Nutri-Senex

Research for improved quality of life of older persons

Recommendations based on expert group discussions carried out within the Nutri-Senex project - a co-ordination action funded by the European Commission

Contract: Food-CT-2003-506382

Deliverable 39

Gunnar Hall
SIK The Swedish Institute for Food and Biotechnology, Gothenburg, Sweden

Jacqueline Köhler
Justus-Liebig University, Giessen, Germany

Hans Snel
NIZO Food Research, Ede, The Netherlands

Hans-Joachim Franz Zunft
DIFE – German Institute of Human Nutrition, Potsdam-Rehbrücke, Germany
Summary

Ageing is an integral part of life. Due to the interaction between many factors the life expectancy is increasing in developed as well as developing countries. The recognition of the need of a high quality of life also for the older European population was one of the backgrounds of the EU-funded project Nutri-Senex which was a so called co-ordination action. Nutri-Senex had special focus on ageing and health in relation to food, nutrition, health, sensory perception, food related behaviours and attitudes and development of new food products. Participants were researchers with expertise in areas such as food, nutrition and consumer sciences, experts working in food industries and in nursing homes and also representatives of organisations specially working with food and nutrition in relation to ageing.

The aim with one of Nutri-Senex’ work packages (WP3) was to contribute to the co-ordination of European research within the area of ageing, food, nutrition and health. This was done by bringing researchers and experts together to present on-going research in public seminars and also to meet in discussion groups in order to identify areas in which further research was recommended. The selected themes of the discussion groups, which reflected the special expertise of those who participated in Nutri-Senex, were:

- Ageing and nutrition: needs, risks and recommendations (I)
- Ageing, sensory capability and food perception (II)
- Healthy ageing in relation to lifestyle and food choice (III)

The groups met for about two-hours discussions on two (II) or three (I, III) occasions. This report summarises the conclusions based on the outcomes of these discussions. It was clearly recognised that much research is still needed in this area, which ranges from individual nutrients to consumer behaviour. Due to the multidimensional nature of many of the identified problems the need of multidisciplinary research was particularly emphasised. The European dimension, with all its cultural differences, was emphasised. Each chapter below end with a short summary of the recommendations given by each discussion group.
Contents

1 Introduction and background
  1.1 Ageing, health and nutrition
  1.2 Nutri-Senex
  1.3 Co-ordination of research

2 Ageing and nutrition: needs, risks and recommendations
  2.1 Introduction
  2.2 Basic nutrition for elderly persons
  2.3 Biomarkers to detect cases of malnutrition
  2.4 Strategies to improve food intake in older persons
  2.5 Contributions from the food industry
  2.6 Contributions from nutritional science
  2.7 Conclusions and recommendations

3 Ageing, sensory capability and food perception
  3.1 Introduction
  3.2 Sensory capability – general aspects
  3.3 Sensory capability – methodological aspects
  3.4 Ageing and loss of sensory capability
  3.5 Psychological and neurobiological aspects
  3.6 Regulation of hunger and appetite
  3.7 Sensory design of foods for older persons
  3.8 Conclusions and recommendations

4 Healthy ageing in relation to lifestyle and food choice
  4.1 Introduction
  4.2 Nutrition behaviour and food choice
    4.2.1 Psycho-social determinants
    4.2.2 Environmental determinants
  4.3 Meal pattern
  4.4 Sedentary lifestyle
  4.5 Conclusions and recommendations

5 Acknowledgement

6 References
1 Introduction and background

1.1 Ageing, health and nutrition
Ageing is an integral, natural part of life. Due to the interaction of many factors the life expectancy is increasing in developed as well as developing countries. Europe is said to be the world’s oldest continent in demographic terms. By 2050 about one third of Europe’s population will be over 60. The number of oldest old, i.e. aged over 80, is expected to grow by 180%. However, when talking about a long life it’s also important to consider the quality of this life. A good health and an independent way of living are two characteristics of a long life with high quality. When needed, good care is another characteristic of a high quality life.

The aged population is the single largest demographic group at disproportionate risk of inadequate diet and malnutrition. Ageing is associated with a decline in a number of physiological functions that can influence nutritional status (Attems, Lintner et al. 2005). Thus, such changes in the oral cavity as lack of teeth and reduced saliva secretion make food consumption more difficult. Deficits in sensory function reduce the pleasure of eating and may provoke undernourishment. The reduced energy and nutrient consumption attacks the energy stores of the body and lowers body weight. As a consequence lean body mass can be reduced resulting in a decrease in basal metabolic rate (Hickson 2006). Parallel to the lowering in lean body mass physical fitness will be diminished. With reduced physical capabilities the motivation of older people to integrate physical training and activity programs into their habitual life style will decline. In summary, energetic undersupply among older persons stimulates a vicious circle lowering the levels of muscle mass, physical fitness and physical activity (Figure 1.1).

![Figure 1.1 Vicious circle of diminished energy turnover among older persons](image)

Decreased gastric and intestinal secretion of digestive juices worsens digestion, diminish the bioavailability of nutrients and cause digestive problems. Changes in fluid and electrolyte regulation increase the risk of chronic illness. Medication and hospitalization intended to be a
therapeutic measure to counteract the upcoming diseases may in contrast contribute to nutritional inadequacy. External factors, e.g. social and economical determinants aggravate a poor nutritional status of older people. Finally, the quality of life of senior citizens is downgraded stepwise resulting in a higher level of morbidity and mortality.

The link between nutrient intake and health is very strong. Nutrient intake is dependent on the foods we eat. There is a strong consensus among health and nutritional experts that a balanced diet is the best way to maintain a good health in any age. To sustain their quality of life and independence older subjects should consume diets that meet their individual nutrient requirements (Kallus, Schmitt et al. 2005). However, food has no nutritional value until it is chosen, accepted and consumed. Understanding the factors that determine choice, acceptability and sustained consumption is an essential part of a healthy eating policy directed towards older persons.

1.2 Nutri-Senex

To improve nutrition and health status among older people a broad spectrum of measures has to be considered (Chernoff 2001). The EU-funded co-ordination action Nutri-Senex was carried out during the years 2004-2006. The purpose was to collect a maximum of information about the most promising nutrition related approaches, activities and interventions with the aim to contribute to the improvement of the quality of life of older persons. The global objectives of Nutri-Senex were:

- To co-ordinate research into the nutrition of the elderly
- To improve their quality of life
- To reduce public health costs through the prevention of nutrition-related diseases
- To encourage the development of nutritionally-balanced food products which are specially designed for the elderly

Representatives from about thirty organizations in ten European countries participated in Nutri-Senex. The participants had specific competences related to food, nutrition, caregiving, health and well-being of older persons. Among the participating organizations were: universities and research institutes doing research in relation to food, nutrition and ageing; care-givers and non-governmental organizations representing the interests of older persons and food industries interested in supplying older persons with specially targeted foods.

Nutri-Senex was divided into seven work packages and the main outcomes were:

- Public seminars on various topics with contributions both from experts who were and experts who were not members of the Nutri-Senex consortium
- Reports on various topics, e.g. state of the art in relevant research, legislation or food product development

Summaries of the presentations given at the seminars as well as the reports can be downloaded from the Nutri-Senex webpage (www.nutri-senex.com).

1.3 Co-ordination of research

One of the work packages had the title: Co-ordination of European research activities. The work package leader was Dr Gunnar Hall, SIK The Swedish Institute for Food and Biotechnology, Gothenburg, Sweden.

There is certainly a vast amount of relevant research in this area being carried out throughout Europe. Nevertheless further research will be needed and one main purpose with
this work package was to identify and recommend areas for further research. This was done by organizing discussions in small group of experts.

Nutri-Senex gathered experts from many different areas which in a broad sense are of importance for the understanding of ageing, nutrition and health, e.g. geriatrics, nutrition, food science, sensory science and consumer science. The initial task was to identify themes of high priority for discussions in the small groups. The themes below were identified. The three expert groups met for discussions on three different occasions under the leadership of persons who were appointed by the consortium.

