chemosensory Clinical Research Center. Laryngoscope 1988;98:83-88.

14. de Groot L, Van Staveren W. Description of survey towns and populations. Euronut SENECA investigators. Eur J Clin Nutr 1991;45 Suppl 3:23-29.

15. de Groot C, Van Staveren W, Dirren H, Hautvast JG. Summary and conclusions of the report on the second data collection period and longitudinal analyses of the SENECA Study. Eur J Clin Nutr 1996;50 Suppl 2:S123-S124

16. de Groot LC, Beck AM, Schroll M, Van-Staveren WA. Evaluating the DETERMINE Your Nutritional Health Checklist and the Mini Nutritional Assessment as tools to identify nutritional problems in elderly Europeans. Eur.J.Clin.Nutr. 1998;52:877-883.

17. de Jong, N. Sensible aging, nutrient dense foods and physical exercise for the vulnerable elderly. 1-191. 1999. PhD thesis, Department of Human Nutrition & Epidemiology, Wageningen University, The Netherlands

18. Chin a Paw, JMM. Aging in Balance, physical exercise and nutrient dense foods for the vulnerable elderly. 1-176. 10-19-1999. PhD thesis, Division of Human Nutrition and Epidemiology; Wageningen University, The Netherlands.

19. Chin a Paw J, Dekker J, Feskens E, Schouten E, Kromhout D. How to select a frail elderly population? a comparison of three working definitions. J Clin Epidemiol 1999; 52:1015-1021.

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. Ribbe MW, Ljunggren G, Steel K, et al. Nursing homes in 10 nations: a comparison between countries and settings. Age Ageing 1997;26 Suppl 2:3-12.

22. Yesavage JA. Geriatric Depression Scale. Psychopharmacol.Bull. 1988;24:709-711.

23. Berkhout AM, Cools HJ, Mulder JD. [Measurement or estimation of body length in older nursing home patients]. Tijdschr.Gerontol.Geriatr. 1989;20:211-214.

24. SAS Institute Inc. SAS/Stat user's guide version 6. fourth ed. Cary, USA: SAS Institute Inc., 1989.

25. 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:S9-15.

26. 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.

27. Morley JE, Kraenzle D. Causes of weight loss in a community nursing home. J Am Geriatr.Soc 1994;42:583-585.

28. Elmstahl S, Blabolil V, Fex G, Kuller R, Steen B. Hospital nutrition in geriatric long-term care medicine. I. Effects of a changed meal environment. Compr.Gerontol A 1987;1:29-33.

29. Hininger I, Mathey M-F, Maugourd M-F, Sidobre B, Ferry M. Les modifications du comportement alimentaire des personnes âgées en fonction de l'environnement et de l'âge: le goût, l'odorat, l'appétit. Dietecom 2000, Paris, France. 2000.

3

Social and physiological factors affecting food intake in elderly subjects: an experimental comparative study*

Marie-Françoise A. M. Mathey, Elizabeth H. Zandstra, Cees de Graaf and Wya A. van Staveren

Abstract

The decline in average food intake in elderly people is attributed to both physiological and social factors. These factors are usually studied in isolation. The present study concerns an experiment in which the effect of social setting on food intake is compared with the effect of physiological challenges on food intake in 24 elderly subjects (6 men and 18 women, age: 75± 4.9 y, BMI=26.6±3.5 kg/m^2).

Physiological effects were assessed using a preload-test-meal design with a no load, 0 kJ; and 4 preload conditions: low carbohydrate/low fat, low energy, 0.4 MJ; high fat, low carbohydrate, medium energy, 1.1 MJ; high carbohydrate, low fat, medium energy 1.1 MJ; high fat, high carbohydrate, high energy, 1.8 MJ. The preloads consisted of 300g of strawberry yogurt drink, and were served at 10:00 A.M. The test-meal, served 90 minutes after the preload consumption, was a lunch of which subjects could eat ad libitum. Social effects on food intake were assessed by using two social settings at lunchtime: cozy and non-cozy. Dependent variables were food intake at lunch and ratings of appetite assessed before the preload, and between preload and test-meal.

Results showed that energy intake at lunch was significantly decreased after the high carbohydrate preload and the high fat-high carbohydrate preload (intake compensation of 23% and 15%, respectively), compared to the no preload condition. The other preloads did not have a significant effect on food intake. Energy intake was of 2.5±0.5MJ in the cozy social setting and of 2.5±0.6MJ the non-cozy one. Appetite feelings were generally lower after the preload conditions compared to the no load condition ($P<0.05$), but there were no significant effects of the macronutrient or energy content of the preloads on appetite feelings. It is concluded within the context of this study in healthy elderly subjects that food intake responds more to physiological challenges than to short-term changes in social settings.

*Food, Quality & Preferences 2000, 11(5):397-403

Introduction

Aging is frequently associated with loss of appetite, decline in food and energy intake. Longitudinal studies in elderly confirmed this spontaneous decline in both energy and nutrient intake with age, this effect being paralleled by weight loss (1-4). As requirements in the elderly remain unchanged or increase for most of the nutrients (5), elderly are at higher risk for malnutrition and nutrition-related acute or chronic illnesses (6).

The diminished ability of older adults to control food intake, often described as anorexia of aging, is likely to be the consequence of several internal, physiological and external, social factors as mentioned by Morley and Silver (7). With increasing age, food intake is thought to be influenced by alterations of the gastrointestinal tract and by functional disabilities (8-10). The results of two studies suggested that elderly subjects present an impaired ability to regulate their intake when under- or overfed. These studies indicated that elderly subjects were less capable than younger subjects to control their food intake (11;12).

Aging is also accompanied by various social changes. Psychological and socio-economic problems such as depression as a result of certain life events and loneliness, may reduce food intake and contribute to the risk of undernutrition (13-15).

In young subjects, the social settings of meals or snacks have been shown to play a role on eating behavior. Redd and de Castro (1992) showed that, in real life outside the laboratory, food intake was 60% higher when middle-aged subjects ate with others present than when they ate alone. These results suggest that social facilitation during meals has a causal influence on eating behavior and that the amount eaten in meals by adults is a power function of the number of people present (16). Feunekes *et al.* (1995) showed that social facilitation of spontaneous meal size in young adults was mediated by meal duration. However, another recent study revealed that, in young subjects, physiological cues, and thus the control of food intake, remain unchanged in different social settings (17).

In elderly subjects, changes in meal environment have also been found to result in an increase in both energy and nutrient intake (18). Data of De Jong and coll. (1996) also showed that elderly subjects ingested 50-70% more energy when having breakfast together in a dining room than when having regular breakfast on their own.

Although it is clear that both psychological and social factors play an important role in food intake in elderly people, these factors have mostly been studied in isolation. In the present study, we investigated the influence of both social and physiological factors on food intake in healthy elderly subjects.

In order to meet the aim of the study, both social and physiological manipulations were combined. For the social manipulation, two types of settings at lunchtime were used. To compare physiological factors in those different settings, preloads that varied in macronutrients and energy contents were used. Preloads and lunch were separated by a delay of 90 minutes in order to assess the macronutrient effect of the preload (19;20).

Rolls et al. (1991) reported that the time interval between preload and subsequent test meal may affect the degree of compensation; a nearly perfect complete compensation was shown in young adults after 30 minutes, and a compensation of 61% to 90% was found after 90 minutes. In the present study we chose a 90-minute time interval because we believe that a 20-minute interval does not measure the physiological effects, but only volume and weight effects of the preload, whereas a longer time interval includes both post-ingestive and post-absorptive physiological effects especially in elderly subjects. Besides digestion of regular amounts of fat and carbohydrate results in the largest difference after a time interval of 60 to 90 min in appetite physiological responses (21).

Subjects and methods

Subjects

Twenty-five (25) free-living elderly men and women (Table 1) participated in the study. They were recruited by advertisements and by word of mouth throughout the town and the surroundings of Wageningen (The Netherlands). Excluded from participation were those who were taking medication known to influence food intake, or those who had a body mass index (BMI) below 21 kg/m^2, since risks for frailty are higher in subjects with a low BMI. Subjects signed an informed consent before entering the study.

Table 1: Subjects general characteristics (n=24)

Men/Women	6/18
Age (y)	75.5 (4.9)
Weight (kg)	72.4 (8.9)
Height(m)	1.65(0.1)
BMI (kg/m2)	26.6(3.5)
Restrained score	2.9 (0.8)

Results are given as Mean (SD); BMI (kg/m2): Body Mass Index. The restrained score was measured with the help of the Dutch Eating Behavior Questionnaire (34).

The exact study purpose was blinded to the subjects: they were informed that the study concerned the sensory properties of the yogurts and the test-meal items. They were not aware that their food intake was measured. One subject dropped out because of sickness during the study. In total, 24 subjects successfully completed the experimental period.
The study was conducted at the Division of Human Nutrition & Epidemiology of the Wageningen University, with approval from its Medical Ethical Committee.

Design

For the assessment of physiological effects, a 'preload-test-meal' design with covert macronutrient manipulation was used. The social effect was measured by changing the social setting of the 'test-meal' (lunch). Each subject participated in 5 preloads x 2 social settings of test-meal = 10 conditions, plus an additional test day to familiarize the subjects with the experimental procedure but also to give the possibility to subjects to get to know each other. During this test-day, we noticed that some people already knew each other: most of them were friends, neighbors or even family (husband and wife, cousins). All experimental days were separated by at least two days.
This study design resulted in within-subjects repeated measures with each subject as his own control.

Table 2: Macronutrient and energy contents of the preloads

	LF/LC	HF/LC	LF/HC	HF/HC
Energy (MJ)	0.4	1.1	1.1	1.8
protein (g)	10	8	9	8
% total energy	45	12	14	7
fat (g)	0.2	22	0	20
% total energy	2	71	0	41
carbohydrate (g)	13	12	57	57
% total energy	54	17	86	52

LF/LC: low fat- low carbohydrate preload, HF/LC: high fat- low carbohydrate preload, LF/HC: low fat- high carbohydrate preload, HF/HC: high fat and high carbohydrate preload.

Preloads

The preloads consisted of four strawberry yogurt drinks (300g each) with covert manipulation of energy, fat and carbohydrate contents but matched for weight, volume

and sensory properties by using fat and sugar replacers. Sensory properties were tested in a pilot-study and no significant differences between preloads were found. The preloads were either rich or low in fat and either rich or low in carbohydrate and they had similar absolute protein contents (Table 2). They were prepared within one day of serving and were refrigerated.

Table 3: Energy and macronutrient contents of the food items served at lunch

Items	KCal (/100g)	KJ (/100g)	Protein (g)	CHO* (g)	Fat (g)
Brown bread	222	886	8.8	40.5	2.8
White bread	260	1101	8.1	52	2.1
Margarine	741	3048	0.1	0.7	82
Peanut butter	648	2686	26.2	16.2	53.1
Jam	241	1023	0.2	60.0	0.0
Chocolate paste	321	1358	4.0	65.0	5.0
Cheese	376	1558	24.2	0.0	30.8
Ham	137	573	17.4	1.6	6.8
Milk	46	194	3.6	4.6	1.5
Orange juice	37	157	0.5	8.8	0.0
Tea	0	0	0	0	0
Coffee	1	3	0	0.2	0
Apple	50	211	0.4	12.0	0.0
Orange	47	198	1	10.6	0
coffee creamer	110	464	7.7	10.5	4.2
Sugar	400	1700	0.0	100	0.0

*: Cho=carbohydrate

Test-meal

The test-meal consisted of a bread-based lunch buffet consumed *ad-libitum* served on trays (Table 3). All trays were identical with prepackaged and preweighted foods for each of the ten conditions. Subjects could choose between several items and were told to eat and drink whatever and as much as they wanted.

Social setting of the test-meal

Lunch intake (= test-meal) occurred in two different environments.

In the cozy setting, subjects were eating together in a chic restaurant-style decoration: tables were dressed with tablecloth, place mat and flowers. Subjects were encouraged to converse with each other to obtain an amicable atmosphere. For the non-cozy setting, the same eating room was specially equipped with individual delimited locations: subjects were alone and eating on a non-decorated table in a limited space. The eating room decoration was also kept as undecorated as possible and subjects were not allowed to communicate with each other.
In both settings, research assistants were helping with, amongst others unpacking foods, serving coffee to subjects who asked for it.

Procedure

The schedule of each experimental morning is described in Table 4. On each occasion, participants were instructed to eat their usual dinner the day before the experimental session. They were also required to eat a regular breakfast at 8:00 am and to write down their consumption in a diary. Breakfast diary was used to check compliance with these instructions but also to ensure that subjects would start each test with a similar state of hunger.
Subjects arrived at the department at 9:45 am. At 10:00 am, they filled in the first Visual Analogue Scale (VAS, baseline). Then, they received one of the 4 preloads to be consumed within 15 minutes or no preload in a randomized order. They were not allowed to talk to each other during the preload consumption. They had to fill in new VAS 15, 45, 75, 105 and 150 minutes after the first rating.

Table 4: Experimental Schedule (VAS= Visual Analogue Scale)

Time	Procedure
08:00 a.m.	Subjects consume their breakfast at home
09:45 a.m.	Arrival at the Department of Human Nutrition 1st VAS appetite assessment
10:00 a.m.	Subjects drink the preloads
10:15 a.m.	2nd VAS appetite assessment
10:45 a.m.	3rd VAS appetite assessment
11:15 a.m.	4th VAS appetite assessment
11:45 a.m.	5th VAS appetite assessment and start of the lunch
End of the lunch	6th VAS appetite assessment

In between preload and test-meal, subjects were together playing games, reading but were not allowed to discuss over the preload or the experiment itself, these last being checked by research assistants.
Ninety minutes after the end of the preload consumption, they were offered the *ad-libitum* lunch in one of the two settings. The order of the settings was also randomly assigned.

Measurements

Food and energy intake at lunch

Intake at lunch was assessed by determination of food wrappings and by weighing back the food leftover. Consumed amounts were then converted in energy and macronutrients contents according to the Dutch Nutrient Database (22).

Meal duration

Meal duration was recorded by research assistants in both settings. In both cases, the lunch was considered finished when subjects had completed the last Visual Analogue Scale.

Subjective appetite feelings

Appetite feelings were measured since they are considered as an intermediate variable for the physiological effect. During each experimental morning, subjects were asked to rate their appetite on a Visual Analogue Scale (VAS) in six respects: 'appetite for a meal', 'appetite for something sweet', 'appetite for something savory', 'satiety (fullness)', 'feeble, weak with hunger', 'appetite for a snack' (23). Each of these terms was placed above the center of a 150-mm line, anchored at the left-hand and the right-hand sides with the Dutch terms for "weak" and "strong", respectively. Subjects were instructed both orally and on paper.

Data analyses

Energy intake regulatory responses for the preloads were calculated by assessing the response to the energy content of the preload. The percentage of compensation at lunch was calculated as follows:

$$\% \text{ compensation} = [(\text{ELI no load} - \text{ELI preload x}) / \text{EPx}] * 100$$

with ELI= energy intake at lunch (kJ), x= one of the preloads and EPx= energy content of this preload x (kJ).

Statistical analyses

Effects of preloads and settings on intake were evaluated by analysis of variance (α=0.05). The one-way ANOVA was carried out in stages. First, a repeated measure analysis was conducted on all ten conditions with subjects, settings and preloads as independent variables. When a parameter appeared not to be significant, it was eliminated from the model and results were reported with only subjects and preloads or settings as independent variables.

A two-way analysis of variance, excluding the no load condition, and with both carbohydrate and fat with two levels (low and high), were realized to determine the specific macronutrient effect of preloads on lunch intake (α=0.05).

Appetite rating forms (VAS) were read automatically by an Optimal Mark Reader, and were transformed into scores from 1 for weak to 25 for strong. Absolute ratings were used to carry out repeated measure analyses by time periods (α=0.05)

Setting effects on meal duration were also assessed by a repeated measures analysis procedure (α=0.05).

All statistical analyses were carried out with SAS statistical software package (Statistical Analyses System; SAS Institute Inc., Cary, USA).

Results

Intake at lunch

No influence of social setting on lunch intake was found: the mean intake was of 2510 ± 546 kJ in the cozy setting and of 2526 ± 655 kJ in the non-cozy one (P=0.68).

Table 5: Energy compensation at lunch after different preload condition

	Type of preloads				
	no load	LF/LC	HF/LC	LF/HC	HF/HC
Lunch + preload intake (kJ)[mean ±SD]	2653±550	2957±590	3575±613	3513±533	4217±550
Lunch intake (kJ) [mean ±SD]	2653±550	2563±590	2429±613	2392±533§	2388±550§
Preload intake (kJ)	0	394	1146	1121	1829
Reduced intake (kJ)	-	90	224	261	265
Compensation (%)	-	23	20	23	15

LF/LC: Low fat-low carbohydrate preload (=control), HF/LC: high fat-low carbohydrate preload, LF/HC: low fat-high carbohydrate preload, HF/HC: high fat-high carbohydrate preload. §: Energy intake significantly different, P<0.05, compared with the no load condition intake.

Energy intake at lunch is presented in Table 5. When the data of both settings were combined, a significant effect of the preloads on energy intake at test-meal was found [$F(4,210)=8.8$, $P<0.001$]. Compared to the no load condition, intake was significantly reduced after the carbohydrate-rich (HC) and the fat- and carbohydrate-rich (HF/HC) preloads. Contrast analyses (excluding the no load condition) showed a significant effect of carbohydrate [$F(1,210)=7.5$, $P=0.01$] and a borderline significant effect of fat [$F(1,210)=3.4$, $P=0.07$] on energy compensation during lunch.

Meal duration

Mean test meal duration was significantly longer in the cozy setting (35± 4 minutes) than in the non-cozy one (27± 6 minutes) [$P<0.001$], and this regardless to the type of preload.

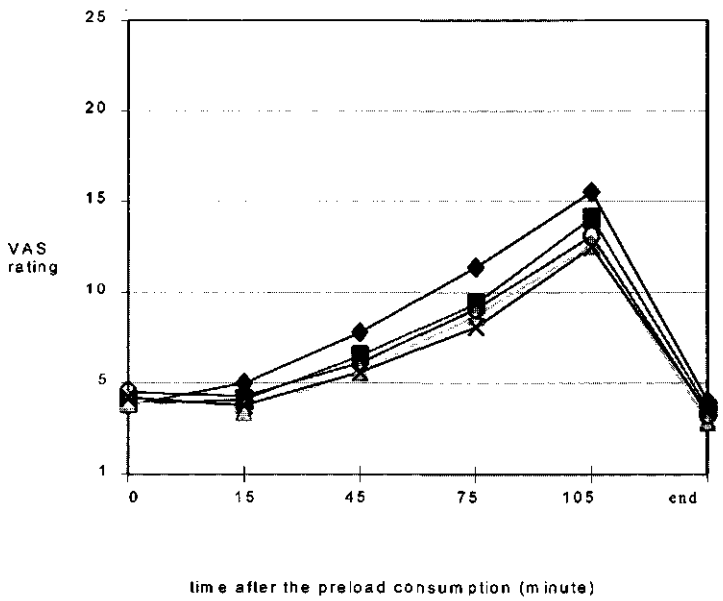

Figure 1: Absolute 'appetite for a meal' ratings after different preload conditions: no load (◆), LF/LC (■), LF/HC (○), HF/LC (▲), HF/HC (✖). Ratings assessed by using a Visual Analogue Scale were measured before (t = 0 min) and at 15, 45,75,105 min after the preloads and after the lunch. The scale was a 150-mm line, anchored at the left-hand and the right-hand sides with the Dutch terms for "weak" and "strong", respectively. Data are mean values.

Appetite feelings

Results for satiety (fullness), appetite for a snack, for something savory, for something sweet, and feeble, weak with hunger were similar to appetite for a meal. Therefore, only appetite for a meal is presented (Figure 1). Subjects started the experimental mornings with a similar state of hunger [F(4,209)=0.4, P=0.78]. As shown in Figure 1, subjects rated their appetite feelings higher after the no load condition [F(4,209)=12.0, P=0.005]. No significant differences were found after the different conditions per time on appetite feelings.

Discussion

Results of this study suggest that food intake of apparently healthy elderly subjects was not influenced by the social environment of the lunch. In contrast to expectations (18; 24;25), subjects did not eat more in the cozy setting than in the non-cozy one. In addition, a physiological ability to regulate food intake at the test-meal was shown, although subjects only compensated to a small extent for the differences in energy intake of the preloads.

