Sensory, attitudinal, and contextual aspects of the meal
Erika Rapp

Sensory, attitudinal, and contextual aspects of the meal
Health implications and connections with risk factors for coronary heart disease and obesity
Abstract

The overall aim was to study risk factors for obesity and coronary heart disease (CHD), in relation to food and meals. A case-control study of people diagnosed with CHD was used to evaluate preferences for full-fat versus low-fat versions of a range of foods, along with basic taste sensitivity and sensitivity to the bitter substance PROP. No significant differences in taste perception were obtained between the groups. However, in the pooled sample, a heightened sensitivity to sour taste was correlated with low BMI, while a heightened sensitivity to bitter taste was correlated with low HDL-cholesterol, and high BMI and abdominal fat. This indicates a relationship between risk profile, taste sensitivity and food intake. Heightened sensitivity to bitter taste might result in lower consumption of fruit and vegetables including those with a bitter tone. Preference related to total fat content per se was not confirmed as a risk factor for CHD. However, a less favourable metabolic profile were seen in the CHD group, indicating a higher intake of fat-rich and energy-rich food. The sensory effects of fat content were also evaluated, using two sauces as the vehicle. Overall, increased butter content resulted in decreased perception of all flavours except butter flavour, which increased, as did viscosity. However, a high fat content could not always be justified in terms of taste; large increases in energy content produced only small sensory differences.

Data were also collected through a survey on eating habits and attitudes to health and food consumption. A cluster analysis revealed the existence of a gender-mixed overweight group, with less healthy eating habits. This group seems to consist of women less interested in health and men more interested in getting pleasure from food than general, demonstrating different reasons for unhealthy eating between genders. The essence of a good meal was found to include a number of demands on both food (a restaurant-type meal, a proper meal, sensory experience, satisfying and nourishing, and primary product quality) and context (spirit of community, aesthetic experience, tranquillity, and frame of mind), which might be relevant to the goal of changing people’s eating habits. Additionally, a deeper understanding was gained about meal experiences, with a focus on acceptance and satisfaction in relation to health outcome. Overall, the present findings could be of interest in health promotion and intervention when identifying individuals' opportunities for and requirements of good meals, starting with one’s own familiar taste and context.

Key words: Abdominal fat, Basic tastes, Bitterness, BMI, Coronary heart disease, Dietary fat content, Eating context, Food, HDL-cholesterol, Health promotion, Intervention, Meal, Perception, Preference, PROP.
List of original publications

The thesis is based on the following original papers, which are referred to in the text by their Roman numerals.


IV. Rapp E and Öström Å. Association of gender, body mass index (BMI), eating habits and attitudes in a middle-aged Swedish population. (In manuscript)

V. Rapp E, Jonsson, IM and Öström Å. Food and context: The essence of a good meal and a potential model for promoting health. (Submitted)

Sammanfattning

Det övergripande syftet var att undersöka mat- och måltidsrelaterade faktorer som bidragande orsak till övertvik och hjärt-kärlsjukdom.


I en enkätstudie påvisades att matvanor och inställning till mat och hälsa skilde sig mellan män och kvinnor samt beroende av BMI. En klusteranalys resulterade i tre grupper, varav en grupp med jämn könsfördelning som i genomsnitt hade högre BMI och sämre matvanor. I den gruppen ingick kvinnor som är mindre intresserade av sin hälsa och män som är mer fokuserade på mat som njutning, vilket indikerar att orsakerna till ohälsosamma matvanor skiljer sig mellan kvinnor och män. I en öppen fråga beskrevs essensen i en god måltid innefatta både krav på maten (råvaror, maträtter, menyer, sensoriska egenskaper samt näring och mättnad) och krav på sammanhanget (estetik, gemenkap, lugn och ro, och sinnesstämning). Att identifiera individers olika anspråk på en god måltid kan vara komplementära kunskaper till hjälp vid förändring av mat- och måltidsvanor. Slutligen bidrog en litteraturfördjupning till kunskaper om matmåltidsupplevelser med fokus på uppskattning och tillfredsställelse i relation till hälsotillstånd.

Resultaten indikerar att det är av betydelse att identifiera enskilda individers förutsättningar och preferenser för mat och måltider vad gäller smak, matvanor och kontext i vardagen för att underlätta intervention och hälsofrämjande arbete.

Nyckelord: Beska, BMI, Bukfetma, Fetthalt, Grundsmaker, HDL-kolesterol, Hjärtinfarkt, Häl-sa, Intervention, Mat, Måltidsmiljö, Preferens, PROP, Sensitivitet
**Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BMI</td>
<td>Body mass index</td>
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<td>CHD</td>
<td>Coronary heart disease</td>
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<tr>
<td>CVD</td>
<td>Cardiovascular disease</td>
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<tr>
<td>FAMM</td>
<td>Five aspects meal model</td>
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<tr>
<td>fB-glucose</td>
<td>Fasting glucose in whole blood</td>
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<td>HbA1c</td>
<td>Glycosylated haemoglobin</td>
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<td>HDL-cholesterol</td>
<td>High-density lipoprotein cholesterol</td>
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<tr>
<td>HTAS</td>
<td>Health and taste attitude scale</td>
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<tr>
<td>LDL-cholesterol</td>
<td>Low-density lipoprotein cholesterol</td>
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<tr>
<td>NaCl</td>
<td>Sodium Chloride</td>
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<tr>
<td>OGTT</td>
<td>Oral glucose tolerance test</td>
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<tr>
<td>PROP</td>
<td>6-\textit{n}-propylthiouracil</td>
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<td>S-cholesterol</td>
<td>Serum cholesterol</td>
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<td>S-triglycerides</td>
<td>Serum triglycerides</td>
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<tr>
<td>SCB</td>
<td>Statistics Sweden</td>
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<td>SES</td>
<td>Socio-economic status</td>
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<td>SLV</td>
<td>Swedish National Food Administration</td>
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1. Introduction

The gastronomic landscape in Sweden as well as other Western countries is currently subject to a number of parallel ongoing trends. On one hand there are trends in slow food, organic, and fair trade produced foods; and on the other hand there are trends in molecular gastronomy and eating out. There are also a number of opinions on the healthiest way to eat; for example, specific diets such as the GI (glycaemic index) or Atkins diets are claimed to be superior to current medical advice. Laymen are promoted to experts in nutrition, and many of them write cookbooks to share their philosophy. These different diets are not always evidence-based, and research results to date have been mixed (SLV, 2008), and thus, might be confusing.

Amidst all these trends and different sources of information, we must make our individual choices. Most people are more or less aware of the importance of nutritious, well-balanced food, but ingrained behaviour and preferences are great obstacles to any attempt to change to healthier eating habits. Several diseases are partly related to food habits. In addition, the World Health Organization (WHO, 2003) has declared obesity to be an epidemic in the Western world.

Both in Sweden and throughout the world, public authorities are responsible for public health within their nation’s population. There exist national and international evidence-based guidelines for what to eat, how much to eat, how often to eat, and when to eat (NNR, 2004; SNR, 2005; WHO, 2003). For example, food pyramids, food circles, and plate models are used to encourage the population into healthy food habits. Lately, the importance of the meal situation has been noticed (SLV, 2007a, 2007b). In addition, there are demands for restaurants to take their share of responsibility, and so guidelines for nutritious meals (“key-meal” guidelines) have been developed (Bohman & Laser Reuterswärd, 2006).

My interest within this gastronomic landscape is the intersection between gastronomy and health. It is often said that the major reason behind our choice of what to eat is our individual preferences. Beliefs about the taste of foods or meals have been identified as probably the most important determinant of food choice, and eating is considered as high on the list of pleasure-providing activities (Brug & van Assema, 2001). Many factors influence how foods taste to us; not just the sensory properties and initial palatability, but also how much we have already eaten, our past experiences with different foods, our genetic makeup, the food we have just finished eating, our nutritional state and health beliefs, convenience, cultural norms, education level, and customs (Goldstein, 1999; Schiffman, 2001). Furthermore, there are many models available describing different aspects of food choice including several different reasons why we eat what we do (Bisogni, Jas-
Thus, priorities about food choice in real life are not just made through preferences, and dietary instruction and information, but are also determined by social and cultural norms and financial, physical, and retail resources (Anderson, Milburn, & Lean, 1995).

In the complex area of eating, health aspects are embedded, and the outcome in terms of health or sickness is influenced by what, how, and why individuals eat as they do. The meal includes a wide range of aspects; biological, health-related, cognitive, and social (Gustafsson, Öström, & Annett, in press). The person consists of biological and psychological systems, which interrelate. Moreover, the person interrelates with the social systems of his or her world. Each system can affect and be affected by any of the other systems (Sarafino, 1997). This can be illustrated by the biopsychosocial health model (Figure 1). Thus, the experience of a good meal is highly dependent on how the biopsychosocial needs of the individual are fulfilled. Individual behaviour and lifestyle are strongly implicated in the development of chronic diseases such as cardiovascular disease (CVD) (Brannon & Feist, 2007). It may, therefore, be important to increase our knowledge about individuals’ perceptions and preferences, as well about the eating context, when searching for tools to influence people’s daily preferences and habits in a healthier direction.