- Ageing and nutrition: Needs, risks and recommendations  
  Leader: Dr Hans Snel, NIZO, Ede, The Netherlands

- Ageing, sensory capability and food perception  
  Leader: Prof. Dr Hans-Joachim Franz Zunft, DIfE, Potsdam, Germany

- Healthy ageing in relation to lifestyle and food choice  
  Leader: Dipl. oec. troph. Jacqueline Köhler, Justus Liebig University, Giessen, Germany

This report presents the outcomes of the expert group discussions, i.e. the recommendations regarding future research that were identified. The report has been jointly prepared by the work package and discussion group leaders. A draft version of the report was circulated to all Nutri-Senex participants in order to give them the opportunity to give their comments. It was also presented and discussed at the final Nutri-Senex seminar as well as at the final project meeting which were held on the 27th and 28th of November 2006 in Sabadell, Spain. The recommendations thus represent the view of the Nutri-Senex consortium.
2 Ageing and nutrition: needs, risks and recommendations

2.1 Introduction
Together with getting an older chronological age go processes of ageing. Ageing is a normal physiological process that is correlated with several physiologic changes including loss of body muscle mass, and reduction of cognitive functioning. This age-related loss of muscle mass and function, or sarcopenia, has substantial health consequences. The decline in lean body mass is accompanied by reduced physical performance and loss of functional capacity. Reduced physical exercise accelerates the loss of muscle mass. Furthermore, a decline in lean body mass is correlated with an increased risk of developing chronic metabolic diseases, like obesity and type 2 diabetes (Karakelides and Sreekumaran Nair 2005). A balanced diet can slow down the ageing process. Unfortunately, many elderly do not maintain an adequate and balanced nutritional status which leads to either malnutrition or obesity, both of which strongly contribute to the ageing process. Therefore, it is of utmost importance that elderly persons are stimulated to consume a nutritionally balanced diet in adequate amounts. Within the expert discussion group “Ageing and Nutrition: Solutions to meet physiological needs” of the Nutri-Senex project, this topic was discussed with different experts in the field, ranging from health workers, nutritional scientists, to people from the food industry. All those groups of experts have the potential to influence the choices from elderly consumers by different means, as schematically presented in a simplified way in Figure 1.1. Therefore it is valuable that these parties exchange their experiences in their ability to influence the food choices of elderly people. Importantly to add, the consumer is also strongly influenced by its social environment such as friends and relatives.

Figure 2.1. Schematic simplified overview of the different groups participating in the expert discussions and their role in influencing the food intake of elderly persons.

2.2 Basic nutrition for elderly persons
The ageing process leads to several changes in the body, including loss of muscle mass, diminished cognitive functioning, altered bowel functioning and several poorly understood factors such as changes in intestinal microflora composition (Mueller, Saunier et al. 2006). On a molecular level, during ageing there is a gradual loss of telomeric DNA in dividing
somatic cells, resulting in a reduced ability of these cells to replicate. A reduced telomere length is shown to be associated with higher mortality from heart disease and infectious disease in elderly (Cawthon, Smith et al. 2003).

During expert group discussions on the nutritional status and needs of the elderly it became evident that a low energy intake is not usually the most important issue. Although the energy intake in elderly persons is usually lower than in adults the energy expenditure is usually also reduced. A recent survey among European countries (Elmadfa and Weichselbaum 2005) identified the key nutrients at risk to be (amongst others):

**B vitamins.** The natural intake of folate (Vit B11) is in almost all countries lower than the recommended daily intake of 400 µg/day. Since high folate intake is associated with improved cognitive functions, it is especially important for the slowing down of the ageing process. A low vitamin B6 intake was only found in a few Central European countries. In all other countries, intake is sufficiently high. The intake of thiamine (vit. B1), and cobalamin (vit B12) are on average regarded as sufficient. Despite a sufficient intake of vit. B12 from (unfortified) food, older people are often found to have difficulties in absorbing vit. B12 due to chronic gastritis (prevalence: up to 30%). However such people can typically absorb vit. B12 from fortified foods or supplements.

**Vitamin D.** The mean vitamin D intake is below recommended intake of 10 µg/day in most European countries. The need for vitamin D increases with age, and exposure to sunlight contributes to the circulating vitamin D levels in the body.

**Vitamin E.** For this vitamin, the Scientific Committee of Food (SCF) of the European Union does not give any absolute recommendations. In general, however, the intake of elderly persons is lower than of other adults.

**Sodium/Potassium.** The intake of sodium is generally too high in European elderly, especially in men. In contrast, the mean supply of potassium is not sufficient in elderly of most countries. This contributes to increased blood pressure.

**Other minerals.** In some countries the mean calcium, iron, zinc or iodine intake remains below the recommended level. This is however country dependent. The concentration of selenium in European diets is usually low for the whole population, and therefore also in elderly persons. The supply of magnesium, manganese and copper is usually sufficient.

**Water.** This is a nutrient that is generally overlooked but it has a significant impact on health.

Gender plays an important role in food choices. Several studies have described remarkable differences in food choice between men and women. Consistently, women are reported to have a healthier life style, as is seen by higher intakes of fruit and vegetables, higher intakes of dietary fiber and lower intakes of fat. In accordance with such more healthy food choice, women usually attach greater importance to healthy eating (Westenhoefer 2005).

Despite a healthier life style of women, they are twice as likely to develop frailty as men. This is likely due to several physiological factors. First, higher baseline levels of muscle mass may protect men from reaching a threshold that would put them into a category of frailty. Second, specific neuroendocrine and hormonal factors like testosterone, cortisol and growth hormone may make men less likely to develop frailty (Walston and Fried 1999).

It was pointed out during the expert group discussions that the recommended daily intakes, especially for specific subgroups of elderly persons, are not well-established and continuously under debate. Therefore, the figures on average food intakes of these age classes should always be taken with care. It is recommended to establish a nutrition
monitoring/surveillance system across Europe to detect dietary inadequacy in the diets of elderly at an early stage by means of population based dietary assessment methods and/or dietary surveys. The development of accurate recommendations for nutrient intake during different stages in the ageing process are considered to be of interest, and would be more valuable than recommendations based on chronological age.

2.3 Biomarkers to detect cases of malnutrition

It is of utmost importance that people at risk are identified in an early stadium of nutritional imbalance, before getting frail or obese. However, it is very difficult to identify elderly people in an early stage of an unbalanced nutritional status since this group is usually not under regular medical treatment.

The most important biomarker for an imbalanced nutritional status is the change in body weight. The disadvantage of this biomarker is that it requires multiple measurements of body weight within a time span, and therefore is not the suitable for elderly without regular health checks. An alternative biomarker is based on serum albumin level, which drops down when someone loses weight. The analysis of a blood sample requires an invasive procedure which is not wanted if there are no side indications for a disturbed health status. There is a clear need for a preferably non-invasive biomarker for determining a person’s nutritional status. This is an important topic for future research.

There were several options suggested to improve the early detection of people in need before accurate new biomarkers are developed. A simple approach may be to educate elderly people that a stable body weight is more important than a lean figure. They should be stimulated to use the scale more frequently in their home situation and monitor differences in body weight themselves. If they are capable to record body weights in a health diary, this may be of help for health professionals.

Getting an indication of someone’s daily food consumption is helpful in the diagnosis of the nutritional status. A validated evaluation list on food intake leading to the classification of elderly in well-nourished, at risk and malnourished persons is needed. The social environments of older persons could use this check list to get indications of the nutritional status of elderly, especially the ones free-living at home. It was suggested that nurses, neighbours or others (“anyone who can check the fridge”) that frequently visit the home run a check on what a person eats. It is important that those people are trained for this job. In addition, a validated food intake questionnaire for this purpose should be developed.

If the nutritional status of older persons is taken seriously, all residents of care and nursing homes need a nutritional care plan, preferably made together with the individual residents or their near relatives. Such a plan should define any particular medical requirements on the diet, likes and dislikes of the resident and should preferably include the recording of simple health parameters such as body weight.

A more advanced health system performs routine health checks on elderly, as is currently the case for infants in most EU member states. Physicians indicate that this is not part of their normal practice since they are only expected to examine the factors related to a person’s complaint. In the UK there are some efforts to change the contracts of physicians to include preventive measures in their daily routine.

Although there are tremendous differences between the health systems in different EU member states, most health systems are not equipped for preventive medicine but focus solely on curative medicine. The only examples of preventive medicine are perhaps the vaccination programmes against e.g. influenza and certain cancer screening programmes in which most elderly can participate. Screening of elderly persons without medical indications to monitor their nutritional status is not common practice in the European Union, but may need to be introduced. The implementation of a health system based on preventive medicine
needs to be accompanied by a research and development phase in which different aspects of such a system can be tested.