Although the energy intake was lower after all preloads as compared to the no load condition, compensation at lunch was found to be slightly more influenced by the macronutrient than by the energy content of the preloads. If appetite regulation would be based upon the energy content of food as postulated in other studies (1;20), than energy intake at lunch would have proportionally decreased according to the energy level of the preloads. I.e. results would have been similar for both high fat and high carbohydrate preloads and much lower for the very energy-rich preload. This suggests then that in this study healthy elderly would have still been capable to detect macronutrient challenges. In other words, macronutrient would have a post-ingestive effect on the control of food intake of elderly and might influence more the subsequent energy intake than the energy content of foods.

Results of the VAS data indicated that preloads reduce more appetite feelings than the no load, but there were no differences in between preloads. These results in appetite feelings were strangely not confirmed by the energy intake during the following meal: despite the fact that subjects started the lunch with similar states of hunger after the preloads, they did not show similar energy intakes. In young adults, the VAS is a good indicator of what is the food intake going to be (23). One possible explanation why we did not find this in our study is that this difference between physiological and VAS results might indicate an impairment in the ability to detect nutrient density. This impairment of the physiological control of intake may reflect an

alteration of the endocrine system between the gastrointestinal tract and the appetite center. For example, cholecystokinin, hormone release by the gut in response to food, and especially fat and protein ingestion, has been shown to decrease appetite. Besides, CCK levels have been found to be elevated in older humans (14;26;27) so these high levels combined with an increased sensitivity to CCK may lead to early satiety in elderly people or decreased precision in elderly appetite control. This might be one of the underlying parameters partaking in the so-called anorexia of aging.

In addition results of the present study are based on a single exposure to the preload in an imposed social environment. Since it is known that food acceptance patterns can be modified by post-ingestive consequences of food intake, further study with repeated exposures are required. The optimal length of the time interval in a preload-test-meal design remains a lively debate whether it aims at assessing satiety or satiation effects of energy or macronutrient challenges in a culturally adapted setting. In this regard, we believe that a 90-minute time interval has a greater validity and reliability than a shorter one regarding Dutch usual eating patterns in daily life, where Dutch elderly people are used to consume a mid morning snack (22).

Several studies showed that people tend to eat more in company of others than when they eat alone (16;28;29). This has often be heeded as an example of social facilitation, defined to be the enhancement of a certain behavior due to the sheer presence of others. In fact, a positive association has been found between the energy intake at an eating and drinking time and the number of people present at that time, independently from the day or period of measurement. Therewith, the number of people present has been suggested to have a causal effect on food intake mediated by an increase in the meal duration. Those results were observed with young and middle-aged adults in their usual environment such as family or close friends (25;29-31). However, this phenomenon was not observed in our study despite the significant difference in meal duration showing that changes in social settings did have an important influence (17).

There are a few possible explanations regarding the absence of effect of the social environment on food intake. The first possible explanation is that, in the present study, lunches in both social settings were consumed at the research institute which can not be considered as a 'natural' eating environment (30;32). Furthermore, the presentation of the foods was identical in both the cozy and the non-cozy environment. In the more naturalistic studies (16;33) it seems probable that changes in social settings of meals were accompanied by changes in the presentation and serving of foods. It is now well

known that the presentation of foods can have a dramatic effect on the food intake (33).

Another explanation referred to the fact that subjects participating in this study were apparently healthy volunteers. They were obviously not suffering from denture or digestive disorders but also did not present any external sign of depression or sadness, which would have made them more responsive to environmental changes. Besides, the Dutch restrained eaters' scale (34) showed that this group was quite weight conscious. This together with the fact that the day to day variation of energy intake at lunch is rather low in the Dutch adult population, lunch being mainly bread-based meals (22), might explain why food choice and energy intake at lunch were not affected by the changes in meal environment. The positive findings of Elmståhl and coll. (1987) on food intake occurred by modifying the meal environment in homes for elderly people, thus in a natural environment of in general frail elderly people and over a longer period with repeated exposures.

In conclusion, in our study physiological parameters have a stronger effect than changes in social environment on appetite and energy intake in apparently healthy, free-living elderly. However, meal duration in this elderly population was more strongly affected by meal environment in line with other studies in young subjects.

Acknowledgment

We would like to thank Henny Rexwinkel, Marloes van der Kamp en Bas Duijkers for their help in collecting the data and Dr KJ Melanson for her precious suggestions during the data analysis. We also gratefully acknowledged the " Holland Sweetener Company" (Maastricht, The Netherlands) for their donation of aspartame.

References

1. De Graaf C., Hulshof T, Weststrate JA, Jas P. Short-term effects of different amounts of protein, fats, and carbohydrates on satiety. Am J Clin Nutr 1992;55:33-38.

2. de Groot L, Van Staveren W. Description of survey towns and populations. Euronut SENECA investigators. Eur J Clin Nutr 1991;45 Suppl 3:23-29.

3. Roberts SB, Young VR, Fuss P, et al. What are the dietary energy needs of elderly adults? Int J Obes.Relat.Metab Disord. 1992;16:969-976.

4. Lehmann AB, Bassey EJ. Longitudinal weight changes over four years and associated health factors in 629 men and women aged over 65. Eur J Clin Nutr 1996;50:6-11.

5. van der Wielen RP, de Wild GM, de Groot CP, Hoefnagels WH, Van Staveren WA. Dietary intakes of energy and water-soluble vitamins in different categories of aging. J Gerontol A Biol Sci Med Sci 1996;51:B100-B107

6. Mowe M, Bohmer T. Nutrition problems among home-living elderly people may lead to disease and hospitalization. Nutr Rev 1996;54:S22-S24

7. Morley JE, Silver AJ. Anorexia in the elderly. Neurobiol.Aging 1988;9:9-16.

8. Clarkston WK, Pantano MM, Morley JE, Horowitz M, Littlefield JM, Burton FR. Evidence for the anorexia of aging: gastrointestinal transit and hunger in healthy elderly vs. young adults. Am J Physiol. 1997;272:R243-R248

9. Rolls BJ, McDermott TM. Effects of age on sensory-specific satiety. Am J Clin Nutr 1991;54:988-996.

10. Stubbs RJ. Nutrition Society Medal Lecture. Appetite, feeding behaviour and energy balance in human subjects. Proc Nutr Soc 1998;57:341-356.

11. Pfau C. Methodology of a survey on meal patterns in private senior households. Appetite. 1999;32:38-45.

12. Rolls BJ, Dimeo KA, Shide DJ. Age-related impairments in the regulation of food intake. Am J Clin Nutr 1995;62:923-931.

13. Goodwin JS. Geriatric ideology: the myth of the myth of senility. J Am Geriatr.Soc 1991;39:627-631.

14. Morley JE. Anorexia in older persons: epidemiology and optimal treatment. Drugs Aging 1996;8:134-155.

15. Mulley GP. Preparing for the late years. Lancet 1995;345:1409-1413.

16. De Castro JM, Brewer EM. The amount eaten in meals by humans is a power function of the number of people present. Physiol.Behav. 1992;51:121-125.

17. Kim JY, Kissileff HR. The effect of social setting on response to a preloading manipulation in non-obese women and men. Appetite 1996;27:25-40.

18. Elmstahl S, Blabolil V, Fex G, Kuller R, Steen B. Hospital nutrition in geriatric long-term care medicine. I. Effects of a changed meal environment. Compr.Gerontol A 1987;1:29-33.

19. Rolls BJ, Kim S, McNelis AL, Fischman MW, Foltin RW, Moran TH. Time course of effects of preloads high in fat or carbohydrate on food intake and hunger ratings in humans. Am J Physiol. 1991;260:R756-R763

20. Rolls BJ, Hammer VA. Fat, carbohydrate, and the regulation of energy intake. Am J Clin Nutr 1995;62:1086S-1095S.

21. Maas MI, Hopman WP, van-der-Wijk T, Katan MB, Jansen JB. Sucrose polyester does not inhibit gastric acid secretion or stimulate cholecystokinin release in men. Am.J.Clin.Nutr. 1997;65:761-765.

22. Anonymous. NEVO 1996. Stichting Nederlands voedingsstoffenbestand. Dutch Nutrient Database 1996. The Hague, The Netherlands: Voorlichtingsbureau voor de voeding, 1996.

23. Hulshof T, De Graaf C., Weststrate JA. The effects of preloads varying in physical state and fat content on satiety and energy intake. Appetite 1993;21:273-286.

24. 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.

25. Feunekes GI, De Graaf C., Van Staveren WA. Social facilitation of food intake is mediated by meal duration. Physiol.Behav. 1995;58:551-558.

26. Berthelemy P, Bouisson M, Vellas B, Moreau J, Albarede JL, Ribet A. Postprandial cholecystokinin secretion in elderly with protein-energy malnutrition. J Am Geriatr.Soc 1992;40:365-369.

27. Morley JE. Neuropeptides, behavior, and aging. J Am Geriatr.Soc 1986;34:52-62.

28. De Castro JM. Social facilitation of the spontaneous meal size of humans occurs on both weekdays and weekends. Physiol.Behav. 1991;49:1289-1291.

29. De Castro JM. Social facilitation of food intake in humans. Appetite 1995;24:260-26s.

30. De Castro JM. Family and friends produce greater social facilitation of food intake than other companions. Physiol.Behav. 1994;56:445-445.

31. De Castro JM. How can eating behavior be regulated in the complex environments of free-living humans? Neurosci.Biobehav.Rev 1996;20:119-131.

32. De Castro JM. How can energy balance be achieved by free-living human subjects? Proc Nutr Soc 1997;56:1-14.

33. Meiselman HR. The contextual basis for food acceptance, food choice and food intake: the food, the situation and the individual. In: Meiselman HR, MacFie HJH, eds. Food choice, acceptance and consumption. London: Blackie, 1996:239-263.

34. van Strien T. The concurrent validity of a classification of dieters with low versus high susceptibility toward failure of restraint. Addict.Behav. 1997; 22:587-597.

4

Health effect of improved meal ambiance in a Dutch nursing home: a one-year intervention study*

Marie-Françoise A. M. Mathey, Vincent G. G. Vanneste, Cees de Graaf,
Lisette C.P.G.M. de Groot and Wija A. van Staveren

Abstract

Objective: To determine the effect of an improved ambiance of food consumption on health and nutritional status of Dutch nursing home elderly residents (n=38) in a one-year intervention study.

Design: parallel group intervention study.

Intervention program: Improvement of ambiance focused on 3 points: 1. Physical environment and atmosphere of the dining room, 2. Food service 3. Organization of the nursing staff assistance

Measurements: Dietary intake, biochemical indicators of nutritional and health status and quality of life (Sickness Impact Profile and Philadelphia Geriatric Center Moral Scale) were assessed at baseline and after one year of intervention. Body weight, used as an indicator of compliance and nutritional status, was assessed every four months.

Results: 22 subjects completed the one-year intervention trial. Mean body weight significantly increased (+3.3 kg, $p<0.05$) in the experimental group (n=12), not in the control group (-0.4 kg, $p=0.78$; n=10). Health status biochemical indicators and the SIP score remained stable in the experimental group indicating relatively stable health conditions. On the contrary, negative changes in the control group suggested a decline in health status. Dietary intake, which was insufficient at baseline, increased in both groups.

Conclusion: This study showed that improving the ambiance of food consumption is a non-negligible issue to improve nutritional status and to stabilize health of nursing home residents.

*provisionally accepted

Introduction

In western countries poor nutritional status is highly prevalent in nursing home residents (1-3). This poor nutritional status, caused by low food and energy intake, is often associated with unintentional weight loss, a higher risk of morbidity and a lower quality of life (4-7).

Food intake in nursing homes depends to a large extent on the quality of the food service system (8). In most of the nursing homes, meals are individually served on trays to the residents either in a common dining room or in their own room. This serving system combined with an inadequate physical environment does not seem to be the most appropriate way to stimulate appetite and mealtime enjoyment (9).

Since poor appetite is one of the factors for an insufficient diet in institutionalized elderly, a stimulating ambiance should be considered in meal services. Earlier studies in younger people showed that social facilitation of eating was related to a better social atmosphere during meal consumption (10-12). Changing the social ambiance of food consumption in nursing homes might therefore be a realistic and effective way to improve mealtime enjoyment and nutritional health. Since we believe that nursing home residents are not capable anymore to make change to improve their eating environment, the nursing staff is then responsible for it. The idea behind it was that if the nursing staff would provide a better meal service and improve the ambiance during food consumption, the residents would feel more comfortable and secure in their eating environment. Therefore their appetite and food intake might be stimulated and could result in health benefit on the long-term.

In the present study we investigated the influence of a 1-year intervention, combining selected social and environmental manipulations of food consumption on nutrition and health status of nursing home residents.

Patients and methods

Design and setting

A parallel design was used for this one year intervention study conducted at the nursing home Aeneas, Breda, the Netherlands. Dutch elderly people are referred to a somatic ward of a nursing home when, because of diseases, a person cannot take care of herself and is thereby unable to function at home (13). Four wards, each with 15 residents and comparable for diseases and treatment, were randomly assigned to be in either the control (two wards) or in the experimental group (two wards). Data were collected at baseline and after the intervention.

Patients

Sixty Dutch nursing home residents from four somatic wards were invited to join the study. Both residents and their contact person received detailed information about the study. The main inclusion criteria were to be older than 65 y of age and to be resident in this home for more than 3 months at the start of the study. General exclusion criteria were parenteral nutrition, terminal phase of a disease. A specific exclusion criterion for the analyses of biochemical indicators of health was applied for the patients with severe anemia.

Before the start of the intervention, all volunteers or their contact person had to sign an informed consent. The study protocol was approved by the Ethical Committee of the nursing home.

The intervention program

The intervention program, developed after discussion with nursing staff and patients, aimed at creating a better ambiance during food consumption and focused on three issues: physical environment and atmosphere of the dining room, meal situation, and organization of the nursing staff assistance (Table 1). During the intervention, the same meals were served in both groups and the usual meal pattern was maintained: breakfast and supper were bread-based meals and at noon a cooked meal was served.

In the control group the original situation was kept. The dining room was not decorated and the 15 residents of a ward would eat in the dining room with about 2 to 4 nurses present. In this way attention would be paid only to residents with known eating disorders and residents did not consume their meal at the same time. The cooked meal was served on a tray and the carers did stay in the dining room during mealtime. For the bread-based meal, residents got ready-to-eat sandwiches that were prepared in advance by the nurses thereby restricting the daily food choice.

Measurements

Body weight

A fixed protocol was defined and used to assess patients' body weight as index of the nutritional status every four months. It was measured before breakfast after voiding (to the nearest 0.1 kg, Seca weighing scale in which the patients could sit in) with the patient dressed in light clothing without shoes.

Table 1: Description of the program used for the one-year intervention in the institution

Issues	***Desired improvement***	***Means***
physical environment and atmosphere of the dining room	Decoration of the room adapted to the activities	• Plant or flowers placed on every table and sufficient lighting. • Background music chosen by the patients.
	Cleaning organization	• Just before meals tables dressed up in the dining room with appropriate tablecloths and dinner plates. • No cleaning activities in the dining room during meal consumption. • Immediately after meals, tiding up the dining-room for the social activities.
Food service	Meal service	• Trays and covers removed from the table, carts out of patients' sight. • Dishes served on dinner plate per course and per table. • Simultaneous start of the meal per table and possibility of receiving help when necessary. • Breakfast and supper served per table and at patients' discretion: no ready-to-eat sandwiches.
	Between meals periods	• Continuous availability of coffee, tea and soft drink such as fruit juices outside meal periods.

To be continued

Nursing staff	Organization of the assistance	• Rescheduling nursing staff time table to have enough nurses at mealtime (1 nurse for 2 patients). • No walking around of the nursing staff in the dining room during meals. • Medications handed out before the start of the meal to distinguish medical care and meals. • No interference with patients' meal: no questions or wishes for the next meal.
	Standardization	• Program monitoring every trimester by both nursing staff and researchers.

Dietary intake

Dietary intake data were collected by project dietitians using both observation and weighing-back methods (14) and lasted three consecutive days including a weekend day. For bread-based meals food intake was followed by means of precise individual weighing of foods before service and left-overs up to an accuracy of 0.1 g. For the cooked meal, individual menus and recipes of the 3 days of dietary record were obtained in advance from the kitchen. Food consumption at the cooked meal was registered by keeping records of chosen foods and amounts served. After the meal, waste was weighed. All foods and beverages consumed outside regular mealtimes were also carefully recorded. Portion sizes were derived from a Dutch table of regular food portion sizes and household units (15). Dietary data were converted into nutrients using a computerized version of the Dutch food composition table (16).

Biochemical indicators of health status

Fasting blood samples were taken at baseline and at the end of the intervention for hematological analyses by antecubital venipuncture with the patient in sitting position (one 5 ml EDTA tube, one 5 ml gel tube). Hemoglobin and leukocytes were analyzed in fresh EDTA blood on a Technicon hematology H1 analyzer (Technicon Instruments Co., Tarrytown, NY, USA). The gel tube was centrifuged and frozen at -75°C to be analyzed in one run.

Quality of life

Quality of life was assessed by combining the Dutch versions of two validated questionnaires to detect possible changes in health related behavioral and functional status. The first questionnaire, a part of the Sickness Impact Profile 68 (SIP, 17 items) focusing on self perceived physical autonomy was used as a behaviorally based measure of health status. Together with the SIP, a Dutch version of the Philadelphia Geriatric Center Moral Scale (PGCMS, 17 items) focusing on self perceived life satisfaction was added (17;18).

Data analyses

For the residents who completed the trial, means ± standard deviations (SD) of baseline and absolutes changes values were calculated per group for the outcome variables. For the dropout group, only baseline characteristics as well as body weight data were analyzed. Changes were compared by using an unpaired t-test for differences between groups and by using a paired t-test for difference between baseline and follow-up within groups. A p-value ≤ 0.05 was considered statistically significant. Data were analyzed using the SAS program (19)

Results

Patients baseline characteristics

Figure 1 present the study flow chart. From the sixty elderly invited to participate in the trial, forty-two were volunteers and thirty-eight could be enrolled. After one year, twenty-two could complete the whole study. Drop out cases (control, n=7 and experimental, n=9) were patients who failed in completing the study mostly because of death (75%), move (12.5%) or progressive diseases /personal reasons (12.5%)

Table 2 presents patients baseline characteristics. Gender distribution, age and mean body weight were similar for control, experimental and drop out groups.

Patients were comparable with respect to quality of life, diseases and treatments. All participants used medications (3.5±1.8 medications per individual and per day) mainly prescribed for cardiovascular diseases, pain or digestive track disorders.

Table 2: Baseline characteristics of the study population

variable	total populatio n=38	control group n= 10	experimental group, n= 12	drop out n=16
Mean age (y)[1]	82.2 (7.9)	78.2(7)	82.6(7.5)	84.8 (14.9)
Gender (male/female)	13/25	3/7	4/8	6/10
Mean body weight (kg)[1]	62.9(13.4)	63.9(12.5)	66.5(14.0)	59.2(10.8)
Dentures (% yes)[1]	80	80	84	82
Wheelchair (% yes)[1]	90	80	92	95
Diagnosed diseases (mean per subjects)[1]	2.6 (1.3)	2.3 (1.3)	3 (1.2)	2.6 (1.4)
Drug use (mean number/day)[1]	3.5 (1.8)	2.9(1.7)	4.1 (1.7)	3.5(1.9)
SIP (range 0-100)[2]	-	42(19)	33(21)	-
PGCMS (range 0-100)[2]	-	67(30)	58(16)	-

Data are shown as group: (1) mean (SD) or percentage of 'yes' answered. (2) SIP [Sickness Impact Profile] and PGCMS [Philadelphia Geriatric Center Moral Scale] were only assessed for n=8 in control group and n=8 in the experimental group.

Body weight

Mean body weight significantly increased over one-year period in the experimental group: +3.3 kg±5.0, $p<0.05$; n=12, while it stayed relatively stable in the control group :-0.4±4.0 kg, $p=0.78$; n=10. These changes in body weight over one year period differed significantly between groups ($P<0.05$).