Figure 1. A diagram of the interplay of systems in the biopsychosocial model, adapted and modified from Sarafino (1997, p. 17).
1.1. Culinary Arts and Meal Science

The interdisciplinary research discipline of Culinary Arts and Meal Science is built around a philosophical framework which aims to broaden the concepts of knowledge including science, practical skills, and aesthetics (Gustafsson et al., in press; Gustavsson, 2000; Molander, 1996). The framework for education and research is further based on the five aspects meal model (FAMM, Figure 2), which focuses on how to achieve a meal experience which satisfies individuals’ expectations and needs (Gustafsson et al., in press). The structure is guided by the control management system, which prescribes the frames of the meal occasion, for example economic, legal, and logistical frames. Within this frame, there are three aspects known as the room, the meeting, and the product; these deal with the aspects that influence the individuals’ meal experiences in relation to their individual expectations and needs regarding ambient and social factors and the food and beverage. The outcome of the efforts to satisfy these needs may be regarded as the fifth, all-embracing aspect; the atmosphere.

![Diagram of the five aspects meal model (FAMM)](image)

Figure 2. The five aspects meal model (FAMM). Adapted from Edwards and Gustafsson (2008, p. 7).
1.2. Design of the thesis

The main focus in this thesis is on food and the meal in relation to being overweight and/or at risk for cardiovascular disease (CVD), in particular coronary heart disease (CHD). There are a myriad of aspects included in the field of food and health, and there are also other highly important lifestyle-related risk factors in addition to food and meal habits (e.g. physical activity, alcohol consumption, and smoking), these additional lifestyle factors are not in focus here.

The thesis is divided into two parts, reflecting different perspectives on the area of interest. The first part, Sensory properties and responsiveness, deals with sensory characteristics and individual response to food products. The second part, Food attitudes and eating context, deals with peoples’ attitudes and food habits, as well as the substance of different parts within a meal. An overview of the structure of the thesis is shown in Figure 3.

1.3. Overall aim of the thesis

The overall aim of the thesis was to study mediating risk factors for obesity and cardiovascular disease (CVD), in particular coronary heart disease (CHD), in relation to food and meals.
Figure 3. Overview of the studies and the structure of the thesis.

Part 1: Sensory properties and responsiveness
- Sensory effect of butter in sauces
  - Sensory evaluation
    - Chicken velouté and tomato sauce varying in butter content.
  - Consumer test
    - Tomato sauce with two levels of butter.
- Taste responsiveness – an underlying risk factor for CHD?
  - Paired preference test
    - Thirty-four food items, both sweet and savoury, presented as low-fat and full-fat alternative.
  - Taste sensitivity
    - Basic taste thresholds for sour, bitter, salty, sweet, umami, and metallic.
    - PROP-intensity test.
- Paper I
- Paper II
- Paper III

Part 2: Food attitudes and eating context
- Attitudes to health, food, and the meal situation related to gender and BMI
  - Postal survey
- Meal environment as a tool to improve health?
- Course paper
  - Interpretation of literature research, lecture notes, and group discussions.
- Paper IV
- Paper V
- Paper VI

Questionnaire
  - Food consumption and attitudes to health and consumption.
Open ended question
  - What involves a good meal?
2. Background

The rapid changes in diets and lifestyles that have occurred with industrialisation, urbanisation, economic development, and market globalisation have accelerated over the past decade. Changes in the world food economy are reflected in shifting dietary patterns; for example, increased consumption of energy-dense diets high in fat (particularly saturated fat) and low in unrefined carbohydrates. These patterns are combined with the decline in energy expenditure that is associated with a sedentary lifestyle. Because of these changes in dietary and lifestyle patterns, chronic diseases including obesity and cardiovascular disease (CVD) are becoming increasingly significant causes of disability and premature death (WHO, 2003).

2.1. Obesity and cardiovascular disease

2.1.1. Prevalence

More than half of Swedish men and slightly more than a third of Swedish women aged between 16 and 74 are overweight (BMI ≥ 25) or obese (BMI ≥ 30). Being overweight is more common among men, while obesity rates are about the same among men and women. Overweight and obesity are less common in Sweden than in many other European countries and in the USA, but the rate of increase is almost as high as in those countries. The proportion of overweight individuals is increasing in all age groups, even children (Socialstyrelsen, 2005), and it has been shown that obesity at a young age implies an increased risk for obesity later in life (Guo, Roche, Chumela, Gardner, & Siervogel, 1994).

CVD, including CHD, is a dominant health problem in Western societies (WHO, 2003), and the most common cause of mortality in Sweden (Socialstyrelsen, 2005). CVD refers to the class of diseases that involve the heart or blood vessels (also including stroke), while CHD or acute myocardial infarction occurs when one of the arteries that supply the heart muscle becomes occluded. The risk of CHD increases strikingly with age, and in middle age there is a pronounced gender difference, with the risk for men being 5-6 higher than that for women. Even though mortality is decreasing, mainly due to lifestyle changes and medical treatments, CHD is still a significant health problem (SBU, 1997). About 1170 new incidents of CHD per 100 000 inhabitants are reported yearly in Sweden, and the mortality rate is about 35% (Socialstyrelsen, 2005). Despite the decrease in mortality, morbidity is still a major problem due to individual suffering, and high health care costs (Leal, Ramón, Gray, Petersen, & Rayner, 2006).
Obesity is more common and has increased more among those with low educational levels than among those with high educational levels. Obesity is also more common among blue-collar workers than among white-collar workers, and more common in the rural parts of Sweden than in the urban areas (Socialstyrelsen, 2005). Furthermore, CVD mortality is higher among blue-collar workers than among white-collar workers (Socialstyrelsen, 2005). A British study has shown that weight gain and CVD prevalence are increasing faster in lower social classes than in higher social classes (Martikainen & Marmot, 1999).

2.1.2. Risk factors
Genetic influences partly determine whether a person can become obese, but it is the environment that determines whether such a person does become obese, and also the extent of that obesity (Eiben, 2007; Sarafino, 1997). The increasing prevalence of overweight is probably due to an excessive food intake, and to insufficient physical activity in relation to actual food intake (Socialstyrelsen, 2005; WHO, 2003). Food and meals high in fat and sugar and low in vegetables, fruit, and cereals increase the risk for obesity. In addition, obesity increases the risk for high blood pressure, CVD, and type 2 diabetes; this is particularly the case when the individual has a significant amount of abdominal fat (Socialstyrelsen, 2005), which to some extent can be related to food intake (Masson, McNeill, & Avenell, 2003). However, obese and normal weight individuals seem to have similar levels of knowledge about risk factors for CVD (Andersson, 2006).

CVD has a multifactorial aetiology, with many established risk factors. The non-modifiable risk factors include older age, male gender, heredity, and a family history of premature CVD; whereas the modifiable risk factors include tobacco smoke, alcohol consumption, physical inactivity, obesity, hypertension, elevated total cholesterol and low density lipoprotein cholesterol (LDL-cholesterol) concentrations, reduced high density lipoprotein cholesterol (HDL-cholesterol) concentrations, and type 2 diabetes. Serum cholesterol concentrations are profoundly influenced by the composition of dietary fat, with saturated fatty acids and trans fatty acids being the major determinants (Katan, Zock, & Mensink, 1994; Masson et al., 2003); however, there is no straightforward relationship. The combination of several of these symptoms is known as metabolic syndrome. Metabolic syndrome is a risk indicator for CVD; it is diagnosed using elevated waist circumference together with elevated blood pressure, triglycerides, fasting glucose, and lowered HDL-cholesterol (Grundy et al., 2005).
2.1.3. Dietary behaviour and advice

On average, the standardised mortality from CVD is about 40% higher in Sweden than in the countries of southern Europe. The most common explanation for this is that the food habits in the Mediterranean area contribute to the lower mortality in these countries, above all the intake of olive oil and other unsaturated fatty acids (Socialstyrelsen, 2005); in Sweden, the consumption of saturated fats is high. Also, diets rich in vegetables and fruit have been linked with lower rates of CHD (Drewnowski & Gomez-Carneros, 2000). There is, however, no unambiguous explanation, so heredity and social networks may also be contributing factors (Socialstyrelsen, 2005).

There are several studies about dietary behaviour in relation to CVD (Gustafsson, Vessby, Öhrvall, & Nydahl, 1994; Nicklas, Webber, Thompson, & Berenson, 1989; Panagiotakos, Pitsavos, Arvaniti, & Stefanadis, 2007; Rosen gren, Stegmayr, Johansson, Huhtasaari, & Wilhelmsen, 1999; Szeto, Kwok, & Benzie, 2004; Vessby et al., 2001). For example, it has been shown that a diet with greater intake of fried vegetables, salad, chicken, fish, and wine is associated with lower blood pressure and higher HDL-cholesterol concentrations, compared to diets with greater intake of red meat and potatoes and less intake of low-fat dairy products and fruit; or diets with greater intake of French fries, high sugar beverages, and white bread and less intake of whole-grain bread and boiled vegetables, both of which were also associated with higher BMI (van Dam, Grievink, Ocké, & Feskens, 2003). Furthermore, a recent study identified several markers for the risk of developing type 2 diabetes and CVD, and suggested that potential goals for intervention could be reduced consumption of convenience foods; increased consumption of whole grain products, fruit and vegetables, vegetable oil, and pasta; and increased physical activity (Krachler, 2007).