If physicians get the possibility to check an older person’s health status even without a medical indication, this would greatly facilitate the identification of elderly at risk. The development and validation of clear guidelines for specific target groups (e.g. institutionalized, hospitalized or patient groups) can be helpful in making the decision who to examine and who not.

2.4 Strategies to improve food intake in older persons
Elderly care should provide the necessities for elderly to maintain their quality of live and their health status. From the moment an older person is diagnosed for having developed a suboptimal nutritional status or being at risk for developing such a status, actions should be taken to encourage this person in having a more adequate food intake. A drawback in this is that nutrition is frequently considered as a separate aspect of health whereas it should be seen as part of other elderly issues. Therefore, an integrated approach in which also the social environment of older persons is taken into account is likely more successful. Studies in this field are ongoing, and the results are promising.

A recent Dutch survey assessed the effect of family style mealtimes on quality of life, physical performance, and body weight of nursing home residents (Nijs, de Graaf et al. 2006a; Nijs, de Graaf et al. 2006b). Mealtimes in nursing homes provide an opportunity to integrate and implement physical care with measures to improve quality of life. In most nursing homes, however, meals are individually served on trays in a non-stimulating social environment. Such meals may be nutritionally adequate but do not provide resident-oriented care. A family style meal was recognized by full table dressing, cooked meals served on the table instead of trays, around 6 persons per table, and no other activities during the mealtime protocol. The survey during a 6-month study period demonstrated that elderly residents receiving family-style meals remain more stable with respect to quality of life, physical performance and body weight. Family-style meals stimulate daily energy intake and protect nursing home residents against malnourishments. It is not known if these studies did get any follow up, or how the results are implemented. However, it is recommended that these types of studies that directly focus on the quality of life of elderly person’s are further stimulated.

An efficient and smooth supply of meals in care and nursing homes requires a good and frequent contact between the nursing and the kitchen staffs. With their limited budgets cooks may need a specific training to work in elderly homes in order to offer balanced menu choices that are appreciated by the residents. Food preferences are important factors that affect nutrient intake. In general, the nursing staff is the first to identify the likes and dislikes of the residents. Since training of the nursing staff is limited with respect to optimal nutrition for the elderly, there is a risk that they are not capable to oversee the impact of specific eating habits of the residents. A good communication between cooks and nursing staff stimulates menus that are appreciated by the residents. In an ideal situation older persons in care and nursing homes should be involved as much as possible in the choice of food for the meals. The possibility to order food in addition to the ordinary meals is needed to give residents more control on their own food intake. It is expected that an improved kitchen facility contributes to the quality of life of elderly residents, but further research on this subject is needed.

A frequently forgotten issue is that of oral health. A good set of teeth is a prerequisite for optimal chewing, sufficient food intake and food appreciation. Chewing and swallowing difficulties are frequently diagnosed in a late stadium. A closer collaboration between oral
health services and nutritionists has been suggested. To what extent this can contribute to improved nutrient intake needs further investigation.

2.5 Contributions from the food industry

Although the food industry may certainly play a role in providing foods to the kitchens of elderly care centres, the focus of the discussions on the role of the food industry was on non-institutionalized elderly. There are very few convenient foods or functional foods that are specifically targeted at elderly. In several cases, the products that are directly marketed to elderly are not foods but food supplements (Figure 2.2). Nevertheless, according to EU regulations food supplements are regarded as foods. It is also noteworthy that there is a very flexible age range for products aiming at seniors, even starting at 40 years and older (Figure 2.2). A reason for this may be that older persons do not want to be approached as seniors: “everybody wants to get old, but no one wants to be old”.

![Figure 2.2. Examples of food supplements and special care products especially for elderly persons. Note the differences in describing the elderly population: seniors, 40+ and 50+.](image)

It was a general opinion that food products specially designed for other target groups can also be suitable for elderly with problems. For example, most shops sell bread without crust. This bread is marketed as a product for children who dislike bread crust but it can just as well be bought by elderly with chewing problems. In addition, certain products are marketed for certain health benefits that are not restricted to elderly. An example of this is the cholesterol-lowering margarines that can be used by all age groups. Those products that are targeted towards elderly are frequently supplements and special care products. A broad definition of elderly age (starting from 40 years of age and up) is commonly used. Younger people are also usually used in advertisements and commercials. It was concluded during the expert
group discussions that the food industry should focus more on product adaptations and reformulations than on the development of completely new products for elderly.

A major pitfall of current products for elderly relates to packaging: a too large portion size is a frequently observed problem. Many products are sold in family size packages whereas many elderly live alone. Even a portion for an average adult is too large for an elderly person. As a consequence, elderly buying those products have to throw away a large part of the product, or have daily meals with little variation. Throwing away food is costly, especially for elderly with a minimal income as it is seen in many European countries.

Another aspect related to packaging is the difficulty to open certain products. This is a problem for many other groups in the society too, e.g. disabled people or younger people with specific health problems. Tins, jars and bags require certain strength and two hands to open them. Packages that can be opened with one hand and with limited hand strength are needed.

Also food safety was mentioned as an important aspect to consider. Most products are safe as long as the package is unopened. There is however a risk that products get contaminated after they are opened at home. A large package is likely to be kept longer after opening. The package size may therefore contribute to an increased infection risk. Since elderly in general are more vulnerable towards infectious diseases, ways to produce and store safe products for this target groups should be investigated. However, the wish of many consumers for minimally processed foods needs also to be considered. Therefore, research is needed to find an optimal balance between minimal processing conditions and maximum safety. Many food industries have recognized this as an important need.

2.6 Contributions from nutritional science

Scientists in the field of nutritional epidemiology are the first ones to observe relations between dietary intake and development of certain diseases. The generation of data on prevalence of malnutrition in specific groups is very important, not least for increasing political attention. Further, research into specific needs of elderly and into key nutrients that can slow down or even reverse the ageing process is needed.

Epidemiological research focussing on habitual nutrient intake in elderly is very difficult since different age groups are not homogenous but consist of frail elderly as well as elderly almost in the prime of their life. Besides, the methods used for the assessment of dietary intake are frequently based on recall via questionnaires, which usually leads to underreporting. Nevertheless research in this area is of great importance for the development of recommendations for these groups.

Research on key nutrients that slow down the ageing process is going on and gives information that is needed for the development of optimal nutrition guidelines for the elderly. Nevertheless, presently there are no solutions that prevent sarcopenia in elderly or that boost the immune reactivity against food- or airborne pathogens such as salmonella, influenza or common cold. Therefore, substantial research in this area is still needed.

Many studies focus on the effects of certain biomarkers without taking the actual health benefit into account. This can lead to biased information or information that is even not true. An example of the latter is the abundant information from in vitro, animal and human studies demonstrating that immune responses in elderly can improve after micro-nutrient supplementation. This is an important observation since elderly persons are more susceptible to infections such as common cold or influenza. However, efficacy trials in which
the effect on infections in elderly is studied are scarce. An intervention study, in which 652 people were followed for two winter periods and were given multivitamin-mineral supplementation or vitamin E did not show any decrease in incidence or severity of respiratory infections. In contrast, adverse effects of vitamin E were seen (Graat, Schouten et al. 2002). Similar studies in which the real health benefits are investigated are of utmost importance, and should be supported.

Fortunately, there are several positive news from nutritional science. For example, it was recently found that a high intake of folate slows down the hearing loss, which is another frequently observed health problem in elderly (Durga, Anteunis et al. 2006). Also numerous publications that link diet and life style to diseases such as cardiovascular diseases, colon cancer, osteoporosis or metabolic syndrome provide valuable information for the health sector. This illustrates that research in this area can lead to new knowledge that will help in the development of nutritional strategies for risk reduction of these diseases.

It is important that the results obtained in nutritional research reach the people who need them for implementation. This requires a communication channel between scientists and policy makers. Only in this way, you can expect the governments to move resources in health sciences from acute to prevention.

2.7 Conclusions and recommendations

Ageing is a normal physiological process. Nevertheless, some of the processes that influence quality of life negatively can be prevented, slowed down or even reversed. The nutritional status of a person is an important factor that in several cases can be controlled by providing an adequate nutrition, especially when any imbalance is recognized. The in-depth discussions on this topic in this expert group lead to recommendations for further research and development of particular relevance for health science, nutrition science and also food industry.

In health care for older persons, the most important challenge is the development of a system that identifies people at risk in the earliest stadium of nutritional imbalance. Therefore, the system should be changed to allow health professionals to check a person’s health status without a clear medical indication. The development of such a system should be based on scientific input from health scientists that can validate methods to improve the quality of life.