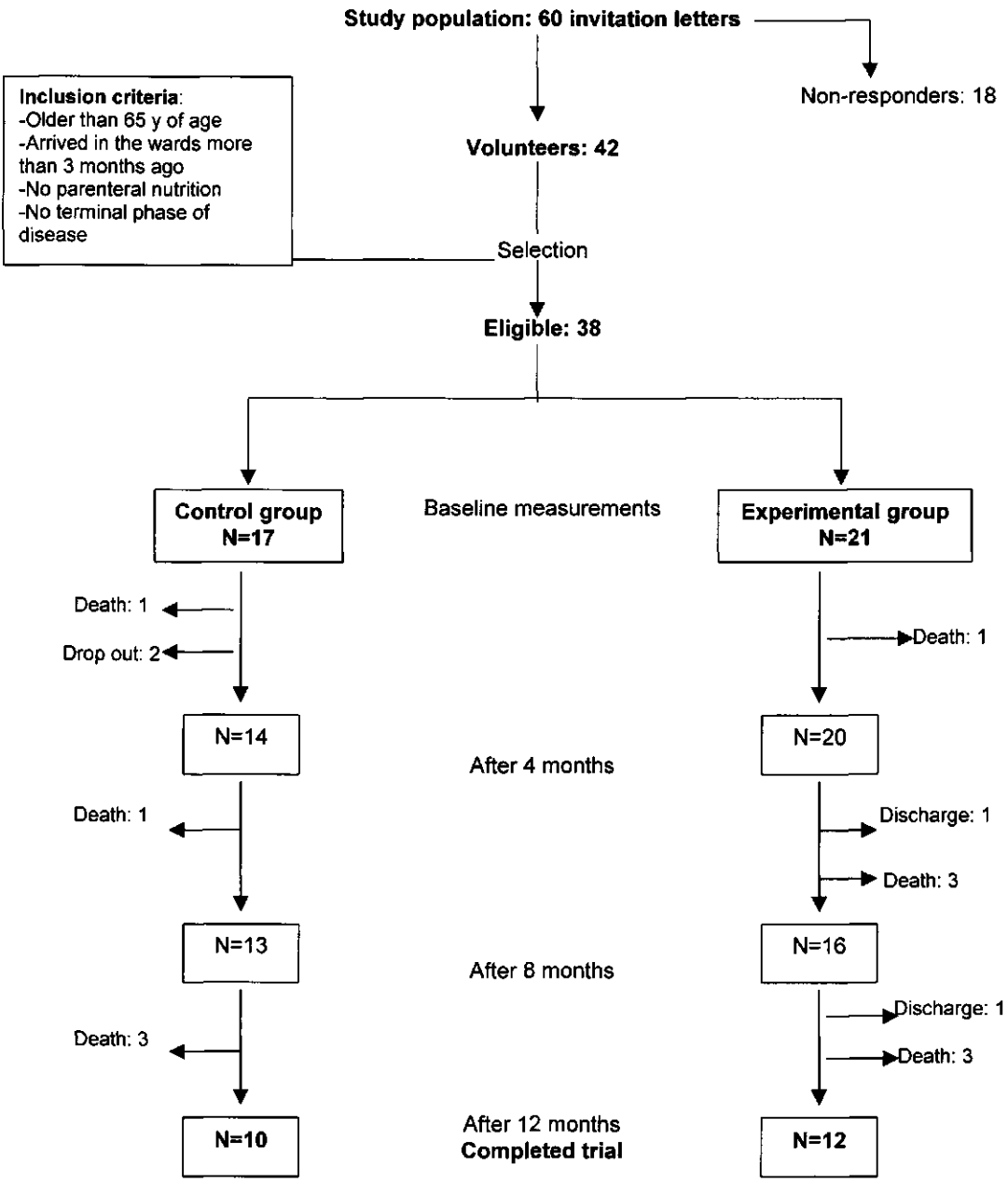

Figure 1: Flow chart of the nursing home residents for the one-year intervention study

Figure 2 shows the repartition per group for weight changes. Number of people losing and gaining weight was similar in the control group. In the experimental group a trend for weight gain was observed.

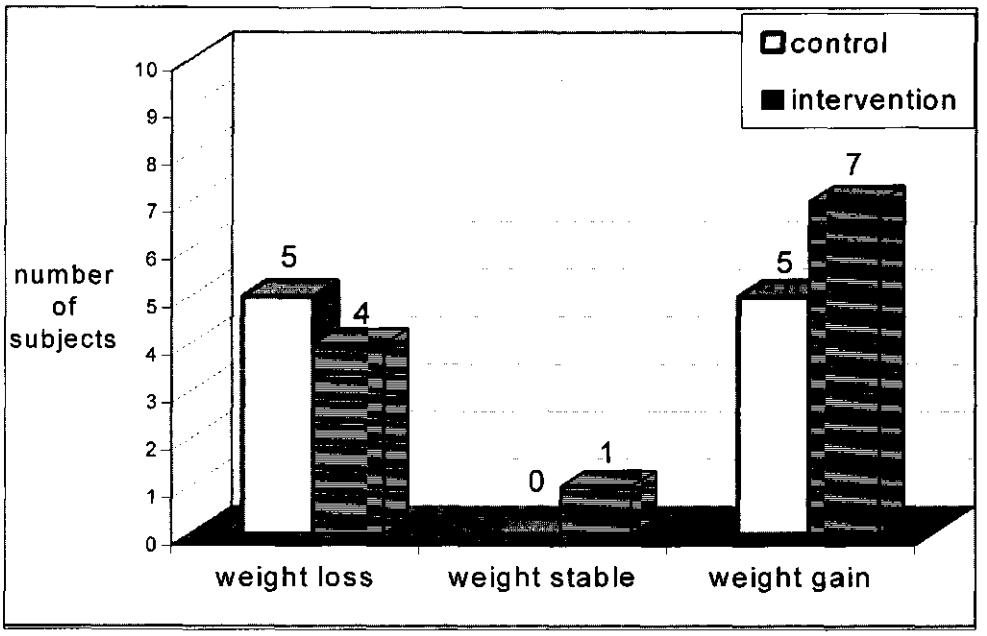

Figure 2: Number of residents losing or gaining weight over the one-year intervention period.

Body weight characteristics of the drop out subgroup are presented in table 3. Most of the drop out residents presented weight loss in the last 4 months.

Table 3 Characteristics of the dropout groups: age and body weight at baseline and absolute changes at a given time (C; control group, E: experimental group)

Period of dropout	0-4 months		4-8months		8-12 months	
Group	C	E	C	E	C	E
n	3	1	1	4	3	4
Age at baseline	85.7±12.2	91.0	95.0	84±11	82.7±4.5	83.3±9.8
Body weight:						
Baseline	55.6±12.5	52.0	48.1	64.0±19.3	69.7±10.1	55.5±12.7
After 4 months	-	-	48.0	64.1±18.7	70.8±8.1	55.0±14.4
After 8 months		-	-	-	62.7±7.9	54.2±12.8

Dietary intake

Table 4 presents dietary intake and absolute changes after a one-year intervention period for the residents who completed the trial. At baseline dietary energy intake

was low in both groups (5.4±1.5 MJ for the control group and 6.1±1.4 MJ for the experimental group) and below the minimum Dutch requirement for nursing home residents (6.8 MJ/Day).

Table 4: Selected nutrient and energy intake of nursing home elderly residents: baseline values and absolute changes after one-year intervention

variable	Control group (n=10)		Experimental group (n=12)	
	baseline	Absolute changes	baseline	absolute changes
Energy				
kJ	5431 (1540)	767 (1040)*	6055 (1360)	819 (1699)
kcal	1292 (368)	185 (247)*	1440 (324)	199 (406)
Energy (kJ)/ Weight (kg)a	87(26)	12 (21)	96 (27)	4 (27)
Carbohydrate (g)	167 (44)	7 (40)	189 (46)	-4 (48)
% total energy	54 (10)	-6 (5)*	53 (6)	-8 (6)*
Fat(g)	48 (20)	14(12)	52 (15)	21 (21)
% total energy	32 (8)	5 (5)*	32 (5)	8 (5)*
Protein (g)	47 (16)	7 (11)	52 (15)	8 (16)
% total energy	14 (2)	0 (2)	15 (3)	0 (3)
(g) /body weight (kg)a	0.7 (0.2)	0.1(0.2)	0.8 (0.3)	0.0 (0.3)
Alcohol	1 (0)	0 (1)	1 (2)	0 (2)
% total energy	0 (1)	0 (1)	0 (1)	-0 (2)
Dietary fiber (g)	10 (4)	3 (2)	12 (4)	4 (2)*
Calcium (mg)	756 (204)	-115 (147)*	893 (254)	32 (269)
Total iron (mg)	5.8 (2.4)	1.4 (1.7)*	6.4 (2.5)	0.7 (3.0)
Vitamin B1 (mg)	0.6 (0.2)	0.1 (0.2)	0.7 (0.3)	0.1 (0.4)
Vitamin C (mg)	55.5 (17.7)	-9.3 (23.8)§	45.0 (24.6)	22.3 (43.9)*
Total tocopherol (mg)	9.5 (3.5)	-2.4 (2.1)*§	9.5 (2.8)	3.5 (4.4)*

Results are given as mean (SD); a: n=11 for the experimental group and n=9 for the control group. §: Significant difference between control and experimental group, ($P \leq 0.05$), *: Significant difference in changes within group as compared to baseline ($P \leq 0.05$)

As expressed per unit of body weight dietary intake was also lower than the recommended adequate intake (120 kJ/kg body weight) with 87±26 kJ/kg body weight and 96±26 kJ/kg body weight for the control group and the experimental group, respectively. As a consequence of the low energy intake, intake of vitamin A, vitamin B complex and vitamin C was below the Dutch minimum requirements.
At the end of the intervention period, no differences in energy and macronutrient intake were observed between groups. Changes in intake of vitamin C and vitamin E

differed significantly between the control and the experimental group. Despite a significant increase, dietary intake in the control group was still below the Dutch RDA for both energy and nutrient intake.

In the experimental group, changes in energy intake showed a positive trend and a significant increase in intake of vitamin C and vitamin E brought these values above the RDAs. The increased intake in vitamin E was the consequence of an overall increase in dietary intake and could not be related to a particular type of food. Increase intake of vitamin C in the experimental group was mainly due to the consumption of fruit juices and dairy products, which represented about 2.8 drinks (or 420 g) per patient and provided about 85.7 % of the vitamin C intake.

Biochemical indicators of health status

Hemoglobin and its related factors stayed relatively stable in the experimental group while they decreased in the control group (Table 5). Significant differences between groups were observed for changes in hemoglobin and two hemoglobin-related factors: MCH (Mean Corpuscular Hemoglobin) and MCHC (Mean Corpuscular Hemoglobin Concentration).

Table 5: Biochemical indicators of health status of nursing home elderly residents: baseline values and absolute changes at the end of one-year intervention.

	control group			experimental group		
	n	baseline	absolute changes	n	baseline	absolute changes
Hb (mmol/l)	8	8.15 (1.20)	-0.33 (0.43) *§	10	8.24 (0.59)	0.18 (0.68)
Ht (l/l)	8	0.40 (0.05)	-0.02 (0.02)	10	0.42 (0.02)	0.00 (0.03)
RBC (*10E12/l)	8	4.45 (0.57)	-0.00 (0.41)	10	4.61 (0.45)	0.09 (0.29)
MCV (fl, 10E-15)	8	90.4 (3.6)	-3.5 (4.2) *	10	90.8 (7.7)	-1.7 (1.9) *
MCH (amol)	8	1825 (142)	-66 (113) §	10	1798(162)	8 (48)
MCHC (mmol/l)	8	20.2 (0.4)	0.1 (0.4) §	10	19.8 (0.4)	0.5 (0.5) *
Leukocyte (10E9/l)	7	5.9 (1.2)	-0.8 (1.3)	10	8.0 (1.0)	-0.9 (1.2) *
Thrombocyte (10E9/l	7	234.9 (32.7)	25.4 (39.0)	9	280.8 (86.8)	12.7(50.7)

Results are presented as mean (SD); §: significant difference between control and experimental group, (P≤0.05); *: significant difference in changes within group as compared to baseline (P≤0.05), Ht: hematocrit, hb: hemoglobin

Quality of life

Quality of life could only be assessed in 8 of 10 and 8 of 12 subjects for the control and experimental group, respectively. The mean SIP (Sickness Impact Profile) score in the control group significantly declined (-13±12%, p<0.05) while it stayed stable in the experimental group (-2±11%). Mean changes in PGCMS (Philadelphia Geriatric

Center Moral Scale) scores were relatively stable with -2±19% for the control group and -3±20% for the experimental group.

Discussion

This study showed that in a group of nursing home residents with poor health, improving the social ambiance of food consumption led to a positive change in mean body weight and a relatively stable health condition. The nutritional and health benefits of the intervention program were reinforced by a stable self-perception of functional status in the experimental group. In the control group slight declines in body weight and biochemical indicators of health status were paired with a significant decrease of the self-perceived functional status.

These results are in agreement with former findings revealing that a higher body weight appear to be a favorable factor in residents above 85 years old (20;21) and that a low or decreasing mean body weight is associated with poor health in Dutch nursing home residents (22). In other words weight gain does not seem to be detrimental in such an elderly population. Furthermore, our results emphasize the importance of long-term body weight monitoring as a screening tool to assess change in health and subsequently quality of life in a nursing home setting.

A striking issue in this study was the relatively high drop out rate with about 42% in each group. However this observed rate is in accordance with the mean time of residence in somatic wards in a Dutch nursing home of 392 days. According to the latest survey about 64 % of the nursing home resident will move or die within 6 months of arrival (23). This drop out rate is more likely to be explained by the preexisting morbid conditions than by study apathy.

Mean daily energy intake in the experimental group was increased and was above the limit of 6.8 MJ (24). We assume that the positive changes in health and nutritional status may result from a change in dietary intake, which was probably the effect of the intervention program. As an example, the higher choice offered between meal with the availability of fruit juices and dairy drinks was partly responsible for the increase in vitamin intake.

In this study biochemical measures of vitamin status were not included but the blood parameters used were related to health and less so to the diet. However, the observed increase in dietary intake was not reflected in a higher measured energy intake in the experimental group compared to the control group. This might be explained by the fact that the dietary intake was measured for three days at baseline and follow-up giving actually a snapshot of usual dietary intake. Day to day variation might be rather high especially in a nursing home resident population. Furthermore, considering the very low baseline values -although similar to other studies in nursing

home elderly resident (25-27)-, one could hardly expect a further decrease in food intake in both groups. The measured differences in mean body weight give a better estimate of the overall changes in cumulative differences in energy intake over the one-year experimental period.

Although it has often been acknowledged that psychosocial factors might have an important contribution to a low nutritional status (27-32), there are few data available on this issue (33). As far as we know only one study also assessed the health effects of a changed meal environment (33). In the latter study an improvement of food intake and biochemical indicators of health status was also observed. However this study was performed on a relatively short-term period and since they had no control group it is difficult to say if the supplementary food intake resulted from the intervention or from other factors. Results of our study shows that environmental factors are important for nutritional health in a nursing home residents population where internal factors like diseases, well-being or morbidity and external factors such as nutritional intake and medications are decisive for compliance rate and the ultimate results.

In this study the chosen option was to re-organize the timetable of the nursing staff in order to have enough nurses present at meal times and to teach them that careful attention to the nutritional intake of nursing home residents was both a clinical and a quality-of-life issue. This could be realized during the whole intervention program by conducting an efficient re-organization of the whole nursing staff planning and schedules. The rescheduling was realized with no extra financial expense. In agreement with nursing staff and patients, it led to special attention for bath and wash and meals activities while a slight reduction occurred for other activities.

By providing individualized care at meal time and ensuring that an adequate number of staff were available to assist patients who needed help, meal time became an individualized and pleasant social event for both staff and patients. Results of this study were sufficiently beneficial to convince the board and management of the nursing home to apply the developed intervention protocol at the end of the trial to all other somatic wards of the nursing home.

In conclusion, improvement of the social ambiance of food consumption in this nursing home was a non-negligible way to stabilize health and nutritional status of nursing home elderly residents.

Acknowledgement

We would like to thank the residents and the nurses of the nursing home Aeneas for their cooperation in this study. We also would like to thank Rineke Meulendijks for her help in collecting the data.

References

1. Gants R. Detection and correction of underweight problems in nursing home residents. J Gerontol Nurs. 1997;23:26-31.

2. Henderson CT. Nutrition and malnutrition in the elderly nursing home patient. Clin Geriatr.Med 1988;4:527-547.

3. 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.

4. Fischer J, Johnson MA. Low body weight and weight loss in the aged. J Am Diet Assoc. 1990;90:1697-1706.

5. Lehmann AB, Bassey EJ. Longitudinal weight changes over four years and associated health factors in 629 men and women aged over 65. Eur J Clin Nutr 1996;50:6-11.

6. Mowe M, Bohmer T. Nutrition problems among home-living elderly people may lead to disease and hospitalization. Nutr Rev 1996;54:S22-S24

7. Silver AJ, Morley JE, Strome LS, Jones D, Vickers L. Nutritional status in an academic nursing home. J Am Geriatr.Soc 1988;36:487-491.

8. Marcus EL, Berry EM. Refusal to eat in the elderly. Nutr Rev 1998;56:163-171.

9. Bower ME. The resident dining room--a CQI project. J Nutr Elder. 1996;15:47-54.

10. Feunekes GI, De Graaf C., Van Staveren WA. Social facilitation of food intake is mediated by meal duration. Physiol.Behav. 1995;58:551-558.

11. De Castro JM. Social facilitation of the spontaneous meal size of humans occurs on both weekdays and weekends. Physiol.Behav. 1991;49:1289-1291.

12. De Castro JM. Social facilitation of food intake in humans. Appetite 1995;24:260-26s.

13. Ribbe MW, Ljunggren G, Steel K, et al. Nursing homes in 10 nations: a comparison between countries and settings. Age Ageing 1997;26 Suppl 2:3-12.

14. Cameron M, Van Staveren W. Manual on the methodology of food consumption studies. Oxford University Press, 1988.

15. Donders-Engelen M.R., Van Der Heijden L, Hulshof KFAM R. Maten, gewichten and codenummers 1997 (food portion sizes and coding instructions 1997). Rapport TNO Zeist. 1997 ed. The Netherlands: 1997.

16. Anonymous. NEVO 1997. Stichting Nederlands voedingsstoffenbestand. Dutch Nutrient Database 1997. The Hague, The Netherlands: Voorlichtingsbureau voor de voeding, 1997.

17. Van Campen C., Kerkstra A. [Perceived quality of life of elderly somatic nursing-home patients. Construction of a measuring instrument]. Tijdschr Gerontol Geriatr. 1998;29:11-18.

18. Van Campen C., Kerkstra A. [Experienced quality of life of somatic nursing home patients: a review of measuring instruments]. Tijdschr Gerontol Geriatr. 1996;27:20-28.

19. SAS Institute Inc. SAS/Stat user's guide version 6. fourth ed. Cary, USA: SAS Institute Inc., 1989.

20. Tayback M, Kumanyika S, Chee E. Body weight as a risk factor in the elderly. Arch.Intern.Med. 1990;150:1065-1072.

21. Mattila K, Haavisto M, Rajala S. Body mass index and mortality in the elderly. Br.Med.J.Clin.Res.Ed. 1986;292:867-868.

22. Berkhout AM, van HJ, Cools HJ. [Increased chance of dying among nursing home patients with lower body weight](in Dutch). Ned Tijdschr Geneeskd 1997;141:2184-2188.

23. 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.

24. van der Wielen RP, de Wild GM, de Groot CP, Hoefnagels WH, Van Staveren WA. Dietary intakes of energy and water-soluble vitamins in different categories of aging. J Gerontol A Biol Sci Med Sci 1996;51 :B100-B107

25. Frisoni GB, Franzoni S, Rozzini R, Ferrucci L, Boffelli S, Trabucchi M. Food intake and mortality in the frail elderly. J Gerontol A Biol Sci Med Sci 1995;50:M203-M210

26. Blaum CS, Fries BE, Fiatarone MA. Factors associated with low body mass index and weight loss in nursing home residents. J Gerontol A Biol Sci Med Sci 1995;50:M162-M168

27. Turic A, Gordon KL, Craig LD, Ataya DG, Voss AC. Nutrition supplementation enables elderly residents of long-term-care facilities to meet or exceed RDAs without displacing energy or nutrient intakes from meals. J Am Diet Assoc. 1998;98:1457-1459.