In Sweden, the risk of developing CVD, in particular CHD, has decreased by 23% over the past fifteen years, and the mortality risk has decreased even more. This is mainly due to improved care and preventive treatment of high blood fat levels and high blood pressure (Socialstyrelsen, 2005); this suggests that dietary modification can modify the risks for CVD including dyslipidemia, hypertension, and obesity. Population-based preventive action focusing on healthier levels of fat and fibre intake has previously led to long-term improvements in cholesterol, blood lipid, and blood-pressure levels (Baltzer & Melinder, 2004). Furthermore, preventive efforts in terms of advice on diet and exercise given to healthy middle-aged men with moderately raised CVD risk factors reduced several important CVD risk factors, and these reductions were maintained up to one year after ending active intervention (Hellénius, 1995). These results are supported by a lifestyle
intervention study which showed that a weight-reducing diet and regular exercise enhanced almost all metabolic CHD risk factors in obese older adults (Villareal et al., 2006).

In everyday life, we are guided by dietary guidelines towards healthier dietary habits (HHS & USDA, 2005; SNR, 2005). The recommendations for preventing CVD focus on eating patterns that limit total fat, saturated fat, refined sugars, salt, and alcohol intake; that maintain a healthy body weight; and that increase fruit and vegetable intake (Reddy & Katan, 2004; WHO, 2003). However, food choice and intake are generally difficult to modify because they are determined by a myriad of biopsychosocial factors (Logue, 1991; Shepherd, 2001; Turrell & Kavanagh, 2006) such as taste, attitudes, and habits; for this reason, many people find it difficult to maintain the recommended diets.

2.2. Eating context

2.2.1. Eating pattern

Eating takes place as an integrated part of everyday life, and thereby contributes to ordering our days into segments; morning, noon, afternoon, and evening. These patterns change over time, but they have a tendency toward regularity (Kjaernes, 2001, p 31). An eating pattern can be defined by three different elements: the rhythm of eating events, the number of eating events, and the alternation of hot and cold meals and snacks (Mäkelä, 2000). Current recommendations in Sweden suggest that the daily nutrient intake should consist of three main meals plus one to three in-between meals, all of which are well-balanced and distributed evenly during the day (SNR, 2005).

Four different terms to describe the different forms of eating have previously been presented by Douglas and Nicod, referred to by (Mäkelä, 2000); 1) A food event is an occasion when food is eaten. 2) A structured event is a social occasion organised by rules concerning time, place, and sequence of action. 3) Food eaten as a part of a structured event is a meal. A meal is connected to the rules of combination and sequence. 4) A snack is an unstructured food event without any rules of combination and sequence (Mäkelä, 2000).

The conventional meal pattern in most Western societies is characterised by three main meals across the day; breakfast in the morning, lunch at the beginning of the afternoon, and dinner at the beginning of the evening. In between these main meals there may be a number of other eating moments, in which people eat snacks (de Graaf, 2000). Sweden is a “hot food” culture; a Nordic study showed that in Sweden, on average, there are about four eating events per day, 1.4 of
which are hot eating events, and also that about 40% of the respondents had two or even three hot meals per day. The Swedish meal system emerged as breakfast with sandwiches and/or breakfast cereals/porridge; a mid-morning snack with sandwiches; a hot lunch; a mid-afternoon cake or sweet pastry; a hot dinner; and perhaps also a sandwich, cake, or snack later in the evening (Kjaernes, 2001).

In Western societies, a proper meal has been described as being a cooked dinner (one course), which is always a variation of meat and two vegetables with the gravy giving the finishing touch to the plate and combining all the ingredients into a proper meal (Douglas, 1997). The meaning of a meal might differ between different socioeconomic (SES) groups. A meal based on foods rich in dietary fat (whole milk and cheese, meat, bacon, cream, and butter) instead of lean and fibre-rich foods (wholegrain bread, fish, root crops, skimmed milk) is something that lower SES groups strove for from the 1800s until these dreams could be fulfilled when public welfare emerged during the 1950s. The negative effects of such a diet were revealed shortly thereafter, but the historical inheritance and the idea of these foods as “proper” food were still ingrained among industrial workers in Sweden at the end of the 1980s (Fjellström, 1990).

One reason for the importance of meals is that structured meals help to structure one’s life in general, however, the role, structure, and content of a meal is gradually changing (Mäkelä, 2000). Over the years, there has been a decrease in the number of daily cooked meals eaten in Sweden. Cooked meals, including the cooked breakfast, have been replaced by lighter eating events, but the eating schedule has persisted. Furthermore, the proportions and roles of meal components have changed. The traditional components – meat, fish, potatoes, bread, and milk – still have a place in the modern Nordic meal, and preparing the meal from raw material is still the norm. However, the ideal does not fit in with everyday life. Pizzas, hamburgers, and other convenience foods all sell well, and boiled potatoes are often replaced by rice and pasta. With the exception of fresh fruits, desserts no longer have a place in weekday meals. Furthermore, while green salads did not previously form part of the traditional Nordic meal, fresh vegetables are now a central part of the modern meal. Today, both men and women work outside the home, and so have less time to prepare meals. Their work is not physically demanding, and they need less energy. At the same time, the availability of fresh vegetables and ready-to-eat meals has increased, and people have more money to buy food. Still, the cooked sit-down meal, eaten together with the family, is highly valued (Prättälä, 2000).
2.2.2. Meal occasions

Food habits are part of and constitute our identity as well as our cultural and social world. This means that, while food habits are individually shaped, social relations such as family and friends and society at large also contribute to this process (Mattsson Sydner & Fjellström, 2006). One alternative idea of a proper meal incorporates three factors: a hot dish, a salad, and company; this illustrates how the idea of sharing food with others is essential for the concept of the meal (Mäkelä, 2000). Furthermore, FAMM assumes a definition of the meal as the eating sphere at a defined occasion (Gustafsson et al.). To distinguish between different definitions, a meal is considered to consist of that which is eaten, while food eaten as a part of a social structured event is referred to as a meal occasion (Meiselman, 2008). During these shared eating experiences, people share their taste experiences as they eat, by sharing their opinion about the food. When we share our taste experiences in this way, we are emphasising the affective aspect of taste, in that we often label tastes as pleasant or unpleasant, and these labels affect which foods we choose to eat and which foods we avoid (Goldstein, 1999). Meal occasions provide meaning not only to the foods eaten, but also to the entire situation, by means of social communication and symbols as well as behaviours which symbolise people’s identity and feeling of belonging (Mattsson Sydner & Fjellström, 2006). Even though the discussion of shared meals is often related to family meals, eating together also creates a feeling of community and solidarity among people who do not share family ties (Mäkelä, 2000).

Food intake and consumption volume may be influenced by the eating environment; that is, by the ambient factors which are associated with eating but which are independent of food, such as the atmosphere, the effort required to obtain food, the social interactions that occur, and any distractions that may be present (Wansink, 2004). A place with a good atmosphere is one where it is possible to feel comfortable and at ease. Meals are always consumed in a setting which may be influenced by a number of factors, such as lighting, sound, and the colour and design of textiles, which in turn may have an impact on the meal occasion (Gustafsson, Öström, Johansson, & Mossberg, 2006). It has previously been shown that food served at home, in a full service restaurant, and/or in a diner/fast food operation was perceived to be significantly higher in expected acceptability than food served in military dining halls, aeroplanes, and hospitals (Cardello, Bell, & Kramer, 1996). Several later studies have shown similar results (Edwards, Meiselman, Edwards, & Lesher, 2003; Hersleth, Mevik, Naes, & Guinard, 2003; King, Weber, Meiselman, & Lv, 2004; Meiselman, Johnson, Reeve, & Crouch, 2000).
2.2.3. Food and health awareness

The notion of balance, in terms of eating a variety of food groups, represents a centre point of healthfulness and reflects a long-standing component of public nutrition education, but also includes reference to the freshness of foods, whether vegetables are to be eaten raw or cooked, and the quality of ingredients (Murcott, 2002). In a pan-EU survey of consumer attitudes and beliefs about food and nutrition (Saba, 2001), the five most important influences on food choice were found to be quality/freshness, price, taste, trying to eat healthily, and what the rest of the family wanted to eat. Women, older individuals, and more highly educated people were more likely than other respondents to state that trying to eat healthily had a major influence on their food choices. Quality/freshness, price, trying to eat healthily, and family preferences were more important for women; while taste and habit were more important for men. The same survey also investigated perceived barriers to healthy eating, finding that cost of food, food preparation, resistance to food, self-control, and lack of time were the most important barriers. About half of the respondents said that they did not think about the nutritional aspects of the food they eat, and about 70% of the Swedish respondents did not think they needed to change their eating habits (Saba, 2001). However, another study has shown that nearly two thirds of Swedes ‘often’ or ‘always’ considered what they should eat to stay healthy. The same study showed that three quarters of Swedes thought that it was easy to define what is healthy to eat, with women, younger people, well-educated people, and high earners finding this easier than men, elderly, less-educated people, and those on a low income (SKOP, 2004).

It has previously been shown that many people define healthy eating in a way which would suggest that dietary guidelines are having some impact. Furthermore, respondents who mentioned the family as a key influence on food choice seemed to be more likely to mention eating more fruit and vegetables as part of a healthy diet, while those who had no source of information about diet were less likely to mention balance and variety, less fat, or more vegetables (Margetts, Martinez, Saba, Holm, & Kearney, 1997). An investigation of behavioural norms showed that highly-educated mothers considered health more often and costs less often than less-educated mothers, while the latter restricted fewer foods, indicating that they were more permissive (Hupkens, Knibbe, & Drop, 2000). Furthermore, people belonging to higher social classes generally have healthier diets (Murcott, 2002; Rockett, 2007), and are more likely to stay in line with dietary recommendations than are those of lower SES (Hupkens et al., 2000). Thus, ine-
qualities in food use include socio-economic patterning in food purchases as well as disadvantages in access (Murcott, 2002).