Residential care and nursing homes should work towards more personalized systems to offer meals. Medical needs as well as likes and dislikes of individual residents should be taken into account and residents should be able to order food in addition to the ordinary meals. Research that demonstrates the effects of different meal supply systems on quality of life is needed.

Nutrition research can contribute to an improved health of older persons in several ways. Important development areas are: methods for better monitoring of food intake in subgroups of older persons, better biomarkers for detection of early stages of malnutrition and increased knowledge on effects of different nutrients on the ageing process.

It is clear that our present understanding on what adequate nutrition for elderly people should look like is in part based on extrapolation of data that are relevant for adults. It is also clear that there is considerable variation in health status between elderly people which is not taken into account when formulating daily intake recommendations. Therefore, nutritional scientists are encouraged to fine tune the daily intake recommendations to specific subgroups, and to further study the impact of specific nutrients on the ageing process. It is recommended to
establish a nutrition monitoring/surveillance system across Europe to detect dietary inadequacy in the diets of elderly at an early stage by means of population based dietary assessment methods/dietary surveys.

There is a strong need of non-invasive biomarkers for early detection of cases of malnutrition. Currently, changes in body weight over time and blood analysis are the best options, but both have their drawbacks: body weight needs to be recorded at multiple time points and blood analysis involves an invasive procedure. Further research in this area is needed.

An increased knowledge on the impact of nutrients on the ageing process is also needed. Our present understanding on nutrients that can prevent or slow down the ageing process is limited. The effect of folate on cognitive functions is getting more and more recognized, but also other nutrients such as anti-oxidants, specific amino acids or minerals may be of importance. It is recommended that this research field gets more attention.

For the food industry, the most challenging task is not to develop completely new functional products that meet the physiological needs of this group. It is concluded that many healthy products for this target group are already available. A better focus would be to adapt and re-formulate existing products to make them more attractive for older persons. Further, packaging sizes should be adapted from family size to a size suitable for one person without increasing the costs too much. In addition, packages should be developed that are easier to open. Marketing of healthy products aimed at other target groups can be adjusted to make it more attractive for elderly.
3 Ageing, sensory capability and food perception

3.1 Introduction

The food choice of individuals changes during the entire life, especially in the course of ageing (Westenhoefer 2005). Ageing is frequently associated with loss of appetite and therefore also with diminished daily intakes of foods and beverages. These adjustments in intake are due to many physiological changes associated with age, including altered functions of smell and taste (Figure 3.1). Older people rate perceived flavour as a strong determinant of their food choices, although they are often unaware of their impaired ability to smell and report no decrease in their appreciation of foods (Rolls 1992). However, gradual sensory losses are usually parallel to the decline in appetite (Rolls 1993). Declining food intake usually means declining intake of both energy and various nutrients leading to higher risks for malnutrition and nutrition related acute or chronic diseases.

Figure 3.1 Putative role of age-related impairments of chemosensory functions on food intake and health (Rolls 1999)

Consequently there is a high potential for minimising undesirable health effects of ageing by diet (Kallus, Schmitt et al. 2005). To sustain independency and quality of life of older persons they should consume nutritious diets that meet their individual requirements. However, food has no nutritional value until it is chosen, accepted and consumed.

One of the most important factors influencing food choice and food intake of persons at any age is the perception of pleasantness which is strongly related to the sensory properties of food. Foods do not only contain various nutrients. They also contain a lot of sensory stimuli. Various senses are stimulated both before foods are eaten and during the eating process. Different types of food components, i.e. molecules, and different physical structures in foods act as sensory stimuli. The perceived sensory properties of a particular food are the result of more or less complex interactions between stimuli in the food and different human senses. In fact, pleasure of consuming foods and enjoyment of eating meals are to a large extent impaired taste and odour sensation

altered food preference and food choice

altered food intake

altered body weight

diet-dependent chronic diseases
sensory related rewards that have direct influence on food consumption and thereby also on nutrient intake.

It’s not only the composition and the structure of different foods that affect the perception of sensory properties. Also the sensory capabilities of individual consumers are very important. Irrespective of sense modality the sensory perception depends on a series of events, from the peripheral receptor stimulation to the mental processing in the brain. It is well known that ageing influences these processes, generally in a detrimental way. Losses in sensory capabilities might have a negative influence on the perceived pleasure of eating and drinking and the consequence might be that smaller amounts of food are eaten which in turn might lead to under- or malnutrition.

This chapter presents research recommendations based on expert group discussions in which ageing dependent changes in sensory physiology and food liking were discussed. Also the implications of such changes for the genesis of malnutrition in older persons were highlighted during the expert group discussions. It became rapidly clear that the relationship between sensory physiology and food perception on the one hand and the role that both issues play in food choice and healthy nutrition on the other hand still is quite unclear. This is true although recent research projects have resulted in interesting new insights. Thus, at present there are more open questions than clear answers, to a large extent this lack of knowledge is due to a lack of suitable methods to investigate the specific questions.

3.2 Sensory capability – general aspects

Many sense modalities are involved in food perception, e.g. taste, olfaction, vision, touch and hearing. The word sensory capability is used to describe either an individual’s or a group’s ability to perceive sensations. Sensory capabilities are related to a range of variables, from the physiological processes involved in the initial receptor stimulation to the nervous and/or psychological processes which interpret primary signals of perception. Also the subject’s general health, which may be impaired irrespective of the subject’s age, may have a great influence. Moreover, also external variables such as social, economic and environmental determinants might influence a person’s sensory capability (Larsson, Nilsson et al. 2004).

Perceived flavours of foods are usually caused by mixtures of many different taste and odour compounds. The perception of the flavour of any particular food is therefore the result of a complex interaction between single gustatory and olfactory sensations which are analyzed and interpreted by the brain. There has been a long-lasting scientific interest in investigating taste-taste, taste-odour and odour-odour interactions (Mojet, Heidema et al. 2004). The general impression is that the interaction effect in younger adults is strongly dependent on the particular compounds and foods being studied. Consonant odours and tastes seem to enhance the perceived taste, dissonant odours and tastes tend to suppress the perceived taste. Only a few authors have investigated the impact of ageing on these interrelationships. Findings show that older subjects are less able than younger to discriminate between the different taste qualities in a product. Also, for young people olfaction seems to play a greater role than for older. However, so far there is too little data to generalize on the influence of ageing on taste and odour interactions in flavour perception. This kind of fundamental knowledge on the influence of ageing on food perception is highly requested, both because it would give a deeper understanding on the ageing processes and because it could help food industry and care-givers when developing and providing foods for older persons.

Another serious problem is the lack of knowledge on how ageing-related decline in sensory capabilities depends on dietary factors (Saugstad 2006). As an example, zinc is involved in the activation of gustatory receptors. Consequently, its nutritional depletion might have negative effects on the taste perception. Research is needed to better understand the role of
nutrients and other dietary factors on sensory capability and to give recommendations for covering the specific needs of the elderly.

With increasing age there is a considerable increase in the use of drugs. It is well known that many drugs are associated with negative side effects. Thus, many drugs influence the sensory function negatively, especially the function of the chemical senses - taste and smell. It’s of particular importance that these negative side effects in older persons are documented. General practitioners need recommendations on how to avoid these objectionable side effects when prescribing drugs. Also, the influence on food perception needs to be understood so that means to counteract the negative effects can be developed.

Microorganisms in the gut may influence several metabolic and physiological processes, among them sensory physiology, too (Parker & Chapman 2004). Little is known about age-dependent differences in microbiota composition. More research is needed to get a better understanding of how gastrointestinal processes affect specific functions of the host. One interesting future application of such knowledge could be better targeted functional foods for older persons.

3.3 Sensory capability - methodological aspects

Disorders of taste and smell are quite widespread, particularly among the aged but also in the general population. However, these kinds of deficiencies present several diagnostic problems to the medical investigation (Wrobel & Leopold 2004). Available clinical tests of olfactory (smell) and gustatory (taste) systems allow the detection of the degree of sensory loss, but are unable to determine the cause and they give neither prognostic information nor therapeutic guidance. Moreover, there is a general lack of knowledge and understanding of taste and smell deficiencies on the clinical side. The reason seems to be a low level of interest among professionals in disorders in these senses compared with the interest in other senses such as sight and hearing. Impairments in taste and smell might be caused by many factors. Increasing age is one of the major causes that contribute to sensory dysfunction, as the ageing processes change both the normal anatomy and physiology of the senses and the functions of nerves and the brain. For subjects affected by disorders the quality of life is changing severely. Therefore, not only control but also management of these conditions is needed.