28. Potter J, Langhorne P, Roberts M. Routine protein energy supplementation in adults: systematic review. BMJ. 1998;317:495-501.

29. 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.

30. Van Houten P, Lowik MR. [Nutrition and nutritional status of female somatic nursing home patients]. Ned Tijdschr Geneeskd 1995;139:227-231.

31. Tripp F. The use of dietary supplements in the elderly: current issues and recommendations. J Am Diet Assoc. 1997;97: S181-S183

32. Morley JE, Silver AJ. Nutritional issues in nursing home care. Ann.Intern Med 1995;123:850-859.

33. Elmstahl S, Blabolil V, Fex G, Kuller R, Steen B. Hospital nutrition in geriatric long-term care medicine. I. Effects of a changed meal environment. Compr.Gerontol A 1987;1:29-33.

5

Effect of an evening supplement provided to nursing home elderly on body weight and dietary intake*

Marie-Françoise A. M. Mathey, Cees de Graaf, Wim Schimmel

and Wya A. van Staveren

Abstract

Objective: to investigate the effects of the introduction of an evening vitamin- and energy-rich snack on average dietary intake and body weight of nursing home elderly.

Participants: men and women aged 65 and over participated either in the experimental group (N=26) or the control group (N=26)

Methods: a parallel intervention study design was used. Every evening for 30 days, the experimental group consumed an energy and vitamin-rich drink (200 ml; 1,2 MJ) around 19:30, whereas the control group received usual coffee and tea. Outcomes were body weight, average dietary intake based on 3-days record measured before and after the experiment.

Results: a weight gain trend was observed in the experimental group (+0.8kg, $P \leq 0.05$) whereas the weight of the control group stayed stationary (+0.1 kg). Dietary intake increased more in the experimental group compared to the control group.

Conclusions: in our nursing home elderly, a regular intake of energy and vitamin -rich drinks in the evening had a positive influence on food intake and prevented weight loss.

*Submitted

Introduction

Unintentional weight loss leading to low body weight is one of the first indicators of reduced nutritional status in elderly patients (1;2). This is important for nursing home elderly where adequate nutrition seems to be essential for well-being and optimal medical care (3-6).

In addition to age-related changes, factors such as lack of food choice, lack of help at eating time, depression, medications and cognitive function impairment may contribute to a low food intake and weight loss. Several studies showed that, due to its multifactorial origin, decrease in appetite remains a difficult problem in geriatric care (7-10).

Nursing home elderly with reduced physical capacity often have a fixed meal pattern that might not be physiologically adequate (8). An individual spontaneous intake outwith regular mealtime is not possible within most organizations. In western country institutions, the last meal is often served in the late afternoon. Thereafter there is a time gap during which no foods are provided. When food is only served between 9 a.m. and 5 p.m., it seems difficult to ensure sufficient intake of macro- and micronutrients. In this situation, it might be beneficial from a nutritional but also social perspective to provide a snack in the course of the evening.

The aim of this study was to assess, in a one-month period, the effect of an evening vitamin- and energy-rich snack in nursing home elderly on dietary intake and body weight.

Subjects and methods

Design

For the intervention we used a parallel design with repeated exposures (30) to an evening snack. Wards were randomly assigned to control or experimental group.

Subjects

Sixty-one nursing home elderly from two somatic wards were invited to join the study. The main inclusion criterion was to be older than 65 y of age. Exclusion criteria were renal dialyze, or specific nutritional disease-related care such as parenteral nutrition. Before joining the study, subjects and their contact person received detailed information describing the study and signed an informed consent.

The study was conducted at the institution Tilburg Zuid (Tilburg, The Netherlands), with approval from the Medical Ethical Committee of the Division of Human Nutrition & Epidemiology of the Wageningen University.

Supplement

We chose for an easy to drink milk-based product available in small volume (200 ml), with an attractive packaging and tasty flavors (strawberry-raspberry, vanilla, apricot, chocolate) but also a high nutrient density especially for water-soluble vitamins, calcium and magnesium (Table 1). This type of drink was also selected for its availability in most institutions.

Table 1: nutritional composition of the snack offered to institutionalised elderly

	Per portion of 200 ml	% RDA per 200ml
energy (kJ) [kCal]	1200 [300]	15
carbohydrate (g) [En%]	42 [55]	-
fat(g) [En%]	10 [30]	-
protein (g) [En%]	11 [15]	-
vitamin B1 (mg)	0.30	21
vitamin B2 (mg)	0.36	23
vitamin B6 (µg)	1.5	21
vitamin B12 (µg)	0.90	90
vitamin C (mg)	16	27
vitamin A (µg)	150	19
vitamin D (µg)	0.76	15
vitamin E (mg)	3	30
folic acid (µg)	54	27
calcium (mg)	160	20
magnesium (mg)	60	20
iron (mg)	3	21
sodium (mg)	160	-
potassium (mg)	340	-
zinc (mg)	3	20

[En%]: percentage of the energy of the snack supplied by this macronutrient

Procedure

Every evening around 19:30, subjects from the experimental group were personally offered the drink. They were asked to choose the flavor and to consume the drink before 20:30. If needed they could receive help from the staff. The drink was served either in their bedroom or in the living room. Compliance, consumed quantity, chosen taste and place of consumption were registered. Simultaneously, the control group received coffee and tea only to pay the same attention to both groups.

Before and at the end of the intervention, dietary intake and body weight were recorded.

Measurements:

Dietary intake

Dietary data were collected by trained research assistants using both observation and weighing-back methods (11). For all subjects dietary measurement lasted three consecutive days starting on Sunday. The usual meal pattern in the institution was continued during the intervention: breakfast and supper were bread-based meals and at lunchtime around noon a cooked meal was served. Bread-based meals were prepared and served by the nursing staff in the dining room. Intake was recorded after weighing of these foods before service and left-over up to an accuracy of 0.1g.

For the cooked meal food consumption was registered by keeping record of foods and portion sizes served; after the meal, waste was weighed. Portion sizes were derived from a Dutch table of regular food portion sizes (12). All foods and beverages consumed outside regular mealtimes were also carefully recorded.

Dietary data were converted into nutrients using a computerized version of the Dutch food composition table 1996 (13).

Body weight

A fixed protocol was used to assess subjects' body weight as index of the nutritional status. It was measured before breakfast, after voiding and with the subjects in light clothing without shoes on a sitting Seca weight scale(to the nearest 0.1kg).

Data analysis

Baseline means ± standard deviations (SD) and absolutes changes ± SD were calculated per group for all outcomes. They were compared by using an unpaired t-test for differences between experimental and control groups and with a paired t-test for difference within groups.

A p-value $\leq$ 5% was considered as statistically significant. All analyses were conducted with SAS statistical package (14;15).

Results

Subjects characteristics and dietary intake at baseline

Table 2 presents subjects' compliance to the trial. Drop out cases were subjects who failed in completing the study because of death, low snack consumption (snack consumed less than 20 times in 30 days), parenteral nutrition due to a daily energy intake below 600kCal (2500kJ) or absence during part of the observation period.

Table 3 presents baseline characteristics. Gender distribution and age were similar for both groups. Experimental group mean body weight was slightly but not significantly higher than in the control group. All participants used medications (4.2±1 per subject and per day) mainly prescribed for cardiovascular diseases or nervous system disorders.

Table 2: Compliance of institutionalised elderly to evening snack

Reason	Control	Experimental
total number of patients per group, refusal	31	30
non-respondents	3	2
exclusion criteria	2	2
number at the start of the study	26	26
drop out		
deceased	1	2
snack consumption below 20 portions/month	-	7
other reasons (•)	5	3
Total completing the trial	20	14

(•): Absence during dietary record, acute illness during the trial, death of a family member

Energy intake was rather low with 6.3±0.4MJ for the control group and 6.8±0.4MJ for the experimental group, and below the Dutch RDA (7.8MJ/Day). Energy intake expressed in kJ/kg body weight was also lower than the RDA (120 kJ/kg body weight) with 99 ± 5 kJ/kg body weight for the control group and 100 ± 7 kJ/kg body weight for the experimental group. Macronutrient intake was comparable in the two groups: percentage of energy derived from carbohydrate was lower than the RDA (50-55% of total energy) while percentage of fat intake was higher than the RDA (30-35% of total energy).

Table 3: baseline characteristics [mean (SD)]of institutionalised elderly

	Control	Experimental	p-value
Anthopometric data§			
gender (M/F)	9/17	8/18	-
age (y)	80.5 (2)	79 (2)	0.63
weight (kg)	63.5 (2.6)	69.5 (2.3)	0.09
Dietary intake data§§			
energy (MJ)			
mean(SD)	6.3 (0.4)	6.8 (0.4)	0.43
median	6.5	6.8	-
kJ/ body wt (kg)	99 (5)	100 (7)	0.91
carbohydrate (g)			
Mean (SD)	167 (9.5)	188 (12.8)	0.20
% total energy	46 (1)	47 (2)	0.41
fat(g)			
Mean (SD)	70 (25.5)	71 (25.3)	0.87
% total energy	41 (1)	39 (1)	0.35
protein (g)			
Mean (SD)	50.0 (3.8)	56(4.3)	0.33
% total energy	13 (1)	14 (1)	0.58
Protein /body wt (kg)	(0.1)	0.8 (0.1)	0.61

§: N=26 in both groups; §§: N=20 for the control group and N=22 for the experimental group.

Percentage of protein intake as well as absolute intake were in general adequate at baseline for both groups. Intake of vitamin and minerals in both groups did only fulfill 60% (vitamin B1, B6, calcium and magnesium) to 75% (vitamin B2, C) of the Dutch RDA (data not shown).

After the intervention period

The experimental group was separated in two sub-groups: compliers (n=14) and drop out subjects i.e. those who consumed the snack less than 20 times (n=7). Therefore results on dietary intake and body weight changes are presented for the control vs. compliers of the experimental group and for the compliers vs. the drop out of the experimental group.

Dietary intake

Dietary intake after the intervention period and absolute changes are presented in Table 4. Total energy intake was significantly different between control and compliers. Changes in macronutrient intake occurred in both groups but in an inverse direction.

Table 4: Dietary intake of institutionalised elderly after the intervention period: comparison between control and experimental groups

	Control (n=20)	*changes compared to baseline*	Experimental compliers (n=14) §	*changes compared to baseline*	Experimental drop out (n=7)	*changes compared to baseline*
energy (MJ)						
mean(SD)	6.7 (1.7)	*0.4 (0.8)*	8.1 (1.7)†‡	*0.7(1.0)a ‡*	6.0(1.4)	*0.1(1.5)*
median	7.2	*0.7*	7.6	*0.8*	5.8	*0*
energy (kJ)/ body wt (kg)	105 (25)	*6 (15)*	120 (9)‡	*8(17)a ‡*	85 (25)	*0 (3)*
carbohydrate (g)						
mean (SD)	167 (9)	*-0(39)*	224 (50) †‡	*24(24)a ‡†*	173(43)	*-5(33)*
% total energy	43 (6)	*-3 (5)a*	48 (4) †	*3(6) a ‡†*	49(7)	*2(2)a*
fat(g)						
mean (SD)	77(24)	*7(12)a*	80 (6)‡	*-1 (22)*	58(17)	*1(20)*
% total energy	43 (6)	*2(6)*	38 (4) †	*-3 (6) a ‡†*	37(4)	*-0(4)*
protein (g)						
mean (SD)	60 (19)	*10(13)a*	72 (14) †‡	*7(17)*	49(13)	*8(11)*
% total energy	15 (2)	*2 (2)a*	16 (2)	*1(2)*	14(2)	*2(2)a*
protein /body weight (kg)	0.9 (0.3)	*0.2(0.2)a*	1.1 (0.2)‡	*0.1(0.2)a ‡*	0.7(0.2)	*0.1(0.1)*

§: N=14 except for protein/body weight and energy (kJ)/ body wt (kg) where N=13. Significant difference between group: † P≤0.05 compliers vs. control, ‡ P≤0.05 drop out vs. compliers. a: P≤0.05 , significant difference in changes after the intervention period within groups.

While carbohydrate intake of the compliers significantly increased both in absolute intake (24 ± 24 g) and percentage of total energy intake (3%), this intake in the control group stayed relatively stable with a small significant decrease in percentage of total energy intake (-3%). Besides, percentage of fat intake significantly decreased in the compliers but did significantly increase in the control group. Protein intake increased in both groups but, despite a significant change in the control group (10 ± 13 g), it was still significantly higher in the compliers (72 ± 14 g) compared to the control group (60 ± 19 g) or the drop out (49 ±13 g). Energy and macronutrient intakes in the compliers group were found to be generally significantly higher than in the drop out group. Macronutrient intake of the drop out group was relatively stable.

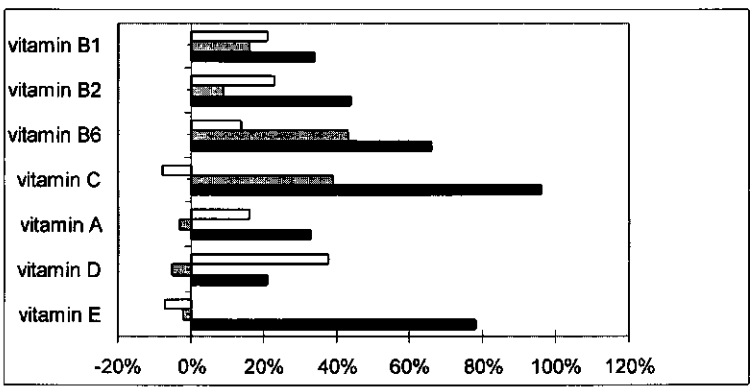

Figure 1a: Relative changes in vitamin intake of elderly nursing home inhabitants: control (□, n=20), experimental drop out (■ ,n=7) and experimental compliers (■ , n=14).

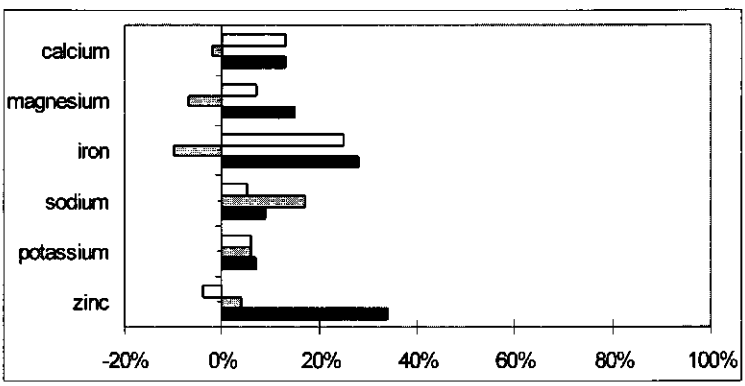

Figure 1b: Relative changes in mineral intake of elderly nursing home inhabitants: control (□, n=20), experimental drop out (■ ,n=7) and experimental compliers (■ , n=14).

Figure 1 shows relative changes in micronutrient intake after the intervention period. As expected, intake of vitamin B6, C and E significantly increased in compliers (66%, 96% and 78%, respectively) compared to the control group (14%, -8% and -7%, respectively). Within the experimental group, comparison of vitamin intake between drop out and compliers significantly differ in riboflavin (9 % vs. 44%), vitamin D (-5% vs. 21%) and vitamin E (-2% vs. 78%). Only changes in zinc intake differed significantly between control (-4%) and compliers (34%). No differences in changes of micronutrient intake were observed between drop out and control group.

Body weight changes

Table 5 presents body weight changes. Compliers showed a small but significant increase of 0.8 ± 1.7 kg (P=0.05) in body weight. A relatively stable body weight was observed in the control group (0.1± 1.5kg) while a decrease (-0.4±1.7kg) occurred in the dropout group.

Table 5: body weight of institutionalised elderly at baseline and absolutes changes [mean (SD)] after the intervention period

Group		Baseline	*absolute changes compared to baseline*
Control	(n=20)	64.6(15)	*0.1(1.5)*
Experimental	compliers (n=13)	69.8 (15.0)	*0.8(1.7) ‡*
	drop out (n=7)	70.1(6.5)	*-0.4(1.7)*

‡: P≤0.05, significant difference in changes after the intervention period within groups.

Discussion

Results of this study showed both qualitative and quantitative improvements of food intake in the group consuming the evening snack.

A snack is defined as a food or a light meal, which can be consumed between the normal meals i.e. between breakfast, dinner and supper. In free-living elderly, snacking habits have been found to be important due to its relative large part in the daily food intake (16;17). In institutions, snacking habits mostly depend on food choice and availability and on physical possibilities that people have to get extra foods. In this situation, providing a vitamin and energy-rich drink as snack is a possibility to correct an unbalanced diet (18). As far as we know this study was the first to assess the effect of an evening vitamin- and energy-rich snack on diet adequacy and body weight in nursing home elderly. However, a drop out of twenty-seven percent shows that compliance to a nutrient-dense snack in the evening is difficult for some

groups. Factors such as diseases, medications and environmental parameters like family visits did distract from taking a drink.

Although this group considered as accelerated agers, benefits from similar health care, it is still heterogeneous regarding disease status and medicine uses but also body weight. Therefore standardized protocols are difficult to conduct within this population. Our subjects had a low energy and nutrient intake. Since dietary data rely on observed intake and weighted left-overs we believe that we have a rather good picture of their food intake. The fact that these data are similar to previous findings regarding compliance and food intake suggest that this group indeed had a low dietary intake (7;19-21).

The daily intake of an energy and nutrient rich snack had a positive contribution on the general intake of macro and micronutrients. When the snack was included in the diet intake of certain micronutrients such as vitamin B1, B6, C and D, calcium and magnesium reached the Dutch RDA. This means that the snack intake was not compensated but consumed in addition to the daily eating pattern. On one hand this indicates that there is indeed a need for an extra snack in the evening. On the other hand, a general decline in homeostatic capabilities has been observed in elderly and it might explain why this extra food consumption was not regulated. The positive weight change confirmed both facts: the need for extra energy and the lack of regulation, in agreement with earlier findings (22-25).

Although baseline body weight in the experimental group was slightly higher than in the control group we think that the observed weight gain after one month indicates a possible improvement of the general nutritional status. This type of supplementation and the time may give an easy solution to help stop or even reverse weight loss. Furthermore, depending on the snack composition, a regular consumption can contribute to a better proportion in terms of type of fat and carbohydrate converted to energy. An additional advantage of this supplement rich in complex carbohydrate is that it helps to shorten nocturnal fasting (26). Further long-term studies with assessment of biochemical parameters are now necessary to confirm the positive effects of snacking in this population.

In summary, this study showed that the intake of an evening vitamin- and energy- rich snack could improve nutritional status in nursing home elderly.

Acknowledgment

We would like to thank Antine Breimer, Bianca Looise, Brenda van Uffelen and Hugo Ngadijo for their help in collecting the data. We also would like to thank the residents

and the nursing staff of the nursing home Tilburg Zuid for their cooperation in this study.

References

1. Berkhout AM, van HJ, Cools HJ. [Increased chance of dying among nursing home patients with lower body weight](in Dutch). Ned Tijdschr Geneeskd 1997;141:2184-2188.

2. Mulley GP. Preparing for the late years. Lancet 1995;345:1409-1413.

3. Lesourd B, Decarli B, Dirren H. Longitudinal changes in iron and protein status of elderly Europeans. SENECA Investigators. Eur J Clin Nutr 1996;50 Suppl 2:S16-S24

4. Lesourd B. Protein undernutrition as the major cause of decreased immune function in the elderly: clinical and functional implications. Nutr Rev 1995; 53:S86-S91

5. Mowe M, Bohmer T. Nutrition problems among home-living elderly people may lead to disease and hospitalization. Nutr Rev 1996;54:S22-S24

6. Payette H, Gray DK, Cyr R, Boutier V. Predictors of dietary intake in a functionally dependent elderly population in the community. Am J Public Health 1995;85:677-683.

7. Fabiny AR, Kiel DP. Assessing and treating weight loss in nursing home patients. Clin Geriatr.Med 1997;13:737-751.

8. Morley JE, Kraenzle D. Causes of weight loss in a community nursing home. J Am Geriatr.Soc 1994;42:583-585.

9. Morley JE. Anorexia in older persons: epidemiology and optimal treatment. Drugs Aging 1996;8:134-155.

10. Morley JE. Anorexia of aging: physiologic and pathologic. Am J Clin Nutr 1997;66:760-773.

11. Cameron M, Van Staveren W. Manual on the methodology of food consumption studies. Oxford University Press, 1988.

12. Donders-Engelen M.R., Van Der Heijden L, Hulshof KFAM R. Maten, gewichten and codenummers 1997 (food portion sizes and coding instructions 1997). Rapport TNO Zeist. 1997 ed. The Netherlands: 1997.