Adoption of health messages seems to depend on health consciousness and knowledge of nutrition, both of which vary across individuals. Those who are more likely to adopt health recommendations are women, older people, white people, highly-educated people, households without children, those with high income, individuals with a chronic disease (e.g. heart disease), and dieticians (Auld et al., 2000). However, it does not seem to be enough simply to provide information. One reason for not adopting dietary guidelines might be that there seems to be a gap between actual risk and perceived risk for developing a disease; this has been studied, for example, in relation to stroke (Harwell et al., 2005).

2.3. Food and hedonic appraisal

2.3.1. Food intake and expenditure

Food-related diseases are associated with food intake and its composition in relation to energy expenditure. Food can be defined as a material which contains nutrients (carbohydrate, fat, protein, vitamins, minerals, water) and which is taken into the body for the maintenance of life and the growth and repair of tissues (Whitney, Cataldo, & Rolfes, 1994, p. 3). Food intake can thus be seen as an equivalent to energy intake. Energy intake depends on the relative intake of fat, proteins, and carbohydrates as well as the total amount of food (energy) consumed, while energy expenditure depends on the basal metabolic rate (BMR), energy consumed during physical activity, and energy needed to digest the food (Johansson, 2004, p. 49-50). However, food is more than just nutrients. To become food, raw materials must be defined as edible, and may be refined and prepared as part of a cultural transformation. By this definition, the natural raw material becomes food when it is defined as food within an existing culture (Lévi-Strauss, 1966). We do not experience proteins, fats, and carbohydrates; we experience meat, sauce, potatoes, and vegetables.

When we eat, all of our senses are involved. The experience of savouring the flavour of something is a combination of that substance’s taste, smell, appearance, texture, temperature, concentration, and perhaps the sound it makes when it is chewed or bitten. This may even include some irritability of the oral and nasal cavities, such as with carbonated beverages and spices. All these factors in combination, as well as the dietary history and the hunger state of the individual, influence the hedonic judgement of the food (Schiffman, 2001). Chefs have described a pleasurable food as one that includes several variables related to sensory
experiences, for example taste and smell, flavour combinations, appearance, and combination of textures (Johansson, 2004; Klosse, Riga, Cramwinckel, & Saris, 2004); however, another important factor might be familiarity in relation to cultural symbols and taste (Mattsson Sydner & Fjellström, 2006).

These sensory variables do not only have an impact on hedonic appraisal, but may also influence the metabolism. The digestion (10-15% of energy expenditure) rate may differ during different eating conditions. The appearance, smell, taste, tactile, and perhaps auditory input starts a cascade of physiological processes in the body, known as cephalic phase responses, within seconds to minutes after exposure to foods; these are aimed at preparing the body to digest the food. Cephalic phase responses might therefore improve the efficiency of the digestion, absorption, and use of nutrients contained in ingested foods (Mattes, 1997). Thus, if the food is perceived as palatable, the ability to digest and absorb the nutrients increases.

2.3.2. Food intake and desire

The liking for particular combinations of food groups and sensory qualities is largely acquired through experience; a general scheme is illustrated in Figure 4 (Mela, 2001). Sensory factors, including both the sensory properties of foods and the sensory abilities of consumers, are widely recognised as having importance for food choice; but the matching of food and context is largely determined by culture and social conventions. Preferences develop to a great extent during early childhood, when children adopt the food and meal habits that are present within the family and the culture. The tastes of frequently-recurring foods might therefore be preferred to the tastes of other types of food. While individual consumers do have individual preferences, exposure and consequently preferences tend to be more or less the same within a cultural group (Tuorila, 1996). Furthermore, the taste for certain foods is determined by education level and by custom (Schiffman, 2001). Thus, how we experience foods depends on various factors.

People often eat more of better-liked foods when offered an ad libitum choice (Mela, 2006), and self-choice is known to be a strong factor that influences food perception and acceptability (Hartwell & Edwards, 2003; King, Meiselman, Hottenstein, Work, & Cronk, 2007). Food intake and consumption volume might also be influenced by the food environment; that is, factors that directly relate to the way food is provided or presented, such as its salience, structure, package or portion size, and how it is served (Wansink, 2004).
Another aspect of food intake is craving. The driver for snack consumption is generally not hunger, and energy intake via snacks seems to be higher in cravers than non-cravers. Food craving episodes have also been associated with mood, but this occurs in a different way in women than in men. Women’s craving episodes seem to be more driven by negative feelings, while men’s craving episodes are more driven by positive feelings. Food cravings are also more common in women than in men; and food cravers, especially women, seem to be more concerned about their weight than non-cravers (Lafay et al., 2001). Individuals who tend to use food as a reward and who crave sweet foods make their choices mainly by how pleasant they consider the food. Besides that, women seem to crave sweet foods more and seem to be more interested in getting pleasure from eating (Roininen, Lähteenmäki, & Tuorila, 1999).

Desire for food can also be strongly influenced by feelings of appropriateness. Moreover, there are psychophysiological conditions that initiate desire independent of other factors, like thirst, but also more subtle effects, such as a feeling of a desire for coffee or chocolate prompted by mood state or hunger. In this case, consumption of particular foods may have the effect of altering a “need state”. Thus, an affective response, such as a liking for a certain food, is not necessarily constant for the same sensory stimulus, and often reflects the situation in which the evaluation takes place as well as other attitudes, beliefs, and expectations of
Furthermore, it has been shown that individuals may be regarded as either “health-conscious” or “taste-conscious” and that those who are taste-conscious view taste as the essential criteria for acceptance while the health-conscious put health first when it comes to acceptance of food (Hamilton, Knox, Hill, & Parr, 2000).

2.4. Dietary fat

Fat is a subset of the class of nutrients called lipids. The lipids include triglycerides (fats and oils), phospholipids, and sterols, all of which are nutritionally important. Food lipids are 95% triglycerides and 5% other lipids. In triglycerides, the fatty acids consist of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), and trans-fatty acids (TFA) (Whitney et al., 1994, 132ff). Dietary guidelines recommend a diet in which about 25-35% of the energy is provided by dietary fat, including no more than 10% from SFA, and a minimal consumption of TFA from partially hydrogenated fats (NNR, 2004; SNR, 2005). Triglycerides carry with them the fat-soluble vitamins and also contribute to the sensory properties of foods. Furthermore, triglycerides in the diet can slow digestion, adding satiety and a sense of fullness (Whitney et al., 1994, p.132); however, high-fat foods are relatively less satiating than equal-calorie portions of high-carbohydrate or high-protein foods (McMillan-Price & Brand-Miller, 2004). Dietary fats are often described as being either visible or invisible. Visible fats include butter, margarine, spreads, and cooking oils; while invisible fats are found in milk, meat, and cheese, or are added to foods during processing.

2.4.1. Sensory properties of dietary fat

Dietary fat is thus a contributory factor to the flavour, aroma, texture, creaminess, and tenderness of many foods (Drewnowski, 1997a), and varying levels of fat can alter perception of these attributes in different types of foods (Bom Fröst, Dijkstra, & Martens, 2001; Brauss, Linforth, Cayeux, Harvey, & Taylor, 1999; Kähkönen, Tuorila, & Hyvönen, 1995; Ritvanen et al., 2005; Stampanoni Koefler, Piccinali, & Sigrist, 1996; Weenen, Jellema, & de Wijk, 2005; Wendin, Solheim, Allmaren, & Johansson, 1997). From fat comes the aroma associated with sizzling bacon and hamburgers on the grill, onion being sautéed, or vegetables in a stir-fry. Fat also endows foods with a characteristic texture or mouthfeel. For example, liquid dairy products contain fats in the form of emulsified globules that are perceived as creaminess; these fats also contribute to product smoothness and creaminess in ice cream by preventing the formation of large ice crystals. The principal sensory cues for fat content in milk or cream are stimulus
thickness, smoothness, and viscosity. The marbling of meat contributes to its tenderness. In addition, the use of fat in frying allows heating of foods to temperatures above the boiling point of water, and along with Maillard reactions contributes to crisp or crunchy textures in products such as fried potatoes and potato chips (Drewnowski, 1990; McGee, 1984; Whitney et al., 1994, p. 132).

Furthermore, it has been shown that fat suppresses bitterness but has less effect on salty, sweet, sour, and umami tastes, so simply removing fat from foods is likely to produce products higher in bitterness (Metcalf & Vickers, 2002).