The determination and description of age-related changes in sensory capabilities is complicated by a variety of moderating factors which may weaken the strength of the evidence that can be obtained for age-dependent reduction in sensory functions. For example, there is a considerable intra-individual variability in onset and progress of the physiological ageing processes. Whereas some persons may experience a specific reduction quite early in their life others may maintain a high level of proficiency until high age. The same is true for loss or maintenance, respectively, of cognitive functions.

Other factors that may influence the evidence of age-related reduction in sensory capability are nutritional state and physical fitness. They may influence sensory as well as cognitive functions by accelerating or inhibiting their decline. They may also be altered themselves by declining sensory capabilities or retarded cognitive function. Thus, every investigation has to control for confounding by other variables.

For research on the receptor level methods of molecular biology have given new opportunities to investigate the structure and the function of chemoreceptors (Conley, Robinson et al. 2003). In the near future structure and function of most of the taste and odour receptors will be detected. The next important step will be to use cloned receptors in models simulating ageing processes and to investigate the consequences for chemosensation.
Another new and promising area is brain research where the implementation of new research methods can help to explain olfactory processing (Ferdon & Murphy 2003; Wang, Eslinger et al. 2005).

Moreover, methodologies of measuring food preferences need improvement. In this area there is a special lack of adequate standardised instruments.

**3.4 Ageing and loss of sensory capability**

There is clear evidence that older subjects are less sensitive to taste and smell substances than young subjects. Results of some studies show that older persons prefer higher concentrations of taste and smell substances in foods than younger (Kozlowska, Jeruszka et al. 2003) but it is yet unclear to what extent higher optimal concentration levels influence food intake (Koskinen, Kalviainen et al. 2003). Thus, although there is a lot of data describing the loss of sensory capabilities among older people (Hummel, Futschik et al. 2003; Kovacs 2004), systematic results that can be generalized are lacking. Especially the relationship between deficiencies in sensory capabilities and food choice needs to be investigated more intensively. Here multidisciplinary approaches will be needed.

A cross-sectional study (Delahunty 2004a) which compared younger adults and older subjects of both genders in different European countries found that odour detection ability decreased somewhat from about the age of 40 years, but impairment accelerated rapidly over age 70. Odour identification ability decreased more progressively from about 40 years, but showed a significant impairment from age 60. The ability to perceive differences in taste intensities was more robust and was not greatly influenced by age. However, taste identification ability decreased from about the age of 50. Changes in oral physiology that accompany ageing, such as an increased likelihood of wearing dentures, muscular problems and saliva flow problems, tended to lead to impaired chewing efficiency and reduced oral sensitivity. Chewing efficiency impairment accelerated after the age of 60, whereas loss of oral stereognosis ability was progressive from the youngest age group tested. No age effect was found for astringency detection or for oral burn detection ability. The implication of these results is that the sensory properties of a particular food are perceived differently by young persons with normal sensory capabilities and older persons who have lost part of their capabilities.

A sub-study in Ireland (Delahunty 2004b) investigated taste and smell sensitivity among Irish consumers over age 60. There were significant differences among these individuals for all the above mentioned sensitivity scores, indicating that sensory losses are by no means uniform within any age group. Therefore, although persons of higher age may have lost ability in one sensory modality it is quite likely that they will have good abilities in other modalities, allowing continued discrimination between different foods and between variants within food type. Further research is needed in this area in order to learn both how this type of compensating mechanisms are employed by older persons and how they can be considered when designing foods for older persons.

Dysphagia, i.e. chewing and swallowing difficulties, and also dental missing and teeth implantation are quite common among older subjects. Both chewing and swallowing play important roles for the release and transportation of taste and odour molecules from foods to the receptors in the mouth and the nose. Thereby chewing and swallowing also have a great influence on the perception of taste and flavour. The effects of dysphagia and similar problems in older persons on taste and flavor perception needs more detailed investigation. Problems related to chewing and swallowing are strongly related to food texture, an issue where food industry may play an important role. When designing foods for older persons with chewing and swallowing difficulties food engineering has to consider the special needs of...
people in this target group, both to make the foods easy to chew and swallow and to give them attractive taste and flavour properties.

3.5 Psychological and neurobiological aspects
Empirical findings from neurological and psychological research demonstrate that with increasing chronological age mental processes start to be altered (Brazel & Rao 2004). These changes, that can be roughly described as stepwise impairments and general slowing down of various processes, result in impaired sensory functions, information processing and also executive motor systems (Enwere, Shingo et al. 2004). Aged persons show decrements in their abilities to manage complex situations and they develop difficulties to divide their attention and to switch from one input to another. Therefore, their capability to conduct multiple and demanding tasks in parallel is reduced. To obtain evidence about these processes a broad variety of tests has been developed, focussing on the assessment of attention and psychomotor function (Kallus, Schmitt et al. 2005).

The brain plays a pivoting role in olfactory and gustatory sensation (Laurienti, Burdette et al. 2006), but it is still unclear what happens in the brain when sensory inputs are transformed into assessments of pleasure. There is stepwise increasing research dedicated to investigate the activities in the brain during these processes (Cerf-Ducastel & Murphy 2003; Tay, Wang et al. 2006). Improved methodologies in neuronal research makes this possible (Hahn, Han et al. 2005). Animal experiments have demonstrated that sensory input is needed for the development of the neuronal networks (Aoki, Kimoto et al. 2005).

Brain research will also increase our understanding of sensory memory (Gilbert, Pirogovsky et al. 2006; Larsson, Oberg et al. 2006). At present it is unknown what is hidden in our brain and how we make use of this hidden knowledge or experience. This is an important issue not only for the understanding of the normal ageing process, but also for understanding diseases like dementia. It is known, e.g., from Alzheimer patients that they have selective deficits in their sensory capabilities. Increased knowledge in this field will allow the development of concepts how to control and to manage sensory losses related to both ageing various diseases (Manrique, Moron et al. 2007).

Olfactory sensations are certainly strongly related to breathing – odorous molecules need to be transported by the air to the nose. There is evidence that Parkinson patients can be enabled to smell again by special training of sniffing. We can expect that olfactory and/or gustatory capabilities that have been lost by ageing or disease can be at least partially relearned by use of special methods that make use of sensory training and also training of motor function. Likewise, saliva secretion in older persons suffering from dry-mouth syndrome may be stimulated by sensory stimulation. Research in these areas will hopefully enable the development of specially targeted sensory therapies.

3.6 Regulation of hunger and appetite
Food intake is to a large extent regulated by appetite. It's well known that many older persons lose their appetite, at least partially. Appetite is particularly controlled by the hypothalamus, especially by the ventromedial and lateral regions. In the last decades several hormones and neurotransmitters which are able to stimulate either the sensation of satiety or of hunger have been identified. They take care both of the short-term and the long-term control of food intake. Ghrelin, one of the strongest orexigenic signal substances, is released in the stomach. Another hunger-releasing signal substance is neuropeptide Y which counteracts the corticotrophin-releasing hormone as a satiety-releasing signal. Research on the influence of ageing on the appetite regulating systems is needed.
Factors such as visual and auditory signals affect the hormonal regulation of appetite. Emotional stress can result in a loss of appetite. There is, however, a clear deficit in information on how gustatory and olfactory sensations are involved in the release of hormones and neurotransmitters responsible for hunger and satiety regulation. Little is known which aspects of sensory sensation drive the appetite besides the hormonal regulation (Schiffman & Graham 2000). Thus, little is known about the effects of the ageing-dependent decline in olfactory and gustatory capabilities. In olfaction, retronasal sensation seems to be more linked to wanting and orthonasal sensation more to liking. In this context also external variables have to be considered, as how appetite can be influenced by social and environmental influences. Again, the aspect of interaction comes in both between different stimuli within one sense and between different senses, as visual and auditory effects influence appetite.

There is little general knowledge on to which degree the functions of the senses of taste and smell depend on diurnal variation. Therefore there is also little knowledge on the influence of ageing on the interplay between sensory function and diurnal variation. Diurnal alterations of enzyme activities, metabolic processes and physiological functions are controlled by hormonal regulation. The 24-h rhythm of the internal clock is primarily fitted to the alterations of daylight. As secondary timer meal intake can be used. As the chemical senses are involved in the process of eating it can be suggested that there might be a link to the internal clock. This is an area for which further research is suggested.