13. Anonymous. NEVO 1996. Stichting Nederlands voedingsstoffenbestand. Dutch Nutrient Database 1996. The Hague, The Netherlands: Voorlichtingsbureau voor de voeding, 1996.

14. SAS Institute Inc. SAS/Stat user's guide version 6. fourth ed. Cary, USA: SAS Institute Inc., 1989.

15. SAS Institute Inc. SAS/Stat procedure guide version 6. fourth ed. Cary, USA: SAS Institute Inc., 1989.

16. Summerbell CD, Moody RC , Shanks J, Stock MJ, Geissler C. Sources of energy from meals versus snacks in 220 people in four age groups. Eur J Clin Nutr 1995;49:33-41.

17. Vincent D, Lauque S, Nourashemi F, Faisant C, Lanzmann-Petithory, Vellas B. Nutritional value and part of snacks in the daily food intake of 186 healthy elderly subjects in the Toulouse study. J Nutrition, Health & Aging . 1998;1 (1):39-43.

18. Turic A, Gordon KL, Craig LD, Ataya DG, Voss AC. Nutrition supplementation enables elderly residents of long-term-care facilities to meet or exceed RDAs without displacing energy or nutrient intakes from meals. J Am Diet Assoc. 1998;98:1457-1459.

19. Van Staveren WA, de Groot CP, Blauw YH, van-der WR. Assessing diets of elderly people: problems and approaches. Am J Clin Nutr 1994;59:221S-223S.

20. van der Wielen RP, de Wild GM, de Groot CP, Hoefnagels WH , Van Staveren WA. Dietary intakes of energy and water-soluble vitamins in different categories of aging. J Gerontol A Biol Sci Med Sci 1996;51:B100-B107

21. 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.

22. Pelchat ML. Food cravings in young and elderly adults. Appetite 1997; 28:103-113.

23. Roberts SB, Fuss P, Heyman MB, Young VR. Influence of age on energy requirements. Am J Clin Nutr 1995;62:1053S-1058S.

24. Rolls BJ. Appetite and satiety in the elderly. Nutr Rev 1994;52:S9-10.

25. Rolls BJ, Dimeo KA, Shide DJ. Age-related impairments in the regulation of food intake. Am J Clin Nutr 1995;62:923-931.

26. Chang WK, Chao YC, Tang HS, Lang HF, Hsu CT. Effects of extra-carbohydrate supplementation in the late evening on energy expenditure and substrate oxidation in patients with liver cirrhosis. JPEN.J Parenter.Enteral Nutr 1997;21:96-99.

6

Flavor enhancement of food improves dietary intake and nutritional status of nursing home elderly*

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

Abstract

Background: taste and smell losses occur with aging. These changes are supposed to decrease the enjoyment of food, subsequently reduce food consumption and negatively influence the nutritional status of elderly, especially the frail ones.

Objectives: to determine if the addition of flavor enhancers to the cooked meal for nursing home elderly promotes food consumption and provides nutritional benefits.

Design: a 16 weeks parallel group intervention consisting of sprinkling flavor enhancers over the cooked meal of the 'flavor' group (n=36) and not over the control group meal (n=31).

Measurements: Intake at the cooked meal: before, after 8 and 16 weeks of intervention.

Feelings of appetite, daily dietary intake and anthropometry: before and after the intervention.

Results: on average body weight of the 'flavor' group increased (+1.1±1.3 kg, $p<0.05$,) as opposed ($P<0.05$) to that of the control group (-0.3±1.6 kg). Daily dietary intake decreased in the control group (-485±1245kJ, $p<0.05$) but not in the flavor group (-208±1115kJ, $P=0.28$). Intake at the cooked meal increased in the 'flavor' group (133±367kJ, $p<0.05$) but not in the control group (85±392kJ). A similar trend was observed for hunger feelings, which increased only in the 'flavor' group.

Conclusion: adding flavor enhancers to the cooked meal was an effective way to improve dietary intake and body weight in nursing home elderly.

*submitted

Introduction

Inadequate dietary intake is often observed in nursing home elderly (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, 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 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, which demonstrated that elderly subjects prefer a higher level of tastants but failed to associate this to a higher consumption of foods containing these tastants (12-14).

These age-related deficits in taste and smell are supposed to decrease food consumption and probably contribute to negative changes in eating behavior (15-18). Few studies explored the relationship between sensory impairment, hedonic response, and altered food intake in the elderly (12). Recently de Jong and coll. (19) demonstrated that a poor appetite is related to loss of sensory perception but they could not show an effect on intake.

Also Schiffman and Warwick (20) observed no changes in dietary intake of elderly subjects after 3 weeks 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-term of the observations.

Therefore our objective was to determine whether the addition of flavor enhancers to the cooked meal during 16 weeks would lead to an increase in food consumption and thereby provide nutritional benefits to nursing home elderly.

Subjects and methods

Subjects and setting

The study was conducted at the nursing home "Rustenburg", Wageningen (The Netherlands). Selection criteria were: being older than 65 y of age, no known dementia or residing in a somatic ward (21), no known depression, no disease in terminal phase, no allergy to monosodium glutamate, already residing in the nursing home for more than 3 months and consuming at least five days a week the cooked meal provided by the nursing home kitchen at lunchtime. 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.

Design and procedure

A parallel group intervention design was applied. The intervention consisted of adding flavors to the main dish of the cooked meal of the 'flavor group' while the control group received normal flavored meals. The study was carried out in 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 to the 'flavor' group (n=37).

Table 1: Description of the 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

*AHSP questionnaire: appetite hunger and sensory perception questionnaire (22); **GDS: Geriatric depression scale (23)

Anthropometry and appetite data were assessed before and at the end of the intervention period. Dietary intake data were collected before, 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 experiment 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). 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 the help of 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.

Table 2: References ingredients for 100g of ready-to-use flavor product

	Chicken flavor (#15 94 5287)	Beef bouillon flavor (#15 94 5401)	Turkey flavor (#13 60 6019)	Lemon butter (fish) flavor (#13 60 5938)
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

MSG: monosodium glutamate; Sugars/starch is mainly lactose; others: free-flowing agents and acids.

Measurements

Anthropometry

Body weight:

Patients' body weight, as index of the nutritional status before and after the study, was measured before breakfast after voiding (to the nearest 0.5 kg, Seca weighing scale, Hamburg, Germany) with subjects dressed in light 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 following formula's (24):

Height (in cm) =3.16*KFH (in cm)

Dietary intake

Total daily dietary intake data were collected using a combination of a 3-days record and weighing-back methods before and at the end of the intervention. Bread-based meal, snack and beverage consumption was recorded by means of 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 (25).

Dietary intake at the cooked meal was assessed with a 3-day weighing-back method before the intervention. Based on the information on the day to day variation, a 7-day weighing-back method was used after 8 and 16 weeks (26). 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 (27).

Appetite, hunger feelings and sensory perception questionnaire (AHSP)

Subjects responded to a 29-items questionnaire about their feelings of hunger, appetite and their taste and smell perception (19). After reading the question together with an interviewer, subjects had to score on 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 to the past, 3 items; appetite, 6 items; and daily feelings of hunger, 9 items.

Geriatric depression scale (GDS)

The GDS (23), used to assess depression status of the subjects, consisted of 15 items to be answered with 'yes' (1) or 'no' (0). The answers summed up 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 absolutes changes were calculated for the outcome variables 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 ≤ 0.05 was considered statistically significant. Data were analyzed using the SAS program (28).

Results

Subjects

Sixty-seven out of seventy-one elderly completed the study. Dropouts were patients who failed in completing the study because of death (1 subject), move (1 subject) or personal reasons (2 subjects). Data on dietary intake and body weight could be obtained from all subjects. Besides, we also have results on appetite feelings and

depression from 42 subjects who were capable to understand and answer the different questionnaires.

Table 3: general baseline characteristics of the elderly subjects who completed the study

Variable	Control group n= 31	'flavor' group n= 36
Age [mean (SD) years]	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 [mean(SD)]	3.2(2.8)a	3.2(2.4)b

a)n= 18; b) n=24. GDS: geriatric depression scale (23)

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

Table 4: anthropometry and daily dietary intake characteristics and changes after the intervention [Mean (SD)] of the nursing home elderly residents

Variable	Control group (n= 31)	'flavor ' group (n= 36)
Body weight (kg) at baseline	69.0 (17.0)	72.0 (17.5)
absolute changes[b]	-0.3 (1.6)	1.1 (1.3)*§
Calculated Height (cm)[a]	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[b,c]	-485(1245) *	-208(1115)
Energy (kJ)/ Weight (kg) at baselin	91(31)	86(30)
absolute changes[b,c]	-8(4)*	-5(17)

BMI= body mass index, a: derived from Berkhout (22); b: absolute changes after 16 weeks of intervention, c: control (n=29) and intervention (n=35). *: Significant difference in changes within one group between start and end of the intervention period, (P≤0.05); §: Significant difference in changes between groups between start and end of the intervention period, P<0.05.

Groups were comparable with respect of mean body weight, 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<0.001) period while it remained stable in the control group (-0.4±1.6 kg, P=0.37). Changes between groups differed significantly (P<0.001). Figure 1 shows the percentage of subjects with stable body weight or losing or gaining weight over the 16-week period.

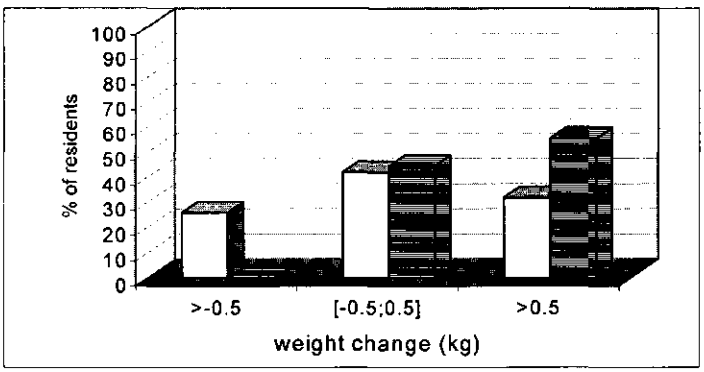

Figure 1: Distribution (%) of nursing home elderly residents losing or gaining weight over the 16-week period (control ( ) n=31 and 'flavor' ( ) n=36).

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 was low on average (5969±1641 kJ for the control group and 5821±1449 kJ for the 'flavor ' group) and below the mean Dutch requirement for elderly (7.8 MJ/Day). 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±30 kJ/kg body weight for the 'flavor' group. Percentage of energy provided by fat, carbohydrate and protein were similar in both groups with 36 %, 46%, 17 % and 1% for fat, carbohydrate, protein and alcohol, respectively.

After a 16-week intervention, energy intake of the control group (-485±1245, P=0.03) declined while it remained relatively stable (-208±1115kJ; P=0.28) 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<0.05) declined in the control group while 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.

When body weight variation after 16 weeks was related with changes in daily dietary intake, positive association were found for changes in daily energy [Pearson r=0.345,

P=0.04] and fat intake [Pearson r=0.407, P=0.01] in the 'flavor' group. Such correlations were not found in the control group.

Dietary intake at the cooked meal

Dietary intake at 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 changes were also observed for the carbohydrate intake. In both groups, intake of vitamins and minerals remained stable (data not shown).

Table 5: energy and macronutrient intake [mean±SD] of nursing home elderly residents at the cooked meal, baseline values and absolute changes after 8 and 16 weeks of intervention as compared to values at the start of the study.

Variable	Control (n=31)			'flavor ' (n=36)		
	Before	Change 0-8[1a]	Change 0-16[2]	Before	Change 0-8[1]	Change 0-16[2]
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*
Fat total (g)	20±9	1±6	0±7	19±7	2±6*	2±7*

Change 0-8[1]: changes observed after 8 weeks as compared to baseline; Change 0-16[2]: changes observed after 16 weeks as compared to baseline, a) N=30. *: Significant difference in changes within group as compared to a given time (P≤0.05).

Table 6: Mean score (SD) of the Appetite, hunger feelings and sensory perception questionnaire and absolute changes after 16 weeks of intervention in nursing home elderly residents.

Variable	Possible Range	Control (n=18)		'flavor ' (n=24)	
		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 to 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 start and end of the intervention period, P<0.05. §: Significant difference between groups, P<0.05.

Appetite, hunger feelings and sensory perception questionnaire (AHSP)

Table 6 presents mean scores and absolute changes of the AHSP questionnaire. No differences were observed between 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 week:

- Repeated consumption of a flavor enhanced cooked meal led to an increase in dietary intake at this meal and a stable daily dietary intake.
- Increased body weight was noticeable after consumption of a flavor enhanced cooked meal.
- Repeated consumption of flavor enhanced foods resulted in increased daily feelings of hunger.

These findings are in agreement with former studies (9;20;29;30) suggesting that adding flavor enhancers might improve appetite and dietary intake in an elderly population. Until now none of these studies could show an increase in actual food intake. Our intervention lasted for 16 weeks and the compliance was high. By using such a time period we assume that the establishment of acceptance and preferences for the foods with added flavor enhancers could be achieved and thereby could be reflected by a rise in energy intake at the cooked meal. This might not have been the case in shorter studies.

Daily energy intake was relatively stable in the 'flavor' group while a decrease of about 0.4MJ 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(31). Therefore we believe that the obtained values for the measurement at the end of the experiment are underestimated. Besides, a significant correlation between changes in daily intake and body weight variation was observed and implies that the 'flavor' group has actually increased rather than being stable in energy intake. 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 at the cooked meal in the 'flavor' group. Since intake data at the

cooked meal are derived from repeated measures for 7 days we believe that we have a good picture of intake at the cooked meal.

The rather high BMI suggests a well nourished population(32). However, interpretation of BMI should be more liberal than in younger adults. First, elderly shrink so their measured body height is somewhat underestimated (33). Second, BMI is not related to the presence of diseases. On the contrary, the attention should be paid to weight since it is one of the major risk factor for morbidity in this population considered as accelerated agers(2;3). Our results indicate that consumption of food with enhanced chemosensory properties in this population could provide nutritional benefits and help to prevent weight loss. These positive observations should also be further confirmed with data on body composition or biochemical indices. A long-term assessment of body weight would be necessary to verify that the gain in body weight remains stable and not start to decrease as soon as the intervention stopped.

The use of flavor enhancers has been suggested to compensate for diminished chemosensory functioning contributing to impaired control of appetite in the elderly or so called anorexia of aging (34;35). Flavor amplification could restore the hedonic functions of food and hereby promote a partial re-establishment of the original attitude/behavioral response of this population towards food intake (30;36).

Previous studies suggested that the consumption of flavor-enhanced foods would stimulate the limbic system and the endogenous opioid activity (20;36). The positive effect on body weight paired with increased daily feelings of hunger observed in our study strengthen this possible path suggesting that the opioid activity arising from the consumption of more palatable foods may promote nutritional and physiological benefits in the elderly.

In the present study we were in favor of stimulating both olfactory and gustative functions. This could be realized by using flavor enhancers containing monosodium glutamate. We were confronted to an arguable issue: the repeated exposure to flavor enhancers containing about 30 % of monosodium glutamate. Since sodium intake remains a sensible matter in the elderly with slower renal function, a possible increase in daily sodium intake through the use of flavor enhancers rich in monosodium glutamate could not seem to be advisable at first sight. Considering a mean daily sodium intake of 9g in this population (37), an additional daily dose of about 30 to 45mg of sodium, i.e. 3.9g 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 (29;38;39). 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 of the table salt (NaCl) (40). From a health point of view these findings together with our results suggest that the uses of flavors enhancers containing MSG could allow the elderly population to decrease their sodium intake from table salt while maintaining palatability and thereby hedonic function of foods.

Adding ready to use flavor enhancers to the cooked meal was in the present study 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.

Acknowledgment

We gratefully acknowledged 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. Further, we are grateful to Alma van der Greft, Jill Idzinga, Marieke Spaan and Marjolein Homs for their help during data collection. We would also like to thank the participants, 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.

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 A Biol Sci Med Sci 1995;50: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, Graaf Cd. Sensory perception and pleasantness of orange beverages from childhood to old age. Food Quality.and.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.A.Biol.Sci.Med.Sci. 1995;50: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.

13. 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.

14. 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.

15. Rolls BJ. Appetite and satiety in the elderly. Nutr Rev 1994;52:S9-10.

16. Rolls BJ. Do chemosensory changes influence food intake in the elderly? Physiol.Behav. 1999;66:193-197.

17. Drewnowski A. Taste preferences and food intake. Annu.Rev.Nutr. 1997; 17:237-253.

18. 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.

19. 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 [see comments]. J.Gerontol.A.Biol.Sci.Med.Sci. 1999;54:B324-B331

20. 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.

21. 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.

22. Schiffman SS, Warwick ZS. Flavor enhancement of foods for the elderly can reverse anorexia. Neurobiol.Aging 1988;9:24-26.

23. Yesavage JA. Geriatric Depression Scale. Psychopharmacol.Bull. 1988;24:709-711.

24. Berkhout AM, Cools HJ, Mulder JD. [Measurement or estimation of body length in older nursing home patients]. Tijdschr.Gerontol.Geriatr. 1989;20:211-214.

25. Donders-Engelen M.R., Van Der Heijden L, Hulshof KFAM R. Maten, gewichten and codenummers 1997 (food portion sizes and coding instructions 1997). Rapport TNO Zeist. 1997 ed. The Netherlands: 1997.

26. Cameron M, Van Staveren W. Manual on the methodology of food consumption studies. Oxford University Press, 1988.

27. Anonymous. NEVO 1997. Stichting Nederlands voedingsstoffenbestand. Dutch Nutrient Database 1997. The Hague, The Netherlands: Voorlichtingsbureau voor de voeding, 1997.

28. SAS Institute Inc. SAS/Stat user's guide version 6. fourth ed. Cary, USA: SAS Institute Inc., 1989.

29. 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.

30. Schiffman SS, Warwick ZS. Flavor enhancement of foods for the elderly can reverse anorexia. Neurobiol.Aging 1988;9:24-26.

31. 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.

32. Berkhout AM. [Limitations in feeding behavior in nursing home patients] (in Dutch). Tijdschr Gerontol Geriatr. 1996;27:62-66.

33. 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:S9-15.

34. Blundell JE. Understanding anorexia in the elderly: formulating biopsychological research strategies. Neurobiol.Aging 1988;9:18-20.

35. Morley JE. Anorexia of aging: physiologic and pathologic. Am J Clin Nutr 1997;66:760-773.

36. Schiffman SS, Warwick ZS. Use of flavor-amplified foods to improve nutritional status in elderly patients. Ann.N.Y.Acad.Sci. 1989;561:267-276.

37. Anonymous. NEVO 1998. Stichting Nederlands voedingsstoffenbestand. Dutch Nutrient Database 1998. The Hague, The Netherlands: Voorlichtingsbureau voor de voeding, 1998.

38. 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.

39. Bellisle F. Effects of monosodium glutamate on human food palatability. Ann.N.Y.Acad.Sci. 1998;855:438-441.

40. 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.

7

General Discussion

Aging is often accompanied by the phenomenon of anorexia of aging, defined as a decline in appetite, followed by unexplained weight loss (1-8). The present thesis described research on anorexia of aging and focused on social and physiological determinants of appetite, food intake and/or body weight in observation as well as in intervention studies.

First a cross-sectional observation study was conducted to assess possible differences in appetite in elderly with a different health status (*chapter 2*). Then several intervention studies were carried out to explore the age-related pathways that may contribute to loss of appetite, as described in Figure 1. Social factors influencing appetite were investigated on a short term in a laboratory setting (*chapter 3*) and on a long term in a natural environment (*chapter 4*). Physiological influence on appetite was explored by assessing the effect of food-related factors: modifying the properties of food enhancing the sensory properties of the cooked meal (*chapter 6*) and by looking at both short-term and long-term responses to energy challenges (*chapter 3,5*).