2.4.2. Dietary fat preference and overweight

High-fat foods are also energy-dense, and often have a higher palatability and lower satiety within and between meals; this might explain why individuals tend to overconsume high-fat foods (Gerstein, Woodward-Lopez, Evans, Kelsey, & Drewnowski, 2004). Attraction to the sensory properties of fats, the textures and aromatic flavours, is often cited as a critical motivating factor in fat consumption (Mela, 1990). The extent to which the apparent liking for fats or other texture-related components in foods is inborn or acquired is not resolved, but there is growing evidence that genetic variation may contribute to the heterogeneity in lipid responsiveness (Masson et al., 2003). A preference for fat and for high-fat foods is often learned early in life (Mela, 2001), and may be maintained by a diverse range of biological and psychosocial factors such as metabolic and sensory variables, attitudes, and classical conditioning (Drewnowski, 1990; Smeets & Barnes-Holmes, 2003). An acquired liking for fat-related textures or flavours appears to be best explained by the post-ingestive effects of fats, or perhaps through early associations with milk, or with lubrication, ease of swallowing, or other positive hedonic experience (Mela, 2001). Studies of potential sex differences in reported patterns of food preferences are corroborated by patterns of food consumption (Drewnowski, 1990), and obese men and women seem to overconsume different sources of fat. One study showed that obese women’s favourite foods were bread, doughnuts, cake, cookies, ice cream, chocolate, pies, and other desserts; while in contrast, obese men listed steaks, roasts, hamburgers, French-fried potatoes, pizza, and ice cream. Women selected foods that were mixtures of sugar and fat, while men’s favourite foods included fat, protein, and salt (Drewnowski, 1997a).

The fact that sugar interferes with oral perception of fat content may help explain why fat is often the invisible component of these sweet, high-fat desserts that are so often viewed as carbohydrate-rich foods (Birch, 1999) (Drewnowski, 1990). The combination of fat and sugar also potentiates the pleasure response. A
heightened appetite for sweet, high-fat foods may be one mechanism by which obese individuals gain and regain body weight (Drewnowski, 1997b). Cravings for carbohydrate-rich snacks are characteristic of obese people, and are reported to be associated with a deficiency of a central neurotransmitter, serotonin. The typical objects of carbohydrate cravings are foods such as chocolate, ice cream, cookies, pastries, and other desserts. In all these foods, the chief carbohydrate is sugar, usually in combination with dietary fat (Drewnowski, 1990).

There is also some evidence that in general, obese individuals experience a greater liking overall for foods, including high-fat foods (Bartoshuk, Duffy, Hayes, Moskowitz, & Snyder, 2006; Rissanen et al., 2002; Roefs & Jansen, 2002). Moreover, obese individuals with a taste preference for fat have been demonstrated to be less prone to restraining their diet (Elfhag & Erlanson-Albertsson, 2006). However, findings from studies examining relationships between sensory preferences for dietary fat and body composition or dietary habits have been mixed. No correlation was found between body size and preferences for plain or chocolate-flavoured milks of differing fat content (Pangborn, Bos, & Stern, 1985). By contrast, it was reported that obese and recently reduced, formerly obese individuals showed enhanced preferences for higher fat levels in a sweetened milk-based test product (Drewnowski, Brunzell, Sande, Iverius, & Greenwood, 1985). Using a range of test foodstuffs, a consistent positive relationship between sensory preferences for fats and body fat percentage was observed in a sample of normal weight individuals (Mela & Sacchetti, 1991). More recently, it was found that hedonic response to sweet and creamy solutions was associated with weight gain in an obesity-prone Indian population, but not in a white population (Salbe, DelParigi, Pratley, Drewnowski, & Tataranni, 2004). As noted, though, preference for fat in liquid test stimuli may not necessarily reflect preference for fat in solid foods (Drewnowski, Shrager, Lipsky, Stellar, & Greenwood, 1989). Furthermore, a recent food preference questionnaire-based study of dietary factors and CVD risk showed that there was a positive correlation between preference for fat in food and waist circumference. Waist circumference was in turn positively correlated with serum cholesterol, HDL-cholesterol, and blood pressure (Duffy et al., 2007).

However, overeating in obesity reflects responsiveness to non-homeostatic stimuli, and variation in obesity is not clearly related to variation in the hedonic experience or the explicit pleasure of eating (Mela, 2006). A recent study found that hunger was linked to explicit liking and wanting, whereas a relationship between hunger and implicit wanting was absent (Finlayson, King, & Blundell, 2008). Non-homeostatic eating has further been identified to involve four aspects of appeti-
tive behaviour; 1) quantity consumed, 2) quality consumed, 3) context, and 4) behaviour in terms of obtaining and consuming the food (Corwin & Hajnal, 2005).

2.4.3. Attitudes and beliefs about dietary fat

There are several reasons why it is so difficult to decrease the intake of dietary fat. For one thing, many individuals are not aware of their own intake. In addition, taste preferences are a strong driver, and there are beliefs that low-fat food will taste less good. Food rich in fat may also seem more satiating. Some people believe that low-fat food is more expensive and more difficult to cook. Low-fat food may also be unavailable, or difficult to identify. Finally, there are people who have limited opportunity to decide what to eat, as they do not or cannot cook for themselves (Brug & van Assema, 2001). However, it has been suggested that attitudes toward and consumption of high-fat foods are unrelated to nutritional knowledge, being more closely linked to their perceived pleasantness than to their impact on health (Mela & Sacchetti, 1991).

Generally, reduced fat foods are considered to be inferior in taste (Hamilton et al., 2000). Women often associate the consumption of reduced fat foods with dieting and weight loss, and also seem to be more conscious than men of what foods they consume (Hamilton et al., 2000). Acceptability has been shown to depend on both the type of product and on the information given about the fat content of the product. Actual liking might be determined by expected liking, and full-fat products are usually expected to taste better (Tuorila, Cardello, & Lesher, 1994). However, women ready for dietary intervention have been shown to rate milkshakes labelled as low-fat higher than full-fat milkshakes (Bowen et al., 2003). In addition, Tuorila et al. (2001) found that hedonic quality, restrained status, and perceived hunger all have an effect on food choice. Finally, a cluster analysis of liquid dairy products found that liking for these products differed by age, gender, and income (Richardson-Harman, 2000).

People frequently choose less “desired” or less liked foods when positive drivers of choice are outweighed, by for example, physical/economic constraints or cognitive/attitudinal considerations such as health concerns (Mela, 2006). Those who are more health-orientated are often willing to accept some loss in pleasantness (Roininen et al., 1999), and a general interest in health seems to be a good predictor for food choice and frequency of consumption (Roininen & Tuorila, 1999). It has further been shown that motivated people can accept and come to like a less-preferred product when they are informed of its reduced fat content; that is, those who choose a low-fat alternative are making a compromise in the pleasure aspect of consumption when making the choice, indicating that choices are affected by restraint status (Tuorila et al., 2001).
2.5. Basic taste perception and preference

The definition of a taste is that it can only be perceived by the taste buds in the mouth. The human sense of taste is generally described in terms of five basic taste sensations; salty, sour, sweet, bitter (Goldstein, 1999; Levine, 2000), and umami (Kurihara & Kashiwayanagi, 1998). It has also been suggested that “metallic” is a primary taste (Levine, 2000; Schiffman, 2001), though it is also an olfactory sensation (Goldstein, 1999). Bitter substances tend to yield low absolute threshold values, with sour substances next, and salts and carbohydrate sweeteners a bit higher. The normal process of ageing affects the taste thresholds of most individuals. The taste qualities of sweetness and saltiness show greatest decrease with age, while bitter and sour taste sensitivity are heightened (Schiffman, 2001). There are also individual differences in sensitivity to basic taste qualities as well as in optimally-preferred taste concentrations in different products (Mojet, Christ-Hazelhof, & Heidema, 2005). Furthermore, tastes are to some extent indicators of what might be harmful and what essential for the body (Goldstein, 1999). Foods with sweet, umami, or sufficiently salty taste are palatable, but those that are sour and bitter are usually aversive (Schiffman, 2001; Torii, Kondoh, Mori, & Ono, 1998).

Accumulating evidence suggests that many foods with bitter notes contain health-promoting substances (Drewnowski & Gomez-Carneros, 2000; Mattes, 2004). However, an aversion to bitter taste protects us from ingesting naturally toxic substances, which typically taste bitter (Kim & Drayna, 2004). Although many factors, including taste, may be responsible for food preferences, taste is often the key reason for food rejection. Bitterness is the most commonly cited reason for disliking a particular food, and has been shown to lead to food rejection (Drewnowski, Ahlstrom Hendersson, & Barratt-Fornell, 2001). Bitterness has been reported in a vide variety of vegetables, and the bitterness of cruciferous vegetables has been repeatedly linked to their low acceptance. Dislike for certain vegetables has been shown to be the major barrier to vegetable consumption. The threshold for what is or is not acceptable may vary from one person to another, because there is enormous variation in individual taste response to bitterness (Drewnowski & Gomez-Carneros, 2000). Thus, low acceptance of bitter-tasting vegetables and fruits may prevent some consumers from adopting healthy diets consistent with dietary guidelines.

The metallic taste is little understood, but is sometimes used to describe the side tastes of sweeteners (Lawless & Heymann, 1998). The aversive aftertaste of several sweeteners has been characterised on a sensory level as bitter and/or metallic (Riera, Vogel, Simon, & le Coutre, 2007).
Variation in sweet perception and preference is partly heritable (Keskitalo et al., 2007; Reed, Tanaka, & McDaniel, 2006), and the perception of sweet taste might partly be linked to sweetness preference (Reed et al., 2006). However, preference for a sweet taste also depends on routine exposure during childhood (Liem & Mennella, 2002). Although humans have some mechanism for regulating salt intake, we also show a powerful, perhaps even unhealthy, preference for salt. Over-consumption of salt may be an important factor in hypertension in certain individuals, and so poses a potential health hazard (Schiffman, 2001). Salt sensitivity has previously been associated with systolic blood pressure (Málaga et al., 2003). There is little evidence for heritability of sour threshold (Kim, Breslin, Reed, & Drayna, 2004), but it has been shown that preference for sour taste in a sweet context is correlated with fruit consumption (Liem, Bogers, Dagnelie, & de Graaf, 2006).