3.7 Sensory design of foods for older persons

The fact that many older persons partially and gradually lose their sensory capabilities put high demands on their foods. The sensory characteristics of the foods should be adapted to the older persons’ physiological and psychological prerequisites – the foods should bring sensory pleasantness and on the same time be of high nutritional value.

As described above, the total complex of odour and flavour substances in a food may be perceived in different ways by persons of different ages. Age groups may also differ in their pleasantness ratings of different types of flavours. However, when designing, or redesigning, foods for older persons specific losses in sensory capabilities reported for specific odour or taste substance must not be generalized as an overall sensory decline. It has been shown that the loss of olfactory capability is not uniform across odorants (Wysocki & Pelchat 1993). Further, the influence of age on preference ratings does not appear to be related to lower perceived intensities in general.

Methodological factors have great influence on both preference and intensity ratings. For example, ratings of pleasantness of different flavour or sweetness concentrations by older persons in a laboratory setting did not predict ratings of pleasantness or food intake in realistic settings (De Jong, Chin et al. 2000; Hoyer & Graaf 2004). Preference tests are usually based on first impressions of evaluated food products. Therefore they do not reflect preferences that result after a longer exposure to the product. Preference tests carried out in the eating environment at home or in a nursing home would contribute to realistic hedonic ratings. This is an area where further research is needed, both to develop methods that can be employed under natural living conditions and to gain knowledge on the influence of various context factors on hedonic ratings.

It has been found that flavour amplification can compensate for age-related perceptual losses, improve food palatability and acceptance, and increase intake in aged people (Schiffman 2000). However, it has also been found that an increase in preference for a particular flavour-enhanced food does not necessarily imply increased intake (Mattes 2002). Thus, still very little is known about the effects of flavour amplification of foods on the hedonic
responses of older subjects and also on their food intake. Further, very few reported studies are available that examine the relationship between sensory capability and hedonic responses over time.

Research in this area will be of particular value for food industry, caterers and others who supply older persons with foods.

3.8 Conclusions and recommendations

The interrelationship between ageing, sensory capability and food perception is very complex and it can only be studied by application of highly sophisticated methods. Existing methodical instruments have to be handled with caution especially in order to avoid confounding with nutrient intake, physical activity, health, and nutrition status. Molecular-biological (in receptor research) and neurological methods (in brain research) are estimated to be promising tools for intensified and to broadened sensory research. Nevertheless, there is a strong need of new and improved methods for sensory, food intake and food perception research, especially methods that are adapted for applications with older people.

The relationship between sensory capabilities and food preferences in older persons is still largely unknown. Further research in this area is therefore recommended. Loss of sensory capabilities is not uniform neither in all subjects of higher age nor in different sense modalities of importance for food choice. Compensation for specific losses in one or more senses by taking advantage of residual abilities in other senses may be crucial to establish preferences for new products tailored for older consumers.

The association between body weight and sensory capabilities in higher ages needs more attention. Different processes interact and research is needed to clarify the interaction between factors such as loss of sensory capability, loss of appetite, malnutrition and loss of body weight. Besides, co-variables such as physical activity and other life style factors as well as mental state need to be considered. Moreover, the role of medication on sensory functions needs more and specific attention.
4 Healthy ageing in relation to lifestyle and food choice

4.1 Introduction

Eating can be considered as the “red thread” passing through life course and is modified and changed through various biographical events, which shape a persons eating behaviour. When giving recommendations for the nutrition of older people we must not forget that eating quality has an important role for the whole quality of life. Eating is very important for senior citizens to enjoy their life and to get structure in the day. Eating together with other people adds a social dimension to life (Brombach 2000). Food and nutrition activities are part of a larger context and linkages can be identified to many disciplines that deal with food and nutrition.

Nutrition behaviour and food choice are very complex processes as many dimensions are involved and people in industrialised societies are faced with many products and diverse eating situations. Contemporary consumers have fears and conflicts involving food and health. Social norms about foods and meal composition that guided previous generations are changing, leaving people with a lack of structure related to food and eating behaviour. (Connors et al 2001). Food habits and nutrition behaviour have never changed so fundamentally and rapidly as during the last fifteen years. But the question remains how the various factors influence food choice and nutrition behaviour.

The European Union experiences major demographic changes with the population increasing gradually in age. This development will largely influence societies. Knowledge on health and nutritional status, nutrition behaviour, food choice and meal pattern might help to improve the quality of life in later years. Studies on nutrient intake and nutritional status of the elderly are quite common while studies analysing nutrition from a social science point of view are rare. Increasing the knowledge in this area is a challenge for research.

The group of older people is very heterogeneous, covering a broad span from young and fit older persons to very old and often ill people. It was decided at the first meeting with this expert group to focus on older people living at home. Therefore, this chapter results and research recommendations regarding institutionalised older people. It was also stated at the first meeting with the expert group that healthy ageing in relation to lifestyle and food choice is a very broad topic which can only be covered by combining different scientific disciplines.

The following main topics were covered in the expert-group-discussions:

- Nutrition behaviour Motives and attitudes towards food
  - What do older people want?
  - What are their meal patterns?
  - Psychological factors
- Environmental factors:
  - Social isolation
  - Alone-living older people
  - Shopping possibilities and Infrastructure
- Inequalities in access to food, differences in/between European countries
- Marketing for older people
- Awareness of older people towards food
4.2 Nutrition behaviour and food choice

Nutrition behaviour and eating habits are formed during childhood (e.g. through nutrition education and behaviour of parents) and are often retained for a lifetime. Especially when investigating nutrition of older persons it has to be taken in mind that they already have undergone a long period of eating and implementing nutrition behaviour during their whole life-course. Behaviour that has once been implemented is very hard to change in older age (Brombach 2000).

Nutrition behaviour and food choice are influenced by a number of factors, e.g.:

- psychological impacts (motives and attitudes)
- income
- education
- gender
- culture
- housework skills
- infrastructure
- medical condition
- and many other.

Besides, many of those who nowadays belong to the oldest group of the elderly have experienced food insecurity and deficiency as well as a limited variety of food in their childhood and youth. These factors also have to be taken into consideration when analysing their nutrition behaviour.

The model shown in Figure 4.1 gives an overview of determinants of nutrition and consumer behaviour. It includes environmental as well as individual factors which lead to special food choices depending on the supply of the market. The final outcome will be the satisfaction of individual needs (Leonhäuser 1995).

![Determinants of Nutrition and Consumer Behaviour](image)

**Figure 4.1: Determinants of Nutrition and Consumer Behaviour (Leonhäuser, 1995)**
Nutrition behaviour causes special choices of food. According to Allen and Newsholm (Allen and Newsholm 2003), food choice is defined to be a complex human behaviour which is determined by many personal and environmental factors, including psycho-social and socio-economic influences as well as market influences such as food availability. These determinants of personal food choice play an important role in establishing nutritional habits and therefore nutrition behaviour. The complex chain of factors related to the food choice of a population is summarised in the model shown in Figure 4.2.

In this model, events and experiences during the course of life are considered to shape current food choices through the influences of an individual’s ideals, personal factors, resources, social relationships and food contexts. The model seeks to explain habitual and unconscious food practices, as well as more thoughtful decisions. It conceptualizes each new food choice as contributing to a person’s life-course experiences related to food. In this model, people use several salient considerations as a basis for food choice. The considerations that people weigh in food choice decisions are labelled as values (Connors et al 2001).

![Figure 4.2: The Food choice process model (Connors et al., 2001)](image)

Both models show the complexity of the eating process by not only focussing on the nutrient intake. Although some of the elements covered by these models have been analysed in the context of food choice and eating behaviour, a survey analysing the complex coherences leading to food choice and food preferences is still missing, especially for the target group of
the elderly. In this field multidisciplinary research combining economic, psychological and social disciplines would be advisable,

Food choice criteria differ between heterogeneous geographical, cultural and religious groups. In this context personal food choice criteria reflect traditions and national identity. But a representative comparison of different cultural and traditional influencing factors has not yet been conducted.

In the following some of the most important psycho-social and environmental determinants of nutrition behaviour and food choice are described in more detail. Research gaps that were identified during the expert group discussions are also mentioned. It has to be pointed out that single factors can not always be clearly assigned to one field of determinants and some factors could belong to various groups.