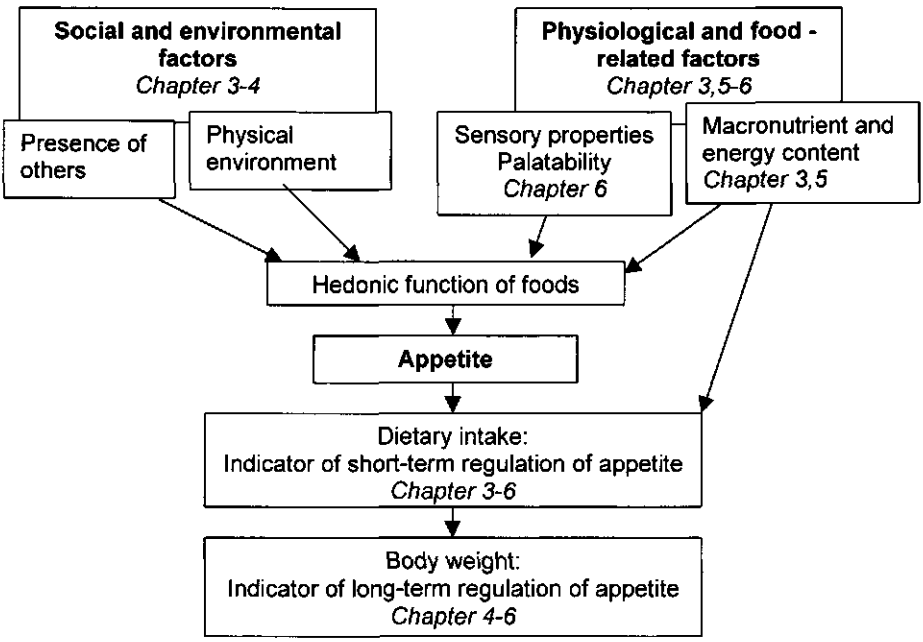

Figure 1: Potential factors influencing appetite in the elderly that were investigated in the intervention studies described in this thesis.

The first part of this chapter summarizes the main findings of all studies, followed by a discussion of methodological aspects. Next, results of this thesis will be put into perspective and implications for daily nutritional care in the elderly will be suggested. Finally, conclusions and recommendations for future research will be proposed.

Main findings

The prevalence of decline of appetite varied among diverse groups of elderly people. Nursing home elderly reported a lower appetite than the free-living frail elderly, and this group reported on average a lower appetite than the healthy free living group. This variation probably results from the large differences in health status and the rate of biological aging. These feelings of hunger and appetite were found to be indicators of body weight in an apparently health elderly group, while in the population of frail or nursing home elderly with a dwindling health status this relationship was not apparent (*chapter 2*).

The results of the frail group (*chapter 2*, (9)) confirmed the effect of a decreasing health status on the ability to counterbalance the age-related loss of appetite. Further, it insinuates that nursing home elderly, who are in a relatively new social and physical environment and depend on others for the basic cares such as washing and eating, present a higher risk for loss of appetite. The external lacks of stimulation of appetite together with a poor health condition make it rather difficult for them to counterweigh the age-related decline in appetite (*chapter 4-6*). This presumably explains the disruption in the relation appetite-body weight in this population (*chapter 2*).

As indicated in Table 1, an overview of the main findings of the interventions, all long-term studies led to a beneficial effect on body weight while the effect on dietary intake varied.

Table 1: overview of the main effects observed in the intervention studies.

Studies described in	Level of intervention	Period of assessment	Effect on dietary intake	Effect on body weight
Chapter 3	Social + Physiological	Short-term	0	n.a*.
Chapter 4	Social	Long-term	0	++
Chapter 5	Physiological	Long-term	+	+
Chapter 6	Physiological	Long-term	+	++

*n.a: not assessed; 0: no effect; +(++): (very) positive effect.

In *chapter 2*, it was observed that changes in meal environment of apparently healthy, free-living elderly affected meal duration, an intermediate factor of social facilitation but did not result in an increased dietary intake. Besides, short-term changes in social environment did not affect physiological influences on appetite and energy intake in this elderly group. This suggests that dietary intake of apparently healthy elderly would not be really sensitive to short-term variations in social factors in a laboratory setting (*Chapter 3*). On the contrary, long term effect of an improved

social ambience of food consumption in nursing home led to a stabilization of health and nutritional status of the elderly residents (*Chapter 4*). This indicates that elderly responded to long term changes of social factors in a rather natural setting.
Enhancing the sensory properties of the cooked meal, i.e. compensating for the age-related decline in taste and smell, was shown to improve daily feelings of hunger, actual dietary intake and body weight in a nursing home population with a steady health status (*chapter 6*). These results show that it is possible to restore the hedonic qualities of food and thereby stimulate appetite in the elderly.
Either a single preload intake or a regular intake of an evening energy-rich drink did not lead to subsequent energy compensation. This lack of response to energetic challenges presumed an impaired regulation of energy intake on short- and long-term period in both free-living and nursing home elderly residents (*chapter 3,5*). However, both long-term physiological interventions resulted in an improvement of dietary intake and body weight (table 1, *chapter 5-6*).

Methodological considerations for research on appetite in the elderly

Population

The study population in this thesis varied according to the mean age and the health status. Part of the study described in *chapter 2* and *chapter 3* were conducted in free-living elderly. Other studies (part of *chapter 2, chapter 4-6)* were conducted in elderly nursing home residents.
Most of our studies (*chapter 2, 4-6*) concentrated on a hitherto neglected segment of society in many research studies, namely the oldest members of each community. However, the definition of 'old-elderly' varies: in most of the communities studied so far as well as in the present thesis, it refers to men and women of 80 years and more.
Results of the SENECA baseline study showed that the participation was somewhat selective with a tendency towards a higher participation of apparently healthy elderly (10). In the follow-up study, this tendency persisted. Consequently data of the final SENECA study participants used in the present thesis are considered as a reference of normal to successful aging(11).
Recruitment of the free living subjects for the study described in *chapter 3* was realized on a voluntary basis. Results showed that the participants were still socially and physically active in daily life and could be classified as relatively healthy or normal agers. These subjects were also relatively young compared to our other studies.
The frail free-living elderly population described in *chapter 2* was found after specific selection to have limited physical fitness and health. Health and nutritional

parameters of these participants described elsewhere (12;13) showed that they were below average and that the downward process of frailty might already have started to proceed in this group of elderly.
Nursing home residents suffer from chronic disabilities, are often wheel-chair bond or use a walking frame and may present decrease in cognitive functioning. They have low energy needs and a relatively poor health condition. Consequently, they are at high risk for nutritional deficiencies. Therefore participating to an intervention study may represent a heavy charge for them because of the duration, the intervention itself, the questionnaires they have to answer and the task, if any, they have to complete. In addition, it is important to mention that none of the nursing home residents who joined our studies had diagnosed of severe impaired cognitive function or dementia. However we were confronted to the fact that some patients were not capable to understand or answer questionnaires especially developed for elderly.
In summary, the population described in the present thesis was heterogeneous and the interventions conducted were 'group-specific'. Therefore, results obtained for one group of subjects might need to be adapted for another group of elderly and can not always be generalized to the elderly population as a whole.

Dietary assessment methods
To assess dietary intake is important for two reasons: first it may act as an absolute measure of appetite and second it is an important determinant of the nutritional status. Further in the absence of reliable tools and/or biochemical indicators to assess of appetite in the elderly, dietary intake remains one of the most objective and feasible assessment appetite in different group of elderly.
Two types of modified 3-day record method were used to assess daily dietary intake in the intervention studies (*chapter 4-5*) described in this thesis. These methods were found to be an appropriate method to get information on the actual food consumption in an accurate way (14). In both cases, consumption at the main meal was assessed by weighing all items before and after. Consumption at the bread-based meal was in *Chapter 4-5* assessed as the cooked meal and between meals consumption was observed and registered in a diary. In *chapter 6*, subjects had to record bread-based meals and snacks consumption in a diary checked by a dietician. The use of a similar basic method in all studies makes it easier to compare the dietary intake between the groups but also to determine possible underreporting.
Table 2 shows a comparison between total measured daily energy intake and calculated basal metabolic rate (BMR)(15) i.e. the minimum energy requirement to maintain vital functions. It indicates that data obtained in *chapter 4-5* are more

accurate than those obtained in the latter study (*chapter 6)* since the measured energy intake is more or less equal to the calculated BMR and suggests no energy expenditure due to physical activity which is quite impossible. Results in table 2 also indicate that women are more likely to report less accurately than men are.

Table 2: differences between calculated estimated basal metabolic rate and measured daily dietary energy intake with different methods at baseline of the studies in nursing homes.

Study	N	sex	body weight (kg)	Measured daily dietary EI (MJ)(a)	Predicted BMR (MJ) (b)	Difference (a)-(b)
Chapter 3: Obs.	10	M	70.3 (16.3)	7.3 (1.2)	6.0	1.3
+ weighing	28	F	60.0 (11.1)	5.8 (0.9)	5.1	0.7
Chapter 4: Obs.	11	M	68.4 (12.5)	7.8 (1.8)	5.9	1.9
+ weighing	23	F	66.0 (16.0)	6.3 (1.8)	5.4	0.9
Chapter 5: diary	13	M	70.7 (12.0)	7.2 (2.0)	6.0	1.2
+ weighing	54	F	70.5 (14.4)	5.6 (1.2)	5.6	-0.0

EI: energy intake, BMR basal metabolic rate, obs + weighing: combination of observation and weighing back method, diary + weighing : combination of food diary and weighing back method. body weight and measured daily EI are given as mean (SD). BMR i.e. minimum energy requirement based on the FAO/WHO/UNU equation predicting BMR from body weight in older adults (15).

Although the method used in *chapter 4-5* seems to be more precise, the disadvantage is that it is a time consuming method. An average 3-days observation of one subject usually requires another half a day before the data are all stored in the computer and suitable for statistical anlysis.

Assessment of dietary intake is a relatively simple way to provide information on appetite but attention should be given to the precision of the method used since it might influence or even bias the results.

Anthropometry

The biological basis for the selection of the anthropometric variables was related to their expected associations with food habits, health and well being in the elderly. Body weight was included because it reflects the recent and present balance between energy intake and energy expenditure and because weight and changes in weight in the elderly are related to risk of mortality. (4;6;16). Weight can be obtained with minimal errors of measurement, although it represents a difficult and relatively heavy measure to conduct in wheelchair bound or bedridden patients. However, body weight has a large variation within a group of subjects with similar health condition (table 2). Further, mean body weight was not low despite a relatively poor health condition in the nursing home groups (table 2).

In young or middle-aged adults, stature is an important index of nutrition and health during growth. For corresponding reasons, stature should be an important measure in the elderly. However, stature decreases with aging to extents that differ among individuals (17). These decreases may lead to bias in data analyses with an overestimation of body mass index, the body mass divided by the square of height. Therefore in the present studies body weight and changes in body weight rather than BMI were chosen as endpoint of the intervention.

The use of questionnaires to assess appetite in the elderly

Two types of questionnaires were used in this thesis to assess appetite in elderly subjects. In *chapter 3* Visual Analogue Scales (VAS) were used. The VAS's give indication on hunger, satiety and appetite feelings in young and elderly subjects. These scales refer to an interval of time between two eating moments. It gives indication on hunger and satiety on a very short term. However the use of such scales are not recommended for elderly with reduced cognitive function or impaired memory functioning. We also assume that it would be biased in subjects who have a fixed time meal service, i.e. eat because they are served but not because they are hungry (*chapter 3*, (18)).

In nursing home elderly, direct questions to the elderly on appetite are not always possible, but from observation and reports from the nurse may help to indicate how appetite of the residents is. However, this is time consuming and results are likely to be biased. In *chapter 2 and 6*, we used a relatively new tool, the Appetite, Hunger and Sensory Perceptions (AHSP) questionnaire in different health groups of elderly. Responses on the AHSP do not inform on the little day-to-day or meal-to-meal variations of appetite, it gives a reliable global assessment of appetite and relates on the long term, e.g. feelings of appetite before and after retirement, in all categories of elderly. It is also sensitive enough to detect differences between health categories of subjects. Besides, the AHSP was well accepted and understood by nursing home elderly.

Determinants and regulation of appetite in the elderly: a social approach

Social influence on food intake has been defined as the effect of environmental circumstances leading to a choice and consumption of foods, i.e., eating and/or enjoying eating (19). Culture, family customs and traditions, and religious beliefs influence appetite. In addition to lifelong eating habits, other factors that affect food intake are living arrangements, food availability, mental and emotional state, physical limitations, and home-making skills. Food habits formed in youth and middle-aged may be difficult to modify at old and very old age.

It has been suggested that elderly eating alone may be eating less regularly scheduled meals and reducing the amounts and types of foods eaten (20;21). In *Chapter 3*, we investigated the effect of social facilitation in healthy elderly during lunch. During the lunch consumption subjects were either in a very cozy environment eating with 6 to 8 people on one table or in a non-cozy environment with a delimited space and only one person per table. Results showed that eating together did promote longer meal duration but no change in dietary intake. In this study in healthy elderly, eating out in different environments, but in a laboratory setting did not interfere with both choice and consumption of the bread based-meal, probably because their lunch intake is the result of lifelong eating habits. Results might have been different if a cooked meal was served: proportions and quantities consumed are less settled and might respond more to the actual appetite than the lunch did. In all cultures, eating with friends is important and particularly so for lonely or isolated old people since it maintains social contacts. In this study the elderly were rather active and were members of several elderly clubs of dance, bridge or tourism association. Social network, social support and social influences are important aspects of the social environment that provide reserves enabling persons to cope with stressful situations in daily life. These aspects may correspond to the environment of free-living elderly but might often be underestimated in a nursing home environment where subjects are dependent on others for the most basic activities of daily life. Further, it is important to recognize that social patterns may be the consequences and not the causes of illness.

The routine for serving the food to nursing home elderly residents include several aspects that might not be suitable for an optimal dietary intake. First an inadapted distribution of the food throughout the day with the main meals served at 3 occasions, delimited in time and within 8 hours might not be the best to stimulate appetite and dietary intake in subjects who report eating and appetite problems. The serving of an evening energy-rich supplement, enough time to consume the meals as well as the continuous availability of drinks throughout the day were shown to be important factors to stimulate dietary intake in a nursing home setting (*Chapter 4,5)*. Second the attention and the whole ceremonial including decoration and service accompanying meals is often neglected for no reason while both staff and residents would benefit from a less busy meal time (*chapter 4*, (22)). It also underlines the importance of the careful attention as well as the respect of the wish of the elderly subjects at the dining table to improve their food intake.

Actually, we assume that attention together with an improved ambiance of food consumption may serve as a buffer against the negative effects of poor appetite on dietary intake (*Chapter 4)*. These results are in line with observation of other studies

where meal environment and/or the immediate and patient support of family, friends and neighbors might help to prevent malnutrition (23).
Lack of attention to social function of meals, with its consequent frustrations, might be an important contributor to nutritional problems observed in nursing home elderly residents (24). In a public health perspective, it means that a simple re-thinking and reorganization of the meal service and environment might contribute to the prevention of weight loss at little costs. This reorganization should obviously be realized according to the will and wishes of the concerned elderly group and the nursing staff.

Determinants and regulation of appetite in the elderly: a physiological approach

The role of flavor enhancers and palatability of foods

Older adults have a decline in the function of taste and smell senses, which may lead to a decrease in food palatability and a possible failure to develop sensory-specific satiety (25). These declines in sensory perceptions of foods may lead to an alteration of the hedonic qualities of foods with increasing age.
Cooking is important in food processing since it helps to produce the desired texture, flavor and palatability of a dish. Nursing home elderly residents, who do not cook for themselves anymore but receive their meals from a central kitchen, do not have the possibility to modify their diet as free living do (26).
The influence of the enhancement of the taste and odor of the main meal was investigated in a real life situation during a 4-month intervention study in nursing home elderly residents. Results showed that a repeated use (about 120 days) of 4 savory flavor enhancers had a positive effect on the pleasantness and palatability of foods as indicated by the increase in hunger feelings, daily dietary intake and body weight (*Chapter 6*). Since the repeated intensification of the actual sensory properties of foods did not lead to a reduced intake or complaints from the participants that could indicate boredom, we assumed that the use of flavor amplified foods was well accepted. This confirms earlier findings observed on a short term, in 2-day and 3-week experiments, suggesting that flavor amplification of foods may change food preferences and/or consumption (27;28). Through a compensation of the age-related olfactory and gustatory deficits, the addition of flavors at optimal concentration for the elderly might have restored the hedonic functions of foods, thereby promoting an increase in dietary intake and reflected by changes in body weight. The positive results obtained with flavor amplified food (*chapter 6* (27-29)) shows that in older adults the palatability of food remains a determinant of appetite and dietary intake as it is in younger adults (30).

Further, the loss of smell has been suggested to happen first and to be followed by loss in taste with decreasing health condition, i.e. increased risk of anorexia of aging (*chapter 2*, (31)). These findings show the importance of the senses of taste and smell in the regulation of appetite in the elderly. Decline in taste and smell might actually be one of the starting points for anorexia of aging.
The observed positive long-term behavioral and physiological effects of flavor enhancers in a population with a diminished odor perception and a poor but steady health shows the general importance that palatability of foods have in the age-related decline of appetite and food intake. From a public health point of view, it implies that the easy intervention, which consists of adding flavor enhancers to the main meal, might be a beneficial and effective way to improve food palatability and dietary intake and might help to reverse, in a first stage, anorexia of aging.

The role of energy and macronutrient of foods
Macronutrient and energy contents are known to be determinants of appetite and dietary intake in adults (30). Few studies (18;32-34) have until now explored if their role remains in elderly people. Impaired physiological regulation of energy and macronutrient intake has been shown to occur in different studies in elderly subjects (33;34).
We explored the short-term regulation of food intake at first exposure with no prior experience in apparently healthy, free-living elderly subjects *(chapter 3)*. A food preload varying in fat, carbohydrate and energy content was offered to the subjects 90 minutes before the consumption of a test lunch meal. Results showed an imprecise and incomplete energy and macronutrient compensation in line with prior studies (18;33), i.e., the lunch energy intake was reduced but not by an amount equal to the energy content of the preload. Hunger ratings also slightly differed between preloads. The slight differences found in the dimension of energy and macronutrient compensation in our group compared to prior studies may be partly explained by the greater size of the group and by the time interval between preload and test meal (33). Rolls(35;36) (1991,1994) suggested that the accuracy of energy intake regulation decrease with increasing time delay. We deliberately selected a 90 minutes interval since we assume that a shorter interval such as 20 minutes would not assess the post-ingestive and post-absorptive physiological effects, but only the volume and weight effects of the preloads.
Results of *Chapter 3* were limited to a single exposure to the preload. Precision of energy compensation might improve with repeated exposures to the preload consequent to the development of learned associations between satiety, energy content and flavor of the food (37). The effect of repeated exposures to an evening

vitamin and energy rich snack on the long-term regulation of energy intake was investigated in *Chapter 5.*

Results showed almost no energy intake compensation and a slight increase in body weight was observed. The observed mean change in body weight of 0.8kg represents an extra energy consumption over 27 days of about 30100kJ. The snack consumed in the same period represented an increased energy intake of about 32400 kJ so it seems that the increase in body weight was the consequence of the extra energy intake. This suggests a loss of ability to adjust energy intake subsequently to energy challenges and it confirms the diminished capacity to regulate energy intake on the long term in elderly subjects.

Energy balance depends on two factors: energy intake and energy expenditure. All long-term studies showed a weight gain in the intervention group, which had, *a priori,* no low body weight problems. First it suggests that concern should rather be given to changes in body weight than simple measure of body weight. It also indicates that energy balance could not be maintained. If there was a lack of regulation of energy intake, impairment in the regulation of energy expenditure has also been suggested lately (34) (38) and should be further investigated.

The incapacity to adjust energy intake in the elderly seems to be a non-reversible process (*chapter 3,5-6*). In daily practice, this lack of regulation suggests that the consumption of energy and nutrient dense supplements between meal could help to increase the daily energy intake and thereby have a beneficial effect in the prevention of weight loss in older adults with reduced homeostatic capacities.

Conclusions

Appetite and the extent to which food is enjoyed varied greatly between people. In the elderly, these differences may be explained by differences in the health characteristics of the groups studied.

Long-term influence of social and environmental factors such as a good meal environment and careful attention during food consumption was found to remain an important determinant of appetite, especially in elderly with an unstable or poor health condition. Therefore it is important to take the local situation and feasibility of the activity/intervention for the individual into account when studying appetite in the elderly.