Umami is a taste which can be described as meaty, brothy, or savoury, and is often associated with the flavour enhancing properties of the chemical monosodium glutamate (MSG) (Goldstein, 1999; Levine, 2000; Schiffman, 2001), which selectively affects other tastes (Schiffman, 2001) and enhances the hedonic tone (Kurihara & Kashiwayanagi, 1998). However, umami does not just act by enhancing the tastes of sweetness, saltiness, bitterness or sourness in foods, but instead may be a flavour in its own right (Rolls, Critchley, Browning, & Hernadi, 1998). Part of the taste of protein is captured by umami, which is the taste common to a diversity of food sources including fish, meats, mushrooms, cheese, certain vegetables (Rolls et al., 1998), seafood, and breast milk (Kurihara & Kashiwayanagi, 1998). There is also a large continuous variation in sensitivity to the umami taste (Lugaz, OPillias, & Faurion, 2002). Furthermore, the preference for monosodium glutamate is probably learned (Beauchamp, Bachmanov, & Stein, 1998). However, when feeding from hunger to satiety, the response to the taste of glutamate decreases (Rolls et al., 1998).

2.5.1. Genetic variation in taste responsiveness

There exist genetic differences between individuals which affect people’s ability to sense the taste of certain substances (Goldstein, 1999). One such chemical is the bitter substance phenylthiocarbamide (PTC) or its synthetic equivalent 6-n-propylthiouracil (PROP). This difference is partially determined by alleles at a putative bitter receptor gene on chromosome 7 (Reed, 2004). The substance is quite bitter for one group (tasters), but is barely or not at all detectable by the remaining group (non-tasters) (Schiffman, 2001). About 30% of Caucasians are non-tasters; the other 70%, who perceive these compounds as bitter, are consid-
ered tasters. (Bartoshuk, 2000; Bell & Song, 2004; Kim & Drayna, 2004; Tepper, 2004). A subset of tasters (~25%) perceive PROP as extremely bitter, and are considered super-tasters (Kirkmeyer & Tepper, 2004).

Those sensitive to PROP have a higher density of fungiform papillae and a higher number of taste pores per taste papilla than those who are less sensitive (Bartoshuk, 2000; Bell & Song, 2004; Cubero-Castillo & Noble, 2004; Duffy, Lucchina, & Bartoshuk, 2004; Prescott, Bartoshuk, & Prutkin, 2004; Tepper & Nurse, 1997); these physiological differences may produce a greater somatosensory sensation on the tongue (Duffy et al., 2004; Kirkmeyer & Tepper, 2004), including viscosity, creaminess, fattiness, and many other textural qualities in foods and beverages (Prescott et al., 2004). Thus, those sensitive to PROP perceive more intense sensations from fats in foods (Bartoshuk, 2000; Bartoshuk et al., 2004; Duffy et al., 2004; Kirkmeyer & Tepper, 2004), and their ability to discriminate between different fat levels in food is increased (Prescott et al., 2004; Tepper & Nurse, 1997). Furthermore, those sensitive to PROP also seem to be more sensitive to other taste qualities such as bitter, sweet, salt, and sour, as well as to mixtures of these tastes (Prescott et al., 2004; Prutkin et al., 2000). Furthermore, they seem to be more sensitive to capsaicin (Bartoshuk et al., 2002; Bartoshuk, Duffy, & Miller, 1994; John Prescott et al., 2004), cinnamaldehyde (Prescott et al., 2004), ethanol (Bartoshuk, 2000; Prescott et al., 2004), and piperine (Bartoshuk, 2000), as well as to irritation from carbonation (Prescott, Soo, Campbell, & Roberts, 2004) and astringency (Pickering, Simunkova, & DiBattista, 2004). Therefore oral sensations from foods and beverages may vary with the ability to sense the bitterness of PROP.

Studies have shown that those sensitive to PROP show less preference for several foods and beverages with varying degrees of bitter taste (Dinehart, Hayes, Bartoshuk, Lanier, & Duffy, 2006; Drewnowski, Ahlstrom Henderson, Shore, & Barratt-Fornell, 1998; Drewnowski et al., 2001; Intranuovo & Powers, 1998; Kaminski, Henderson, & Drewnowski, 2000; Keller, Steinmann, Nurse, & Tepper, 2002). It has also been suggested that those sensitive to PROP tend to show less liking for high-fat foods (Bartoshuk et al., 2004; Prutkin et al., 2000; Tepper & Nurse, 1997).

2.5.2. PROP sensitivity and CVD risk factors

Differences in taste sensitivity to some extent mediate preference variations, and hence have explanatory value for those nutritional behaviours which can be linked to major health issues such as obesity and CVD (Prescott & Tepper, 2004). Among women with low dietary restraint, a lower sensitivity to PROP has
been associated with higher BMI and with greater acceptance of a broad range of high-fat foods (Tepper & Ullrich, 2002). A higher prevalence of non-tasters among both type 1 and type 2 diabetics has been reported, and diabetic individuals experience reduced sweet taste perception and higher preferences for sweet foods as compared to controls (Tepper, 2004). It has also been shown that those who tasted PROP as more bitter had body composition and serum lipids that were more favourable for reduced CVD risk (Duffy et al., 2004). In contradiction to these findings, a recent study found no evidence to suggest that PROP taster status has an influence on obesity and cardiovascular disease, even though those more sensitive to PROP consumed less energy than others (Drewnowski, Henderson, & Cockroft, 2007).
3. Overall study rationale

There are a number of possible biological, psychological, and social reasons why some people might find it difficult to adhere to dietary guidelines; factors of importance include individual sensory responsiveness, the sensory properties of foods, attitudes, and different food and eating contexts. Thus, several mediating factors are relevant in both becoming obese and/or developing CHD.

It has previously been suggested that genetic variation in taste perception, related to the bitter-tasting substance PROP, might be a risk indicator for CHD (Duffy, 2004; Duffy, 2007). Furthermore, sensitivity to PROP is related to sensitivity to the basic tastes. Individuals differ in their ability to perceive and enjoy the basic taste qualities. Most research has focused on the perception of bitter and sweet tastes, which may be partly inherited and might have an influence on preference for certain foods (Keskitalo et al., 2007; Reed et al., 2006). However, individual differences in perception of salty, sour, umami, and metallic tastes might also influence individual preferences. It is not known whether perception for basic tastes is heightened among individuals at risk for CHD compared with healthy individuals, but this is of interest since such a difference might explain some of the variations in food preferences and intake.

It is well known that fat makes a large contribution to the sensory properties of several foodstuffs, meaning that an alteration of the fat content of these foods might influence individuals’ perceptions and preferences (Bom Fröst et al., 2001; Brauss et al., 1999; Drewnowski, 1997a; Kähkönen et al., 1995; Ritvanen et al., 2005; Weenen et al., 2005; Wendin et al., 1997). While fat replacements are often used in retail products, they are not commonly used in either restaurants or in home cooking. It is therefore of interest to evaluate the extent to which it is possible to reduce the amount of fat used without influencing the sensory experience of the food, as well as the effect of fat reduction on the sensory properties of the food, and the importance of a noticeable difference in terms of preference for that food.

Preferences for foods with different fat content have previously been evaluated in several sensory studies. A preference for fat might be related to being overweight (Bartoshuk et al., 2006; Mela & Sacchetti, 1991; Rissanen et al., 2002; Roefs & Jansen, 2002). The association between preference for fat in food and CVD risk factors has also been reported in a recent preference questionnaire-based study of dietary factors and CVD risk (Duffy et al., 2007). However, to the author’s knowledge, it is not known whether individuals at risk for CHD have a heightened preference for fat.
There is a generally held belief that regular foods are usually preferred over low-fat versions. However, the preference might differ depending on the type of product and the information available about the product, for example in relation to gender, product involvement, and individual health concerns (Kähkönen & Tuorila, 1999). Additionally, attitudes to health and food consumption might predict food choice (Roininen & Tuorila, 1999; Shepherd, 2001). Food and meals are bound up with emotions, memories, habits, and cultural aspects; and the liking for and intake of food both seem to be partially context-dependent (Cardello et al., 1996; Hersleth et al., 2003; Meiselman et al., 2000; Wansink, 2004), meaning that it is also necessary to study attitudes to food and health in relation to gender, BMI, food habits, and meal habits.

3.1. Objectives

*Sensory properties and responsiveness*

- to investigate how different amounts of added butter affect the perceived sensory characteristics in two different sauces, and to examine consumer preferences for one of them.

- to compare the preferences of healthy individuals and individuals diagnosed with CHD for full-fat food versus low-fat alternatives.

- to examine whether or not sensitivity to basic tastes and to the bitter tasting substance 6-n-propylthiouracil (PROP) differs between individuals diagnosed with CHD and healthy individuals, and also to examine correlations between taste sensitivity and a range of known CHD risk factors.

*Food attitudes and eating context*

- to evaluate the association of body mass index (BMI) with demographic and socioeconomic background, eating habits, and attitudes to health and food consumption.

- to explore factors behind the idea of a good meal, and further analyse how these experiences differ across genders and individuals of different BMI.