4.2.1 Psycho-social determinants

Motives
Although a high prevalence of overweight is present in older people, the main concern is the reported decline in food intake and the loss of the motivation to eat in the target group. Poverty, loneliness, and social isolation are the predominant social factors that contribute to decreased food intake in the elderly. Depression, often associated with loss or deterioration of social networks, is a common psychological problem in the elderly and a significant cause of loss of appetite. There is now good evidence that, although age-related reduction in energy intake is largely a physiologic effect of healthy aging, it may predispose to the harmful anorectic effects of psychological, social, and physical problems that become increasingly frequent with ageing. Poor nutritional status has been implicated in the development and progression of chronic diseases commonly affecting the elderly. Protein-energy malnutrition is associated with impaired muscle function, decreased bone mass, immune dysfunction, anemia, reduced cognitive function, poor wound healing, delayed recovery from surgery, and ultimately increased morbidity and mortality (Donini et al 2003).

In a study conducted in the United States the older subjects stated that maintaining health, remaining independent and fearing illness provided the motivation needed to adhere to healthier eating behaviours. (Greaney et al 2004). Similar outcomes have been found in an Irish study. Quality of food, personal habits and trying to eat healthy are the main factors that influence the food choice of the retired Irish (Kearney et al 2000).

Medical problems and illnesses are also a strong motivation for elderly people to change their food choice and nutrition behaviour. A study relating to diets and nutrient intakes of older Italian individuals showed that difficulties in nutrition-related activities were associated with inadequate intake of selected nutrients (Bartali et al 2003). Older persons tended to adapt their diets in response to individual functional difficulties, often leading to monotonous food consumption and, as a consequence, to inadequate nutrient intakes. Reporting difficulties in at least 3 nutrition-related activities (chewing, self-feeding, shopping for basic necessities, carrying a shopping bag, cooking a warm meal, using fingers to grasp or handle) significantly increased the risk of inadequate intake of energy.

To conclude, there are some studies on national levels analysing motives towards eating and drinking. A Europe-wide survey comparing especially the cultural motives of food choice and eating behaviour would be advisable.

Attitudes
Minor differences in health, taste attitudes and reported behaviour have been found among Finnish, Dutch and British consumers aged 18-75 years. Finnish citizens showed the most positive attitudes to ‘light’ (low fat, low energy density etc) products compared to Dutch and British consumers suggesting they were more health-orientated. Though females in all three
countries were more interested in health and natural products than males, they consumed more sweets than males (in Finland and in the UK, but not in the Netherlands) (Roininen et al 2001). However the results of the study are cited for adults aged 18 to 75 years without stratifying different age groups. This is a typical example of studies that investigate nutrition behaviour and food choice but do not specifically look at the group of senior citizens. Results from these studies could be applied to the elderly if age groups were defined.

The Health-Sense project examined specifically the attitudes to diet and health of adults aged 55 years and over within the European Union. It was found that the resistance to change nutrition behaviour increased with age. Those selecting “don’t need to change”, or “don’t want to change” were most likely to be in the oldest (51%) rather than youngest (36%) age group of older adults (Allen and Newsholme, 2003). Health-Sense also investigated reasons for, and barriers to, change among older adults. The main reason for change was ‘medical reasons’ (54%) suggesting that much change among the elderly is reactive (to an existing medical problem) rather than pro-active (to prevent the occurrence of a medical problem). The most obvious barrier to a change was the belief that ‘diet is already healthy enough’ (42%).

Similar results were obtained in Germany by the EVA study, where ‘eating types’ and ‘habits’ were only changed in the event of severe illnesses (Brombach 2000). Over half of the elderly in Ireland and Northern Ireland are not willing to change their eating behaviour as they consider their own diet to be healthy enough (Kearney et al 2001). Over 60% of the same sample make efforts to eat healthy.

As there are still only few studies looking at eating attitudes as a basis for food choice and nutrition behaviour of the elderly, it is recommended to expand research in this area to better understand food choice of older people. A good approach in this research field has been done by the EU project “Food in later life” which has focussed on attitudes and beliefs of older consumers and their food preferences (particularly for special products like functional food or ready-made convenience foods). The results of this project have not been entirely published yet, but they might provide a good starting-point for further research.

**Emotions**

Feelings play an important role in nutrition behaviour and food choice. For example, feelings of guilt were reported in several studies of older women after they had consumed foods high in fat. They felt they were acting against healthy eating recommendations. However, widows are often at risk of poor nutrition because they simplify their meals due to the unfamiliar eating alone situation. In addition, a low-fat diet might increase the risk of malnutrition (Gustafsson and Sidenvall 2002).

In a review of nutrition and older people in England, Gabriella (2004) identified factors that hinder food preparation and eating. Emotional factors including isolation with an inability to go out shopping, decreased mobility, loss of spouse and depression were identified as risk factors for malnutrition in the elderly.

Besides studies analysing the special emotional situation of elderly living alone and the above mentioned example of studies which analyse feelings when eating products too high in fat, other emotional factors (e.g. positive emotions associated with eating and drinking) should be analysed more deeply for the group of the elderly. This can be one important factor for the implementation of effective nutritional information and nutritional counselling.
4.2.2 Environmental determinants

Inequality in access to food

Inequality in access to food arose as an important topic during the expert group discussions. Thus, the difference in access to healthy food in European countries, especially between East and West Europe needs to be studied. The impact of these differences on older people has not been analysed on European basis yet.

Inequality not only on country-level but also between social classes becomes a more and more meaningful issue. Poverty plays an important role also in industrialised countries and in the population group of the elderly. Especially older women who live alone are at risk of poverty. Low income is a decisive factor on food consumption and causes limited food choice (Lehmkühler 2002). Future research in the field of poverty and its influences on nutrition should focus on the elderly, too. In this research field longitudinal studies would be important to determine the impact of continuous poverty-situations.

Tradition

As the EU is a multi-cultural community, traditions differ from country to country. However, few studies deal with tradition and nutrition behaviour differences between these countries. The majority of people living in Scandinavia and Denmark traditionally eat one hot meal per day. However, two hot meals are frequently consumed in Finland and Sweden. One of the hot meals is eaten around noon and a second one in the evening. In Norway and Denmark a hot meal in the evening is more common. The main meal usually centres around fish in Norway, vegetables in Finland and meat in Denmark and Sweden. The Finns often eat bread together with their hot meal, whereas potatoes are served in the other countries (Mäkelä et al, 1999).

There is a need of further research in which traditions in different European countries and their impact on nutrition behaviour are compared.

Eating environment

In the UK a study was carried out to investigate the effect of eating environment on food intake in the elderly (Gibbons and Henry 2005). Two environments were considered; the improved environment was a state of the art training restaurant and the standard environment was a staff canteen. Each subject was served an identical meal in both environments and the energy intake was determined using the weighed intake method. The energy intake differed significantly between the improved (4894 ± 613 KJ) and standard (4536 ± 620 KJ) eating environments, suggesting that changes in the eating environment may improve energy intake in the elderly. Further research on the effects of different eating environments is recommended.

Larrieu et al. (2004) found that French people aged 65 years and older living alone and those with low education were particularly at risk of poor dietary habits. The oldest subjects ate less meat, fish, cereals, raw vegetables and pulses less regularly and subjects living alone were less regular consumers of all foods.

Education/ Counselling for healthy ageing

It was discussed by the expert group how older people can be educated, especially in the field of healthy nutrition. The discussions showed that there is a lot of literature dealing with educating old people. So called “andragogic techniques” deal with education of older people and application of adult learning methods and teaching. In case of healthy nutrition that could be cooking courses, competitions etc. However, research in the field of nutrition is rarely existing. Special attention is to be paid on how to best encourage elderly to learn more about healthy diet and to implement their knowledge in everyday life. In 20 years from now older people will be used to computers and other techniques that for example might lead to
changes in their shopping behaviour. Online-shopping will give an easy access to food. So far there are not many studies in the field of new technologies for the elderly. It is an urgent topic and there are many questions that need to be answered. For example, will older persons’ food choice change with access to the internet? And regarding internet, what training is needed? The important research question is if and how new media could be used as tools that aids the elderly to make healthy food choices and to implement healthy lifestyles.

A lot of research has been done about what is healthy and what one should eat, Nevertheless people do not implement the recommendations. Therefore, one of the most important research areas is how to bring research based information to the elderly, to carers etc. It has to be investigated how research based information can be best put into practice and also to what extent such information helps people to stay healthy longer.