Elderly subjects did not express energy compensation or regulation after single and repeated exposure to energetic challenges while the restoration of the optimal flavor concentration of foods stimulated appetite and dietary intake. If the macronutrient and energy contents of foods do not seem to have much influence on the regulation

of appetite in later age, palatability of foods remains an important physiological determinant of dietary intake in older adults.

The properties of foods and the context in which the foods are consumed remain important determinants of dietary intake in the elderly and are thereby major risk factors for anorexia of aging and its subsequent weight loss. Intervention studies in the present thesis suggest that weight loss might be a modifiable public health problem when the adequate nutritional interventions are applied. In this regard, weight loss prevention should not be considered as a utopia. From a public health perspective, the diminished or lack of regulation in appetite and dietary intake should be taken into account in nutritional care and/or policy, and encourage nutritional interventions in elderly at risk.

Further, the most important fact to keep in mind is that one should first try to know what the elderly people want. Whether or not their will is to undergo nutritional or social intervention to adjust their dietary intake if necessary should be up to them. However, attractive adapted nutritional guidance and intervention may help to improve their quality of life in their last years.

Recommendations for future research

The present thesis is the first to describe research on both social and physiological determinants of appetite (figure 1). Longitudinal and somewhat more extensive assessment of appetite, dietary intake and changes in body weight are now necessary to confirm the findings of the present thesis. Further research on appetite in the elderly should give attention to the following points:

- Vulnerability to hunger feeling: when does it start? Is it possible to define biomarkers of nutritional status and appetite in elderly subjects?
- Elderly's food choice, preference and liking: the underlying mechanisms for food preferences and appetite are biological (physiological and genetic) and cultural. Cultural transmission of food preferences commences in early life, at a time when social contacts are limited to the family. With aging, chronic degenerative diseases surface. These phenomena may be contributory to shift of food preference mechanisms. Information, culture and education also affect food preferences. Yet no methods exist to assess these variations of food preferences in the elderly.
- A descriptive study on eating environment and social facilitation in free-living elderly to answer questions such as: With whom do you eat? Who do you see during a day? How many people? The emphasis should be on finding out about 'eating or drinking together' and how they like it rather than if they 'eat out' or 'eat in'

- The influence of social support including emotional, information, physical on nutritional and health status should be confirmed and further explored. This could be realized in a long-term prospective study with a changed environment.
- Study on the effect of isolation in the community: inequalities in social support might exist among the socio-economic groups of free-living elderly. Some differences in findings may be less age or nutrient related than social support related. Some apparent nutrient effects could be related to social factors responsible for the diet differences.
- Longitudinal assessment of appetite feelings and its relation with unexplained unintentional weight loss: are the elderly who report a low appetite at higher risk for weight loss?
- Depression and its relation to food choice and intake. Depression is known to be one of the most important factors influencing weight loss in nursing home elderly (39). It was suggested that depression has not been enough looked for and taken into consideration in nutritional studies. Observed depression, loneliness and/or bereavement are among the warning signals for potential loss of appetite and weight loss. The identification of relevant warning signals and risk factors followed by appropriate grass roots action could be built into future protocols and questionnaires.

References

1. Morley JE, Mooradian AD, Silver AJ, Heber D, Alfin SR. Nutrition in the elderly. Ann.Intern Med 1988;109:890-904.

2. Morley JE, Silver AJ. Anorexia in the elderly. Neurobiol.Aging 1988;9:9-16.

3. Morley JE. Anorexia of aging: physiologic and pathologic. Am J Clin Nutr 1997;66:760-773.

4. Murden RA, Ainslie NK. Recent weight loss is related to short-term mortality in nursing homes. J Gen.Intern Med 1994;9:648-650.

5. Lehmann AB, Bassey EJ. Longitudinal weight changes over four years and associated health factors in 629 men and women aged over 65. Eur J Clin Nutr 1996;50:6-11.

6. Berkhout AM, van HJ, Cools HJ. [Increased chance of dying among nursing home patients with lower body weight] (in Dutch). Ned Tijdschr Geneeskd 1997;141:2184-2188.

7. Blaum CS, Fries BE, Fiatarone MA. Factors associated with low body mass index and weight loss in nursing home residents. J Gerontol A Biol Sci Med Sci 1995;50:M162-M168

8. Fischer J, Johnson MA. Low body weight and weight loss in the aged. J Am Diet Assoc. 1990;90:1697-1706.

9. 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.

10. de Groot L, Van Staveren W. Description of survey towns and populations. Euronut SENECA investigators. Eur J Clin Nutr 1991;45 Suppl 3:23-29.

11. de Groot C, Van Staveren W, Dirren H, Hautvast JG. Summary and conclusions of the report on the second data collection period and longitudinal analyses of the SENECA Study. Eur J Clin Nutr 1996;50 Suppl 2:S123-S124

12. de Jong, N. Sensible aging, nutrient dense foods and physical exercise for the vulnerable elderly. 1-191. 1999. PhD thesis, Department of Human Nutrition & Epidemiology, Wageningen University, The Netherlands.

13. Chin a Paw, JMM. Aging in Balance, physical exercise and nutrient dense foods for the vulnerable elderly. 1-176. 1999. PhD thesis, Division of Human Nutrition and Epidemiology; Wageningen University, The Netherlands

14. Cameron M, Van Staveren W. Manual on the methodology of food consumption studies. Oxford University Press, 1988.

15. Joint FAO/WHO/UNU Expert consultation. energy and protein requirements. 724. 1985. Geneva, World Health Organization. technical report series.

16. Payette H, Coulombe C, Boutier V, Gray-Donald K. weight loss and mortality among frail living elders: a prospective study. J Gerontol A Biol Sci Med Sci 1999;54:M440-M445

17. 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:S9-15.

18. Zandstra E, Mathey M-F, de Graaf C, Van Staveren W. Short-term regulation of food intake in children, young adults and the elderly. European Journal of Clinical Nutrition 2000;54:239-246.

19. Meiselman HR. The contextual basis for food acceptance, food choice and food intake: the food, the situation and the individual. In: Meiselman HR, MacFie HJH, eds. Food choice, acceptance and consumption. London: Blackie, 1996:239-263.

20. Hendy HM, Nelson GK, Greco ME. Social cognitive predictors of nutritional risk in rural elderly adults. Int.J.Aging Hum.Dev. 1998;47:299-327.

21. Jensen GL, Kita K, Fish J, Heydt D, Frey C. Nutrition risk screening characteristics of rural older persons: relation to functional limitations and health care charges. Am.J.Clin.Nutr. 1997;66:819-828.

22. Inspectie voor de gezondheidzorg. Vocht-en voedselvoorziening in de nederlandse verpleeghuizen: beleid en praktijk. 1999. The Hague, The Netherlands.

23. Walker D, Beauchene RE. The relationship of loneliness, social isolation, and physical health to dietary adequacy of independently living elderly. J.Am.Diet.Assoc. 1991;91:300-304.

24. Elmstahl S, Blabolil V, Fex G, Kuller R, Steen B. Hospital nutrition in geriatric long-term care medicine. I. Effects of a changed meal environment. Compr.Gerontol A 1987;1:29-33.

25. Rolls BJ. Do chemosensory changes influence food intake in the elderly? Physiol.Behav. 1999;66:193-197.

26. Drewnowski A. Taste preferences and food intake. Annu.Rev.Nutr. 1997; 17:237-253.

27. Griep MI, Mets TF, Massart DL. Effects of flavour amplification of Quorn and yoghurt on food preference and consumption in relation to age, BMI and odour perception. Br.J.Nutr. 2000;83:105-113.

28. 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.

29. Schiffman SS, Warwick ZS. Flavor enhancement of foods for the elderly can reverse anorexia. Neurobiol.Aging 1988;9:24-26.

30. McCrory MA, Fuss PJ, Saltzman E, Roberts SB. Dietary determinants of energy intake and weight regulation in healthy adults. J.Nutr. 2000;130:276S-279S.

31. Schiffman SS. Taste and smell losses in normal aging and disease. JAMA 1997;278:1357-1362.

32. Rolls BJ. Regulation of food and fluid intake in the elderly. Ann.N Y Acad Sci 1989;561:217-225.

33. Rolls BJ, Dimeo KA, Shide DJ. Age-related impairments in the regulation of food intake. Am J Clin Nutr 1995;62:923-931.

34. Roberts SB, Fuss P, Heyman MB, et al. Control of food intake in older men. JAMA 1994;272:1601-1606.

35. Rolls BJ, Kim S, McNelis AL, Fischman MW, Foltin RW, Moran TH. Time course of effects of preloads high in fat or carbohydrate on food intake and hunger ratings in humans. Am J Physiol. 1991;260:R756-R763

36. Rolls BJ, Kim HS, Fischman MW, Foltin RW, Moran TH, Stoner SA. Satiety after preloads with different amounts of fat and carbohydrate: implications for obesity [see comments]. Am J Clin Nutr 1994;60:476-487.

37. Louis SJ, Tournier A, Verger P, Chabert M, Delorme B, Hossenlopp J. Learned caloric adjustment of human intake. Appetite. 1989;12:95-103.

38. Toth MJ, Poehlman ET. energetic adaptation to chronic disease in the elderly. Nutr Rev 2000;58:61-66.

39. Morley JE, Kraenzle D. Causes of weight loss in a community nursing home. J Am Geriatr.Soc 1994;42:583-585.

Summary

Aging is often accompanied by anorexia of aging, described as a decline in appetite, a lower dietary intake and followed by unexplained weight loss. The present thesis described research on anorexia of aging. Focus was given to social and physiological determinants of appetite and the relationship with dietary intake and/or body weight was examined in observation (*chapter 2*) as well as in intervention studies (*chapter 3-6*).

First a cross-sectional observation study (*Chapter 2*) on taste, smell appetite and hunger feelings in elderly subjects was conducted. The aim was to detect possible differences in appetite between different health categories of elderly using the Appetite, Hunger feelings and Sensory Perception (AHSP) questionnaire. Three health categories of elderly subjects were selected for this study: free-living with no help, free-living with help and nursing home elderly. For each group, collected data were general characteristics, anthropometry and answers to the AHSP. The AHSP questionnaire includes 29-items focusing on feelings of hunger and appetite as well as taste and smell perception addressing both the present situation and the period before retirement.

Results indicated a decrease in feelings of appetite and hunger with a deterioration of health conditions. It also shows that in relatively healthy elderly subjects appetite remained an indicator of body weight while this relation disappeared in nursing home elderly residents.

The decline in average food intake in elderly people is attributed to both physiological and social factors. These factors are usually studied in isolation. The study described in *Chapter 3* concerned an experiment in which the effect of social setting on food intake was compared with the effect of physiological challenges on food intake in 24 elderly subjects. Physiological effects were assessed using a preload-test-meal design with a no load, and 4 preload conditions. The preloads consisted of 300g of strawberry yogurt drink. The test-meal, served 90 minutes after the preload consumption, was a lunch of which subjects could eat *ad libitum*. During the lunch consumption subjects were either in a very cozy environment eating with 6 to 8 people on one table or in a non-cozy environment with a delimited space and only one person per table.

Results showed that the presence of others did only promote longer meal duration but there was no increase in dietary intake. In apparently healthy elderly subjects, physiological parameters have a stronger effect than changes in social environment on appetite and energy intake. However, meal duration, an intermediate factor of social facilitation, was strongly affected by meal environment in this elderly population.

In *Chapter 4*, long-term effects of a changed environment and atmosphere of meal consumption on appetite and health were explored during a one-year intervention study in a nursing home (n=38). An effort was made to improve the quality of the mealtime experience of subjects in the experimental group by changes on the attractiveness of the dining room, the food service, and the organization of the mealtime assistance. For control subjects, mealtime experience was unchanged from the situation before the onset of the study. Both groups were served the same meals and meal patterns were also the same for the two groups. Dietary intake, indicators of nutritional and health status and quality of life (Sickness Impact Profile and Philadelphia Geriatric Center Moral Scale) were assessed before and after one year of intervention. Body weight information was obtained every four months.
Increased body weight, stable biochemical indicators of health status and quality of life scores in the experimental group indicated a relatively stable health condition while negative changes in the control group suggested a decline in health status. These results suggest that relatively minor changes in mealtime circumstances of elderly nursing home residents can have beneficial effects on their food intake and nutritional status. In other words, social support and physical environment could be reported as one of the determinants for dietary intake in elderly nursing home residents. Further these changes were simple to implement ands could be made without additional cost to the nursing home.

In *chapter 5* we investigated the effects of the introduction of an evening vitamin- and energy-rich snack on average dietary intake and body weight of nursing-home elderly. A parallel intervention study design was used. Every evening for 30 days, the experimental group (n=26) consumed an energy and vitamin-rich drink (200 ml; 1,2 MJ) around 7:30 p.m. whereas the control group (n=26) received usual coffee and tea.
A regular intake of an evening energy and vitamin -rich drink in the evening had a positive influence on dietary intake and led to an increase in body weight, thereby helping in the prevention of weight loss in nursing-home elderly.

Taste and smell losses occur with aging. These changes are supposed to decrease the enjoyment of food, subsequently reduce food consumption and negatively influence the nutritional status of elderly, especially the frail ones. Flavor amplified foods have been proposed to be a feasible way to compensate the age-related decreases. In *chapter 6*, we determined if the addition of flavor enhancers to the cooked meal for nursing home elderly

promotes food consumption and provides nutritional benefits. During 16 weeks, the cooked meal of the intervention group (n=36) was sprinkled with flavor enhancers, while the control group (n=31) received the regular cooked meal. Feelings of appetite, dietary intake and anthropometry were assessed before and at the end the intervention.

Intake at the cooked meal, hunger feelings and body weight increased in the intervention group but not in the control group. Since the repeated intake of flavor amplified foods did not lead to boredom, it suggests that the intervention was well accepted. Adding ready to use flavor enhancers to the cooked meal was in the present study a simple but effective way to improve daily feelings of hunger, actual dietary intake and body weight in a nursing home population with a steady health status.

Finally in chapter 7, the main findings of the studies described in this thesis are discussed in relation to the findings of other. First, appetite and the extent to which food is enjoyed varied greatly between people. In the elderly, these differences may be explained by differences in the health characteristics of the groups studied. Second, social and environmental factors remained important determinants of appetite, more especially in elderly with an unstable or poor health condition. Third, the incapacity to adjust energy intake in the elderly on both short and long-term seems to be a non-reversible process. In daily practice, this lack of regulation suggests that the consumption of energy and nutrient dense supplements between meal could help to prevent weight loss in older adults.

The properties of foods and the context in which the foods are consumed remain important determinants of dietary intake in the elderly and are thereby major risk factors for anorexia of aging and its subsequent weight loss. From a public health perspective, the lack of regulation in appetite and dietary intake should encourage the use and consumption of nutritional interventions in elderly at risk.

Résumé

Le vieillissement s'accompagne souvent d'une anorexie caractérisée par une diminution de l'appétit et de la prise alimentaire, et qui est suivie d'une perte de poids inexpliquée. La présente thèse propose les résultats de différentes études sur l'anorexie liée au vieillissement. Ces études ont eu pour but de déterminer l'influence des facteurs physiologiques et sociaux sur l'appétit, et leur relation avec la prise alimentaire et/ou la masse corporelle a fait l'objet d'observations (*Chapitre 2*) et d'interventions (*Chapitres 3 à 6*).

En premier lieu, une étude observationnelle croisée (*Chapitre 2*) sur le goût, l'odorat et de l'appétit et de la sensation de faim a été effectuée chez des personnes âgées. Le but de cette étude a été de mettre en évidence les différences éventuelles d'appétit entre différents groupes de santé de personnes âgées en utilisant le questionnaire " Appetite, Hunger feelings and Sensory Perception" (AHSP). A cet effet, trois catégories de santé ont été sélectionnées : (1) vivant à domicile sans aide, (2) vivant à domicile avec aide, (3) vivant en maison de retraite. Pour chaque catégorie, des données ont été recueillies sur les points suivants : caractéristiques générales, anthropométrie, réponses fournies au questionnaire AHSP. Ce dernier comporte 29 questions portant principalement sur la sensation de faim et d'appétit, et aussi sur le goût et l'odorat, tant en ce qui concerne la situation actuelle des personnes âgées que sur la période précédant leur retraite.
Les résultats ont montré une diminution de la sensation d'appétit et de faim lorsque les conditions de santé se détériorent. On observe également que l'appétit reste un indicateur de la masse corporelle chez les sujets âgés relativement en bonne santé mais que cette relation disparaît chez ceux qui sont en maison de retraite.

La diminution de la prise alimentaire moyenne chez les personnes âgées est attribuée à des causes à la fois physiologiques et sociales mais celles-ci sont, en général, étudiées séparément. L'étude présentée dans le *Chapitre 3* a été réalisée sur un groupe de personnes âgées (n=24) chez lesquelles on a comparé l'influence de l'environnement social et celle des conditions physiologiques sur la prise alimentaire. Les effets physiologiques ont été évalués par la méthode du "supplément suivi d'un repas-test" (preload-test-meal design). Cette méthode consiste à servir aux sujets un repas-test (une fois) non précédé d'un supplément (témoin) et 4 fois un supplément suivi d'un repas-test. Le supplément consistait en 300g de yaourt aux fraises à boire et le repas-test, servi 90 minutes après la consommation du supplément, était un repas froid dont les composantes étaient servies à volonté. Les sujets consommaient ce dernier soit dans les conditions de confort d'un restaurant, par tables de 6 à 8 personnes, ou dans des conditions d'absence de confort, mangeant seuls dans un espace délimité.

On observe que la présence de convives entraîne une prolongation de la durée des repas mais n'augmente pas la prise alimentaire. Chez les personnes âgées apparemment en bonne santé, l'influence des paramètres physiologiques sur l'appétit et la consommation énergétique est plus forte que celle des modifications de l'environnement social. En revanche la durée des repas, facteur intermédiaire de "social facilitation", dépend étroitement du type d'environnement dans lequel ils sont pris.

Dans le *Chapitre 4,* les effets à long terme de la modification de l'environnement et de l'ambiance des repas sur l'appétit et sur la santé ont été l'objet d'une étude d'une année dans une maison de retraite (n = 38). A cet effet, la qualité du moment du repas des sujets du groupe expérimental a été améliorée en ce qui concerne l'ambiance et le décor de la salle à manger, la présentation matérielle et le service des repas tandis que rien n'a été modifie pour les repas du groupe témoin. Les deux groupes ont consomme les mêmes aliments, préparés de la même manière. La prise alimentaire, indicateur de l'état nutritionnel, de la santé et de la qualité de vie a été mesurée avant et a la fin de l'intervention. De plus, une pesée des sujets a été effectuée tous les quatre mois.
L'augmentation de la masse corporelle, la stabilité des indicateurs biochimiques de santé et le niveau de la qualité de vie du groupe expérimental sont l'indice d'une relative stabilité des conditions de vie tandis que la modification négative des mêmes paramètres dans le groupe témoin suggère une diminution du niveau de santé de ce groupe. De tels résultats permettent de penser que des modifications relativement mineures des conditions dans lesquelles les personnes âgées en maison de retraite prennent leurs repas, peuvent avoir des effets bénéfiques sur leur prise alimentaire et sur leur état nutritionnel. En d'autres termes, le soutien et le cadre physique peuvent être considérés comme importants déterminants de la prise alimentaire des résidents de maison de retraite. En outre, les modifications utilisées pour cette intervention sont simples à mettre en œuvre et n'ont pas entraîné de dépenses supplémentaires pour la maison de retraite.

Le *Chapitre 5* traite des effets de l'introduction, le soir, d'une collation enrichie en vitamines et en énergie sur la prise alimentaire moyenne et le poids corporel de résidents de maisons de retraite. L'étude d'intervention parallèle suivante a été conçue et effectuée : chaque soir, pendant 30 jours, un groupe expérimental (n = 26) a consommé une boisson riche en énergie et en vitamines (200 ml, 1,2 MJ) tandis que le groupe témoin (n = 26) ne recevait, comme d'habitude, qu'un café ou un thé. La consommation régulière d'une telle boisson, le soir, a entraîné une augmentation de la prise alimentaire et de la masse corporelle, ce qui en fait un facteur de

prévention de la perte de masse corporelle pour les personnes âgées résidant en maison de retraite.