- to gain deeper knowledge about meal experiences with a focus on acceptance and satisfaction related to health outcome.
4. Materials and methods

The research area of Culinary Arts and Meal Science includes both natural science and social science. Thus, this interdisciplinary approach offers a wide variety of research methods. In order to deepen our understanding of the intersection of gastronomy and health, several methods were used to answer the research questions in this thesis. In the first part of this work, *Sensory properties and responsiveness*, sensory analysis was used to define product characteristics, sensory perceptions, and preferences in relation to CHD and CVD risk factors. The second part of this thesis, *Food attitudes and meal context*, presents the results from an extensive survey including attitudes to health and food, along with questions on meal sequence and habits, and an open-ended question about the idea of a good meal. Finally, a holistic perspective on the meal in relation to health is captured, by providing and discussing some examples of how the meal might be able to influence health outcome. An overview of the study designs and methods used is shown in Table 1.

**Part 1: Sensory properties and responsiveness**

4.1. Sensory effect of butter in culinary sauces (Paper I)

4.1.1. Study design, material and participants

Two basic sauces were evaluated, a chicken velouté and a tomato sauce, both of which are often finished with the addition of a ‘knob’ of butter, varying in size, prior to serving. The butter is used to balance flavours and viscosity; the amount used is exclusively a matter of taste. Therefore, it was of interest to examine the effect on sensory attributes of altering the butter content in the sauces. Unsalted sour cream butter (80% fat) was used at a wide range of butter content levels used; 0-50% by weight of sauce base. In addition, a hedonic test was conducted for the tomato sauce with two levels of added butter. Consumers were recruited on a voluntary basis at a retail store. A total of 92 people participated in the study, all aged between 19 and 88 years old (mean 59.1±15.3); 69.6% were female and 30.4% male.

4.1.2. Sensory analysis

All evaluations were carried out in a sensory laboratory conforming to ISO standards (ISO, 1988a). A selected panel of eight assessors was used for the sensory analysis. The panel were trained in accordance with the ISO standard (ISO, 1993). About 40 hours of training in attributes and scales were conducted before
<table>
<thead>
<tr>
<th>Paper</th>
<th>Research methods</th>
<th>Materials</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>The sensory effect of butter in culinary sauces</td>
<td>Sensory analysis: Ranking test, Descriptive test, Hedonic evaluation</td>
<td>Two sauces with a range of different amount of added butter (0-50% by weight of sauce base), 8 trained panellists, 92 participants, aged 18-88</td>
</tr>
<tr>
<td>II</td>
<td>Preference for full-fat over low-fat foods among individuals suffering from coronary heart disease and healthy controls</td>
<td>Blood samples (serum lipids and blood glucose), Anthropometric measurements, Pair-wise preference test</td>
<td>Thirty-four food items, both sweet and savoury, presented in a low-fat and a full-fat alternative, 24 individuals suffering from CHD, 41 individuals as a healthy control group, Age 41-65</td>
</tr>
<tr>
<td>III</td>
<td>Taste perception – an underlying risk factor for coronary heart disease?</td>
<td>Blood samples (serum lipids and blood glucose), Anthropometric measurements, Basic taste threshold measurements, PROP intensity measurements</td>
<td>Basic taste solutions; bitter, sour, sweet, salty, umami, and metallic, Supra threshold PROP solution with a salt solution as control, 32 individuals suffering from CHD, 42 individuals as a healthy control group, Age 41-65</td>
</tr>
<tr>
<td>IV</td>
<td>Association of gender, body mass index (BMI), eating habits and attitudes in a middle-aged Swedish population</td>
<td>Postal survey – structured questionnaire, Descriptive statistics and cluster analysis</td>
<td>Questions regarding food consumption, attitudes to health and consumption (including HTAS scales), sociodemographic variables as well as reported weight and height for BMI calculation, 455 respondents, Age 41-65</td>
</tr>
<tr>
<td>V</td>
<td>Food and context: The essence of a good meal and a portion size perception – an underlying risk factor for coronary heart disease?</td>
<td>Postal survey – open ended question, Qualitative and quantitative content analysis</td>
<td>An open-ended question: “Describe with your own words what involves a good meal” about food and consumption (including HFA scales), sociodemographic variables as well as reported weight and height for BMI calculation, 358 respondents, Age 41-65</td>
</tr>
<tr>
<td>VI</td>
<td>Application of the meal environment as a tool to improve health?</td>
<td>Literature research and interpretation, Literature, lecture notes, and group discussions</td>
<td>- Application of the meal environment as a tool to improve health, Qualitative and quantitative content analysis, Postal survey – openended question, 99 respondents, Age 41-65</td>
</tr>
</tbody>
</table>
the sensory analyses were performed. The sauce samples with different butter content (serving temperature 45±4 °C) were served in a balanced, random order. The attributes analysed were aroma and flavour intensity of butter, chicken, and thyme in the chicken velouté and of butter, tomato, and garlic in the tomato sauce, as well as acidulous taste and texture in both sauces.

**Descriptive tests**

To find discriminatory butter levels in the sauces, a ranking test (ISO, 1988b) was performed on two replicates for each attribute in order to determine which butter levels should be used for further analysis. The following levels of added butter were evaluated; 0%, 5%, 10%, 15%, 20%, 40%, and 50% by weight of sauce base. To describe the sensory profile and determine the magnitude of the differences between the sauces varying in butter content, a profile analysis (ISO, 1985) was performed in four replicates. Following the results of the ranking test, the following butter content levels were evaluated: 0%, 5%, 10%, 20%, and 50% by weight of sauce base. The intensity of each attribute was assessed on a 9-point continuous and unstructured scale, labelled from low intensity (1) to high intensity (9).

**Consumer test**

Two tomato sauces with 10% and 40% added butter, respectively, were used to measure the liking for tomato sauces differing in fat content. The sauces were served together with a piece of fried plaice. The participants were asked to assess their liking for appearance and their liking for flavour. A continuous hedonic scale was used, labelled from “dislike very much” (1) to “like very much” (7) (Lawless & Heymann, 1998). Participants were not informed about the different butter levels in the sauces prior to the test.

**4.1.3. Data analysis**

Unless otherwise specified, the software package SPSS (SPSS Inc., Chicago, IL) was used to analyse the results and the statistical significance was set at p≤0.05. Friedman’s analysis was used to evaluate the results of the ranking test. Analysis of variance (ANOVA) was used to evaluate statistical significance in the profile data. Principal component analysis (PCA) was used to simplify and describe interrelationships among the sensory descriptors and among the two sauces with varied levels of added butter (The Unscrambler, v. 9.2). The consumer test was analysed with a paired Student t-test (Meilgaard, Civille, & Carr, 1999).
4.2. Taste responsiveness – a risk factor for CHD? (Papers II & III)

4.2.1. Study design

This study was carried out between March 2004 and May 2006, in collaboration with the Department of Cardiology, Örebro University Hospital. Patients with a first-time acute myocardial infarction were recruited individually, immediately following the first hospital admission. Blood sample analysis, anthropometric measurements, a taste sensitivity test, and a PROP sensitivity test were conducted at the Department of Cardiology, during the weeks following admission. A paired preference test was conducted at the Department of Restaurant and Culinary Arts, Örebro University within twelve weeks of admission. The same tests were thereafter carried out on a healthy control group. An experimental overview is shown in Table 2.

4.2.2. Participants

Thirty-two patients (25 M, 7 F; 41-65 years; mean age = 55.5±6.3) with a first-time acute myocardial infarction, not treated with lipid-lowering drugs, were recruited individually immediately following admission. Individuals with diagnosed diabetes mellitus (N=8) were included. Individuals with food allergies or other dietary restrictions were excluded. A control group (29 M, 13 F; 41-64 years; mean age = 54.8±6.4) matched for gender, age, and smoking history was recruited by advertisement in a regional newspaper after the last patient participant had been recruited. Individuals with any previous CHD-related diagnosis or identified genetic factors or any food allergies or other dietary restrictions were excluded. All participants (N=74) were included in Paper III, but there was some drop out prior to the preference test, and so Paper II included 24 patients (20 M, 4 F; 42-65 years; mean age = 56.6±6.0) and 41 control participants (28 M, 13 F; 41-64 years; mean age = 54.9±6.4).

4.2.3. Blood sample analysis and anthropometric measurements

Blood samples were taken after an overnight fast. The patients’ blood samples were taken within 24 hours after admission. Analyses were made of total serum cholesterol (S-cholesterol) and serum triglycerides (S-triglycerides), LDL-cholesterol and HDL-cholesterol, fasting blood glucose (fB-glucose), and glycosylated haemoglobin (HbA1c). Finally, a two-hour oral glucose tolerance test (OGTT) was performed. Individuals with diagnosed diabetes were excluded from OGTT. Weight, height, and waist circumference were registered (Després, Lemieux, & Prud’homme, 2001), and BMI (kg/m²) was calculated.
Table 2. Experimental overview; Taste responsiveness among individuals suffering from CHD compared to healthy controls (Papers II & III)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Patient group (N=32)</th>
<th>Control group (N=42)</th>
</tr>
</thead>
</table>
| Recruitment | -March 2004-September 2005  
-At nursing ward, by research nurses during recovery, USÖ.  
-Information given in place. | -March-May 2006  
-Advertisement in a regional newspaper.  
-Contact with research nurses (USÖ) for information and appointment by telephone.  
-Matching process with patient group regarding gender, age, and smoking history. |

At nursing ward, USÖ  
- Information about the tests and consent to the study.  
- Blood sampling\(^1\)  
- Measurements of anthropometric data.  
- Tasting basic taste references  
- 6-n-propylthiouracil (PROP)-test, replicate 1.