4.3 Meal pattern

Meal patterns are an expression of nutrition behaviour. They refer to particular ways in which food supply, food choice, food preparation, and eating practices are usually carried out or organised (Leonhaeuser 2002).

It seems that older women eat more frequently than men, usually three main meals per day. Lunch is identified as the most important meal to this group and it often consists of vegetables, potatoes and meat. This meal is usually eaten around noon. It takes approximately thirty minutes to prepare and another thirty minutes to consume although regional differences have been identified within the EU. (Rurik 2004, Brombach 2000).

Home-made meals are generally preferred by the elderly and social support and delivery services like “Meals on Wheels” are rarely used until it is not longer avoidable. Less than 10% of a study population aged over 65 years in Hungary were supported by delivery services. These services are used in cases of illnesses, disabilities and handicaps or after the death of a partner (Rurik 2004).

Three large diet groups among men and three groups among women were identified within a representative national British sample aged over 65 years by cluster analysis. According to these results 48% of British men follow a ‘mixed diet’ (incorporating elements of a traditional diet with some elements of a healthy diet), 21% follow a ‘healthy diet’ and 17% follow a diet characterised as ‘traditional’ and high in alcohol content. The most common diet among the female population is a ‘sweet traditional diet’ (33%) followed by a ‘healthy’ diet (32%) and a ‘mixed diet’ with traditional and healthy elements (18 %). Important differences in nutrient intakes and in socio-demographic and behavioural characteristics were identified across the clusters mentioned above (Pryer et al 2001). A study of German women aged over 65 years identified four different eating types (Brombach, 2000). These eating types were only changed in the event of marriage to a partner with another eating type, or in the case of illness or fear of adverse health implications. The eating types were characterised as ‘open’, ‘closed’, ‘authoritarian’ or ‘liberal’. However, these eating types were based on childhood socialisation, which for all participants was either conservative/authoritarian or liberal. Meal patterns of the interviewed German women can be described as “cooked meal with meat-legumes-starch component” and dinner as cold meal with bread and cheese/ sausage spreads. Eating times can be characterised as “8am-12am-8pm” pattern.

The snack pattern of 807 European citizens aged 74 to 79 has been examined in a Seneca follow-up study. In general, older people in various European cities consumed the same snack types. Five distinct snack patterns emerged from the analysis. The large group of light snackers had a low snack use and low energy and micronutrient intakes. Alcohol drinkers and dairy snackers had a high snack use and high intakes of energy and several vitamins.
and minerals. Fruit and vegetable snackers and sweet drinkers often had intake values between the other three groups. The study indicates the existence of identifiable snack patterns that coincide with different intakes of energy and micronutrients. The identification of snack patterns can help to improve dietary advice, especially in countries in which people derive high percentages of energy through snacking (Haveman-Nies et al., 1998).

A study conducted in the United States examined the snacking habits of non-institutionalised Americans aged 55 years and older. The majority of seniors snacked at least once daily. It was found that taste outranked nutrition as selection criteria. Fruits were popular but were chosen less often then other snacks. Findings suggest that snacking should be targeted with specific nutrition education messages that address the influences of time of day, location and qualities of foods upon choices made when snacking (Cross et al 1995).

To conclude, the research situation regarding meal patterns is quite sufficient, but a European-wide comparison is recommended to get an overview of the situation in the EU based on the same research methods. Since many European countries are characterised by migration and mixed cultures research on the cultural influence on meal patterns is also recommended. Such aspects as traditional eating times and duration of meals should be studied in order to achieve better target group oriented nutritional counselling and care services.

**4.4 Sedentary Lifestyle**

Varo *et al* (2003), carried out the first European-wide evaluation of the distribution and determinants of sedentary lifestyles in Europe. Nationally representative samples of 1000 participants in each country completed a questionnaire concerning attitudes to physical activity, body weight and health. In total, information was gathered on 15,239 subjects aged over 15 years, including 1914 participants over 65 years of age. Obese, less educated people and smokers showed a high prevalence of sedentary lifestyle in all age groups. Cultural and demographic differences were high between northern and southern countries. The highest prevalence of a sedentary lifestyle was observed in Portugal, Belgium, Spain, Germany and Greece. Similarly, findings from the HealthSense study support the wide variation in attitudes to physical activity between northern and southern EU states (Allen and Newsholme, 2003). Adults in northern states (Sweden, Finland, Netherlands and Denmark) were more likely to recognise the importance of physical activity to long term good health than did adults in southern regions (France, Italy, Portugal and Greece). Likewise, the percentage of adults of all age-groups reporting to participate in physical activity at least weekly was greater in northern regions of the EU. However, it was also suggested that confusion may exist regarding what exactly is considered to be ‘physical activity’.

The next research step is recommended to be a holistic analysis of lifestyle of the elderly, combining physical activity with other lifestyle factors like nutrition.

**4.5 Conclusions and recommendations**

World-wide, few publications dealing explicitly with eating behaviour of the elderly exist and many of these studies were carried out in the USA. In Europe studies on nutrition behaviour have mainly been focussing on younger and middle aged adults, on elderly only very recently. Studies regarding nutrition of the elderly have mainly focussed on physiological needs and/or medical dimensions. Therefore, there is a strong need of research on eating behaviours of elderly, especially when the demographic changes of European countries are taken into account. Quantitative surveys such as National Consumption surveys which focus on overall representative quantities of foods eaten in various socio-economic groups neither give details on meal patterns nor reveal thorough information on how eating and drinking are integrated in everyday life practices of the elderly. Research using qualitative methods is
therefore recommended. Through qualitative studies holistic and in depth pictures on everyday life practices and motives of eating behaviour can be obtained (Brombach 2000).

Few publications deal with sociological and psychological determinants of meal patterns and food consumption. Findings suggest that nutrition behaviour of the elderly is influenced by nutrition education and health behaviour established already during childhood. Further research in which nutrition during the ageing process is studied from social, psychosocial and cultural points of view is recommended in order to get insight in everyday-life activities in the context of eating and drinking. The knowledge gained is essential for developing concepts to improve health and the quality of life of senior citizens.

The following general research recommendations arose during the expert-group-discussions:

- As nutrition behaviour is a multidimensional topic with lots of influencing factors, multidisciplinary research approaches are needed.
- Longitudinal studies should be initiated in order to follow the formation of meal patterns during the course of life.
- As meal patterns are culturally based and shaped, cultural expectations on meals including cultural values, norms and standards for food choices should be assessed. Cross-cultural studies are needed in this context.

Beside these general recommendations, research gaps were identified in the following more specific areas:

- Attitudes, values and experiences of eating and drinking in the context of the biographical background of older people.
- Shopping behaviour in later life: impact of mobility, infrastructure, package design and marketing.
- Possibilities of age-based strategies for the implementation of nutritional recommendations - If food habits need to be changed in old age because of health reasons, how can it be done?
- Awareness of nutrition and health among older persons.
- Studies on gender differences in nutrition behaviour and food choice.
- Studies on nutrition behaviour and food choice of ethnic minorities in Europe, from the ageing perspective.

Special methods are needed and should be developed for this type of research with older persons. A possible method for analysing behavioural topics might be biographical interviews, which is a common instrument in social sciences but a quite new instrument in the field of care in older age.

In order to raise the quality of life in older age, qualified nutritional counselling is supposed to result in improved diets and better nutritional status. Costs in the health sector can thereby be reduced thanks to the prevention of nutrition related diseases such as obesity, coronary heart disease and diabetes mellitus. Health policies should set up the framework for a successful translation of research results into action. For qualified nutrition counselling and nutrition information not only knowledge of the nutritional status and nutrient intake of the elderly is needed but also more information why people behave in the ways they do and how their food choices are formed. Information relating to eating habits is essential for nutrition counselling. Awareness of current meal and food consumption patterns as well as the kind and quantity of the food consumed are the basis for changes in nutrition behaviour.

Food industry and marketing agents play very important roles. They have to understand and in particular meet the needs and wishes of the elderly consumers. Therefore
research that helps them to better examine and understand the situation and the special demands of older people is strongly recommended.
5. Acknowledgement
The authors wish to thank all those who participated in the expert group discussions and those who have commented on the draft version of this report and thereby contributed to the contents.

Nutri-Senex took place with the financial support of the European Community Sixth RTD Framework Programme (Contract FOOD-CT-2003-506382). The content of this report reflects only the views of the participants in the project and the European Community is not liable for any use that may be made of the information contained therein.
6. References