La perte de goût et d'odorat accompagne le vieillissement. Ce changement entraîne, en principe, une diminution du plaisir de manger, réduit en conséquence la consommation de nourriture et, de ce fait, influence négativement le statut nutritionnel des personnes âgées, en particulier des plus fragiles. L'utilisation d'exhausteurs de goût a été proposée comme l'un des moyens de compensation de cette perte de goût et d'odorat. Le Chapitre 6 examine si l'adjonction de tels exhausteurs aux aliments cuisinés augmente la consommation de nourriture et se révèle bénéfique sur le plan nutritionnel. Pendant 16 semaines, un groupe expérimental (n = 36) a consommé des aliments cuisinés et saupoudrés d'exhausteurs de goût tandis qu'un groupe témoin (n = 31) ne recevait que des aliments cuisinés sans aucune adjonction. La sensation d'appétit, la prise alimentaire et l'anthropométrie ont été mesurées avant et à la fin de l'intervention.
La prise alimentaire de repas cuisinés, la sensation de faim et la masse corporelle ont augmenté dans le groupe expérimental mais pas dans le groupe témoin. Le fait que la consommation répétée d'aliments additionnés d'exhausteurs de goût n'ait pas entraîné de lassitude chez les sujets du groupe expérimental suggère que l'intervention a été bien acceptée. L'adjonction d'exhausteurs de goût prêts à l'emploi a été, pour la présente étude, une procédure simple mais efficace pour augmenter la sensation de faim, la prise alimentaire réelle et la masse corporelle d'une population vivant en maison de retraite et présentant un état de santé régulier.

Le *Chapitre 7* discute les principaux résultats de la présente thèse en relation avec ceux d'autres recherches. En premier lieu, l'appétit et le plaisir de manger varient considérablement selon les individus. Chez les personnes âgées, ces variations peuvent être dues à des différences dans les caractéristiques de santé entre les groupes étudiés. En second lieu, les facteurs sociaux et environnementaux sont des déterminants importants de l'appétit, en particulier chez les personnes âgées qui présentent des conditions de santé mauvaises ou instables. En troisième lieu, l'incapacité des personnes âgées à adapter leur apport énergétique à long terme semble être un phénomène irréversible.

Les propriétés des aliments et le contexte dans lequel ils sont consommés demeurent des déterminants importants de la prise alimentaire chez les personnes âgées et sont, de ce fait, des facteurs de risques majeurs pour l'anorexie liée au vieillissement. Du point de vue de la santé publique, le manque de régulation de la prise alimentaire devrait amener à recommander des interventions nutritionnelles chez les personnes âgées à risque pour prévenir la perte de poids.

Samenvatting

Veroudering gaat dikwijls gepaard met "anorexia of aging". Dit kan beschreven worden als een vermindering van de eetlust en een verlaging van de voedselinname bij veroudering met een niet intentioneel gewichtsverlies als gevolg. In dit proefschrift worden een observationele studie (*hoofdstuk 2*) en een aantal interventiestudies (*hoofdstuk 3-6*) beschreven op het gebied van "anorexia of aging". Deze studies waren gericht op de sociale en fysiologische determinanten van eetlust in relatie met voedselinname en/of lichaamsgewicht.

Allereerst werd een cross-sectionele observationele studie uitgevoerd naar smaak, geur en eetlust op gevoelens van honger bij ouderen (*hoofdstuk 2*). Het doel was om te onderzoeken of er verschil bestaat in eetlust tussen ouderen die zich in verschillende gezondheidscategorieën bevinden. Ouderen uit de volgende 3 gezondheidscategorieën werden geselecteerd: thuiswonend zonder hulp, thuiswonend met hulp en wonend in een verpleeghuis. Voor elke groep werden gegevens verzameld met betrekking tot algemene karakteristieken en anthropometrie. Met behulp van de *Hunger Feelings and Sensory Perception* (AHSP)-vragenlijst, werden gegevens verzameld op het gebied van eetlust, hongergevoelens en perceptie van smaak en geur.
De resultaten lieten een relatie zien tussen de vermindering van gevoelens van eetlust en honger met een verslechtering van de gezondheid. Verder bleek eetlust als indicator voor gewicht te kunnen fungeren bij relatief gezonde ouderen. Deze relatie was niet aanwezig was bij verpleeghuisouderen.

Een vermindering van de voedselinname bij ouderen wordt aan zowel fysiologische als sociale factoren toegeschreven. Deze factoren worden gewoonlijk apart bestudeerd. In *hoofdstuk 3* wordt een experiment beschreven waarin het effect van de sociale setting van de voedselinname werd vergeleken met het effect van een fysiologische preload in de regulatie van de voedselinname bij 24 ouderen. Fysiologische effecten werden bepaald met een zo genaamd "preload-test maaltijd design". De preloads bestonden uit 4 aardbeien-yoghurtdranken (300 g) variërend in energie-, vet- en koolhydraatgehalten. Een vijfde conditie –geen preload- werd gebruikt om de basisvoedselinname bij de testmaaltijd te meten. Negentig minuten na de consumptie van de preload werd deze testmaaltijd in de vorm van een ad libitum lunch geserveerd. De effecten van sociale factoren op de voedselinname werden gemeten in een saaie en een gezellige omgeving. In de saaie omgeving aten de proefpersonen afgescheiden door tussenschotten. In de gezellige omgeving was de eetzaal gedecoreerd en aten de proefpersonen samen aan tafel met 6 tot 8 personen.
De aanwezigheid van anderen verlengde alleen de maaltijdduur. Dit had echter geen verhoging van de voedselinname tot gevolg. Onder deze gezonde ouderen hadden

de fysiologische parameters een sterker effect op eetlust en energie-inname dan de veranderingen in sociale omgevingsfactoren. Maaltijdduur als intermediaire factor van sociale facilitatie werd echter sterk beïnvloed door maaltijdomgeving in deze populatie.

In *hoofstuk 4* werden de lange termijn effecten van een verandering in omgeving en sfeer tijdens de maaltijdconsumptie onderzocht op eetlust en gezondheid. Deze interventiestudie vond plaats in een verpleeghuis en duurde 1 jaar (n=38). In de experimentele groep is getracht om de kwaliteit van de maaltijdconsumptie te verhogen door de eetzaal gezelliger te maken en de organisatie rondom de voedselservice en de beschikbaarheid van voedingsassistenten te verbeteren. Voor de controlegroep bleef de situatie ongewijzigd. Het maaltijdpatroon en de maaltijden die geserveerd werden, waren voor beide groepen hetzelfde. De voedselinname, indicatoren voor voedings- en gezondheidsstatus en kwaliteit van leven werden voor en 1 jaar na de interventie bepaald. Het lichaamsgewicht werd elke 4 maanden gemeten.
In de experimentele groep bleef de gezondheidstoestand stabiel; het lichaamsgewicht nam toe en de indicatoren voor gezondheidsstatus en kwaliteit van leven bleven stabiel. Negatieve veranderingen in deze parameters lieten in de controlegroep echter een vermindering van de gezondheidstoestand zien. De resultaten suggereren dat relatief kleine veranderingen in maaltijdsituatie bij ouderen in verpleeghuizen, een gunstige invloed kunnen hebben op voedselinname en voedingsstatus. Sociale ondersteuning en omgevingsfactoren zijn dus beschreven belangrijke determinanten van voedselinname bij verpleeghuisouderen. Deze veranderingen bleken eenvoudig te implementeren zonder dat dit extra kosten met zich meebracht.

In *hoofdstuk 5* onderzochten we de effecten van een energie- en vitamineverrijkte snack op de gemiddelde voedselinname en het lichaamsgewicht van verpleeghuisouderen. Hiervoor werd een "parallel intervention study design" gebruikt. Gedurende 30 dagen consumeerden ouderen uit de experimentele groep (n=26) iedere avond een energie- en vitamineverrijkte drankje (200 ml; 1,2 MJ). De controlegroep kreeg de gebruikelijke koffie of thee.
Het bleek dat de vaste consumptie van een energie- en vitamineverrijkte drankje in de avond een positieve invloed had op de energie-inname. Dit leidde tot een verhoging van het lichaamsgewicht en helpt hiermee dus gewichtsverlies in verpleeghuisouderen voorkomen.

Met verouderen vindt smaak- en geurverlies plaats. Dit heeft een negatieve invloed op de voedselinname en hiermee op de voedingsstatus van ouderen, vooral bij fragiele ouderen. Het toevoegen van smaakversterkers aan voedingsmiddelen

lijkt een uitvoerbare manier te zijn om leeftijdsgerelateerde verminderingen van voedselconsumptie tot staan te brengen. In *hoofdstuk 6* is bepaald of de toevoeging van smaakversterkers aan de warme maaltijd van verpleeghuisouderen inderdaad de voedselinname verhoogd. Gedurende 16 weken werden er smaakversterkers over de warme maaltijd van de interventiegroep (n=36) gestrooid. De controlegroep (n=31) kreeg de gebruikelijke warme maaltijd. Aan het begin en aan het eind van de interventieperiode werden eetlustgevoelens, voedselinname en anthropometrie bepaald.

De voedselinname tijdens de warme maaltijd, hongergevoelens en lichaamsgewicht namen toe in de interventiegroep maar niet in de controlegroep. Omdat herhaalde consumptie van smaakverrijkte voedingsmiddelen niet leidde tot verveling, wordt aangenomen dat de interventie goed geaccepteerd werd. De toevoeging van smaakversterkers aan de warme maaltijd was in de huidige studie een simpele maar effectieve manier om gevoelens van honger, de voedselinname en lichaamsgewicht bij verpleeghuisouderen met een stabiele gezondheidsstatus te verbeteren.

Tot slot werden in *hoofstuk 7* de belangrijkste bevindingen van de studies uit dit proefschrift besproken in relatie met de bevindingen van andere onderzoekers. De belangrijkste conclusies worden hieronder genoemd. Ten eerste, waargenomen eetlust en aangenaamheid van een product varieert enorm tussen oudere mensen. Bij ouderen kunnen deze verschillen ten dele verklaard worden door verschillen in gezondheidskarakteristieken van de bestudeerde groepen. Ten tweede, sociale en omgevingsfactoren blijken belangrijke determinanten voor eetlust te zijn, vooral bij ouderen met een onstabiele en slechte gezondheidstoestand. Ten derde, het onvermogen om de energie-inname aan te passen aan de behoefte, lijkt een non-reversibel proces op lange termijn. De consumptie van energie- en vitamineverrijkte supplementen tussen de maaltijden is een middel om gewichtverlies te beperken, in de dagelijkse praktijk en insufficiënte inname van vitaminen en mineralen te voorkomen. In het kader van dit proefschrift is aangetoond dat dit binnen bestaande middelen in een verpleeghuis mogelijk is.

Remerciements

Après 4 ans d'aller et venues sur mon petit vélo noir et par tous les temps (!), d'études dans des maisons de retraite aux quatre coins de la hollande, j'ai fini de tout analyser, corriger, rédiger... Maintenant il est temps de souffler un peu!? Auparavant il me faut remercier un certain nombre de personne sans qui ce livre n'aurait pu voir le jour.

Tout d'abord, je souhaiterais remercier mon directeur et mon co-directeur de recherche, professeur Wija van Staveren et Docteur Kees de Graaf.

Kees, bedankt voor de vrijheid die je me hebt gegeven in het doen van het onderzoek, het vertrouwen dat jij in mij had ook tijdens je sabbatical in de US, maar ook jouw inzet en het vinden van diplomatieke oplossingen in alle fasen van de studies. Dat was wel een hele klus om aan een Française te laten zien dat 'social facilitation' niet vanzelfsprekend is maar wel een belangrijke determinant van de voedselinneming.

Wija, bedankt voor de prettige en inspirerende samenwerking. Ik heb veel bewondering voor het enthousiasme, de energie en de inzet waarmee je de relatie tussen voeding en veroudering bestudeert. Ik wil je bedanken voor alle stimulerende discussies die we hadden en voor de kritische wijze waarop je mijn protocollen en manuscripten hebt bekeken.

Lisette, sinds het begin als Franse erasmus student was je bij betrokken! Bedankt voor jouw interesse en adviezen betreffende mijn onderzoek.

Ik heb veel van jullie drie geleerd en niet alleen op werkgebied.

Je tiens aussi à remercier tout particulièrement Professeur Jean Bézard pour ses conseils, ses encouragements ainsi que ses critiques au début de ma thèse.

Au groupe de diététiciennes et assistantes: Els Siebelink, Saskia Meyboom, Henny Rexwinkels en Marieke Spaan. Beste Els: hoewel we tijdens de studies een aantal (onverwachte) hobbels hebben moeten nemen, is alles toch succesvol verlopen. Bedankt voor jouw enthousiasme, flexibiliteit, inzet en gezelligheid tijdens alle fasen van de studies in het verpleeghuis. Saskia: bedankt voor je goede organisatie, tijdschema... maar ook je hulp door zo prompt op een zondag alle metingen te gaan uitvoeren. Ik heb het zeer gewaardeerd. Henny en Marieke: bedankt voor jullie inzet en de prettige samenwerking!

Ben en Dirk: bedankt voor jullie snelle computer oplossingen, woordenboek (wel belangrijk als je in 3 talen wil werken), beeldjes voor dia's, dagboekje...

Het vaststellen van de voedingstoestand van verpleeghuisbewoners en de daarop volgende interventie met een avonddrankje werd in het zorgcentrum Tilburg Zuid uitgevoerd. De verandering in ambiance heeft in het verpleeghuis Aeneas, Breda plaatsgevonden. De verstrekking van 'flavour enhancers' heeft in de keuken het verzorgingstehuis Rustenburg, Wageningen. Mijn dank gaan uit naar alle medewerkers in de verpleeghuizen die, naast hun toch al drukke baan, toch nog tijd en belangstelling hadden voor het werven van deelnemers, het verstreken van supplementen en/of het uitvoeren van interventie en het verzamelen van gegevens. De harde kern werd gevormd door Drs. Schimmel uit Tilburg, Drs. Vanneste en Drs. Pouls uit

Breda en Mw. Pijlman, Dhr Pinkster et Dhr Hardeman uit Wageningen. Allen hartelijk bedankt voor jullie inzet!

I would like to express my gratitude to all organisations that made it possible to carry out and report the studies described in this thesis. A list of financiers is given at the beginning of this thesis and at the end of every chapter.

Alle deelnemers aan de verschillende studies: dank voor de bereidheid om mee te doen.

Een aantal mensen heeft als student Voeding en Gezondheid of Voeding en Diëtetiek vol enthousiasme aan mijn onderzoek gewerkt: Bas, Marloes, Letitia, Monique, Antine, Bianca, Hugo, Brenda, en, last but not least, Alma en Jill. Allen hartelijk dank voor jullie bijdrage en veel succes in de toekomst.

Dr Daniella Schlettwein, Bernard Decarli and Henri Dirren: thanks for giving me the opportunity to conduct the SENECA study in Yverdon.

Xavier, Marianne et Véronique : travailler en votre compagnie fut un plaisir et je le referais sans hésiter. Véronique, Clémentine, Benjamin et Lina: sans vous, mon séjour en Suisse aurait certainement été beaucoup moins mouvementé. Et donc moins enrichissant et nettement moins sympa...

A Angelica, Liesbeth, Juliawati, Elvina, Siti, Marjanka, Natasja en Robert: het was druk op 320 maar oh zo gezellig. Andere collega's, aio's en PhD fellows: allemaal bedankt voor de gezellige tijd. Liesbeth en Nynke wil ik graag bedanken voor de reeks voorbeeldboekjes en tips. Margje en Dorien, ik vond het gezellig om met jullie naar de Exhausted Nutritionist Like to Party te gaan

A Juul: leuk zeg dat mijn kamergenoot meer dan een collega is geworden! Dat je bij alles zo betrokken bent vind ik wel knap. Bedankt voor jouw gezelligheid, belangstelling, brandnetel thee (ja, heel gezond) en abrikozen-dadel koek als we een goede dag hadden. En tja, dat weet ik, we kletsen te veel... maar ik vind het zo leuk! Niek, ik vond het wel leuk dat je altijd bereid was om ons te helpen onze kamer te verbouwen. En straks kan je op wintersport bij ons in de buurt komen.

A Judith et Luc: ik heb alles zeer gewaardeerd wat jullie in de afgelopen tijd voor mij en ons hebben gedaan. Jullie zijn echte goede vrienden. Straks kunnen we weer een lekker glaasje wijn met z'n alle gaan drinken! In zuid Frankrijk misschien?

Judith en Juul, ik vind het hartstikke leuk dat jullie tijdens de verdediging naast me zullen staan. Wel even goed die Franse stellingen oefenen he?

A Monsieur et Madame Renard et ma belle-famille: merci pour les moments de détentes et les bon repas!

A Liliane & Michel, Christine & Pierre, Stéphanie, Nathalie, Marisol y Henry et tous les autres de ma famille et de mes amis, qui malgré que je sois 'si loin', m'ont toujours soutenue.

A mes grands-parents qui, s'ils avaient pu être présents, auraient certainement été très fiers. Papy, cette thèse t'es dédiée car tu as réussi avec quelques paroles à convaincre et motiver une petite fille de huit ans. Maintenant je sais que si l'on a la chance d'aller loin, il faut la saisir et foncer. MERCI !

Jacinthe et Fabrice : pas évident d'avoir une grande sœur qui veut toujours avoir le dernier mot mais bon vous vous en sortez bien ! Fabrice, tu as choisi une autre route que celle que tes sœurs t'avaient tracée, vas-y, fonce et réussi! Jacinthe, c'est maintenant à ton tour. Ne t'en fais pas, il y a des hauts et des bas mais tu vas y arriver j'en suis certaine, et je serai la première à te féliciter! Pour les week-ends de détente, t'inquiète, on s'en occupe avec Greg.

Papa: Ca y est ! Ce coup-ci j'ai fini mes études. Papa et Maman, merci pour votre soutien, votre écoute, vos idées et votre intérêt tout au long de mon séjour en pays batave. J'espère pouvoir faire aussi bien que vous.

Paul, et oui, comme d'habitude, je garde le meilleur pour la fin. Des fins de semaine passées à peser la consommation alimentaire de personnes âgées en maison de retraite, à faire des graphiques, préparer des posters, déménager un bureau etc. tu l'as toujours fait sans sourciller...Et de près comme de loin (je préfère de près mais bon...) tu as réussi à toujours me faire savoir que tu étais avec moi, je t'en suis reconnaissante.

Et puis on n'a pas fini de bouger *...Allez viens, je t'emmène au vent, je t'emmène au-dessus des gens, et je voudrais que tu te rappelles notre amour est éternel et pas artificiel...* Encore plein d'aventures en vue.

Merci à tous.

About the author

Marie-Françoise Anne Madeleine Mathey was born on the 13th of May 1972 in Dijon, France. In 1990, she passed her secondary high school in mathematics and physics (baccalauréat C) at the French school "Lycée Lafontaine" in Niamey, Niger. The same year she started her study in physiology at the "Université de Bourgogne", France. In 1994 she passed her BSc degree with distinction in physiology with majors in human physiology, biochemistry and nutrition and she started her MSc in nutrition and food sciences at the "Ecole Nationale Supérieure de Biologie Appliquée à la Nutrition et à l'Alimentation", Dijon, France. During her MSc, she went for 6 months to the department of Human Nutrition of Wageningen Agricultural University, the Netherlands, to conduct a research on the impact of the type of meals on oxygen consumption during exercise in young and elderly women. In 1995, she obtained her MSc degree with distinction.

From 1996 to 2000 she was appointed as a PhD fellow at the Division of Human Nutrition & Epidemiology of Wageningen University where she carried out the research resulting in this thesis. In 1999 she collaborated to the SENECA final study and conducted the fieldwork in Yverdon-les-bains, Switzerland. She joined the education program of the Graduate School VLAG (advanced courses in food technology, Agrobiotechnology, Nutrition and Health sciences). She participated in international courses on 'Regulation of food intake and its implications for nutrition and obesity' (1996, 1998), 'Nutrition, Lifestyle and Epidemiology' (1997), 'Protein and functional foods' (2000). From 1997 till 2000, she was an editor of the Newsletter published by the PhD students of the Division of Human Nutrition & Epidemiology of Wageningen University. She was selected to participate to the 6th Seminar of the European Nutrition Leadership Program, June 2000, Luxembourg.