At nursing ward, USÖ  
- 2-hour Oral Glucose tolerance test (OGGT)  
  < 12 weeks after admission  
  4-5 weeks after recruitment

- Taste sensitivity test  
- PROP test, replicate 2  
  2-5 weeks after discharge  
  Individually at nursing ward, USÖ  
  7 weeks after recruitment  
  At individual desks in a laboratory (ORU) in groups of about ten.

Dept. of Restaurant and Culinary Arts, ORU  
- Full-fat/low-fat preference test a series of 34 forced-choice paired preference tests.  
- Sweet and savoury full-fat/low-fat food items  
- Individual booths in sensory laboratory, 09.30 - 13.00 am.  
  < 12 weeks after admission  
  8 weeks after recruitment  
  (N=24)  
  (N=41)

\(^1\) In the patient group, blood sampling was performed during the acute phase of cardiac infarction, within 24 h of admission. The clinical tests were carried out at the Department of Cardiology at the University Hospital in Örebro, except for a few individuals in the control group who visited a care centre after referral. All clinical tests were analysed with same methods at the hospital laboratory.

4.2.4. Paired preference test (Paper II)

In order to differentiate between full-fat and low-fat responders, a series of forced choice paired preference tests was performed (ISO, 1983; Lawless, 1999). Full-fat and low-fat versions of 34 food items were evaluated. These samples formed the five menus shown in Figure 5 (see also Figure 12, p. 98). The serving sequences were randomised and balanced across participants. The participants were asked to identify their preferred sample in each pair.
Figure 5. Menus, sample presentation, and sequence of service of the food items used in the paired preference test evaluating low-fat versus full-fat preference response (Paper II).
4.2.5. Taste sensitivity tests (Paper III)

Basic taste thresholds
In order to determine sensory ability among the participants, detection and recognition thresholds for sour, bitter, salty, sweet, umami, and metallic tastes were obtained using an eight-step ascending dilution series as per (ISO, 1991) (Figure 6).

| Medicine vessels containing water solutions in increasing concentration of all basic taste respectively were prepared. The solutions were tasted from left to right. Water was used as a reference. The participants were told to mark the concentration where a taste was perceived and further at which concentration the taste was identified.

The basic tastes were tasted in the order shown below.

<table>
<thead>
<tr>
<th>Session 1</th>
<th>Session 2</th>
<th>Session 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Sweet</td>
<td>4) Sour</td>
<td>7) Salty</td>
</tr>
<tr>
<td>2) Salty</td>
<td>5) Sweet</td>
<td>8) Acid</td>
</tr>
<tr>
<td>3) Bitter</td>
<td>6) Umami</td>
<td>9) Metallic</td>
</tr>
</tbody>
</table>

Figure 6. Schematic description of taste series and taste sequence for evaluation of detection- and recognition thresholds for bitter (caffeine, 0.06-0.27 g/L), sour (citric acid, 0.13-0.60 g/L), salty (NaCl, 0.16-2.99 g/L), sweet (sucrose, 0.34-12.00 g/L), umami (MSG, 0.08-1.00 g/L), and metallic (Ferrous sulphate, 0.0007-0.008 g/L) tastes (Paper III).

PROP (6-n-propylthiouracil) sensitivity
A supra-threshold PROP solution with a NaCl solution as control was used to determine PROP status among the participants (two replications), as described by Tepper et al. (2001). Evaluation was performed using a labelled magnitude scale (LMS), range 0-100, anchored at the lower end with “barely detectable” and at the high end with “strongest imaginable” (Green et al., 1996; Tepper et al., 2001) (Figure 7).

4.2.6. Data analysis
Individual participants were classified as full-fat, low-fat, or equal fat responders according to the number of each item type preferred in the preference test. In addition, a standardised fat preference index (FPI) was computed for each individual, as described by Turrell (1997) (Paper II).
First, the participants tasted the NaCl solution (reference) and rated the intensity of the solution relative to the strength of all sensations experienced in the mouth. Thereafter, the PROP solution was evaluated in the same way.

<table>
<thead>
<tr>
<th>Barely detectable</th>
<th>Strongest imaginable</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaCl 0.1 mol/L</td>
<td></td>
</tr>
<tr>
<td>PROP 0.32 mmol/L</td>
<td></td>
</tr>
</tbody>
</table>

Figure 7. Schematic description of the one-solution PROP test (Paper III).

Group detection and recognition levels for all basic tastes were calculated using Abbot’s formula (Lawless & Heymann, 1998). Geometric means were calculated for all tastes respectively (Meilgaard et al., 1999), and individual detection and recognition thresholds were used for correlations with other variables (Paper III).

Mean PROP and NaCl sensitivity was computed, and participants were classified as non-tasters, tasters, and super-tasters as per (Goldstein, Daun, & Tepper, 2007; Tepper et al., 2001; Zhao, Kirkmeyer, & Tepper, 2003). Group differences were confirmed by two-way ANOVA. Least square difference (LSD) was used for post hoc analysis (Paper III).

Independent t-tests were used to evaluate group differences in continuous variables. Partial correlation, controlling for gender, age, and medical status, was performed to evaluate correlations between continuous variables. Binomial test was used to discriminate preference for full-fat and low-fat food items within groups. Pearson’s chi-square test was used to evaluate association between categorical variables (Fischer’s exact test when expected cell n < 5). Results were analysed using versions 11.0-14.0 of the SPSS software package (SPSS Inc., Chicago, IL). Statistical significance was set at p≤0.05. Where appropriate, adjustments were made for multiple testing.
Part 2: Food attitudes and eating context

4.3. Attitudes to health, food, and the meal situation (Papers IV & V)

4.3.1. Postal survey

A postal survey including an extensive structured questionnaire was carried out in September 2004. The questionnaire was based on a validated Health and Taste Attitude Scale (HTAS) containing 38 statements regarding health and taste (Roininen et al., 1999). The HTAS was used to measure the respondents’ perceived health and taste attitudes in relation to sociodemographic variables as well as meal sequence and habits. In addition to the HTAS scale, eight statements were included covering the importance of meat, fruit, and vegetables and craving for savoury and fatty foods. To evaluate the respondents’ meal habits, a number of items were included regarding consumption frequency of different between-meal alternatives (12 items), lunch alternatives (8 items), and dinner alternatives (8 items). Frequency of breakfast, lunch, and dinner intake was registered as well as frequency of alcohol consumption, physical activity, and smoking habits. Finally, the questionnaire included several socio-demographic questions. Table 3 provides an overview of the questions. SES among the respondents was determined from profession in combination with educational level, using (Socioeconomic index) SEI standards (SCB, 2007a, 2007b). Weight and height were used to calculate BMI, and the respondents were further classified into four categories; underweight (≤ 18.5), normal weight (18.5–25.0), overweight (25.0–30.0), and obese (≥ 30.0) according to WHO (WHO, 2003). The final question was an open-ended question, with 13 printed lines left blank for the answer; “Describe, in your own words, what makes a good meal”. The items on attitudes, meal sequences, and meal habits were evaluated in Paper IV, while the open-ended question was evaluated in Paper V.

4.3.2. Respondents

The respondents were selected from the population of women and men aged 41-65 living in Örebro County, an area of Central Sweden with about 274 000 inhabitants in total (SCB, 2006). The respondents (N=750) were randomly selected by Swedish Population Address Register Board (SPAR). In total, 455 respondents (60.7%) filled in the survey correctly, and 358 of them (47.7%) answered the open ended question. BMI distribution was consistent with the distribution in the total population in Sweden (age 41-65). The questionnaire was also completed by the individuals within the CHD-study (N=74).
4.3.3. Data analysis

The SPSS software package (SPSS Inc., Chicago, IL) was used to analyse the results, and statistical significance was set at p≤0.05. For descriptive statistics, a t-test was used for parametric variables and the Kruskal-Wallis test and Pearson’s chi-square test for non-parametric variables (Fischer’s exact test when expected cell n < 5).

Table 3. Overview of the questions included in the postal survey (Paper IV)

<table>
<thead>
<tr>
<th>Demographic data</th>
<th>Meal habits and sequences</th>
<th>Health and taste attitudes4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Frequency of eating breakfast, lunch, and dinner</td>
<td>Health and Taste Attitude Scale (HTAS) (Roininen et al., 1999), in total 20 questions regarding health attitudes and 18 questions regarding taste attitudes divided into the following subcategories: General health interest Light product interest Natural product interest Craving for sweet foods Using food as a reward Importance of pleasure</td>
</tr>
<tr>
<td>Gender</td>
<td>Frequency of in-between meals composed of the following items2;</td>
<td>In addition to HTAS, the following attitudinal questions were included:</td>
</tr>
<tr>
<td>Civil status</td>
<td>Fruit</td>
<td>-I often have cravings for meat.</td>
</tr>
<tr>
<td>Education level</td>
<td>Ice cream</td>
<td>-I often have cravings for salty food.</td>
</tr>
<tr>
<td>Profession</td>
<td>Chocolate</td>
<td>-I often have cravings for fat-rich food.</td>
</tr>
<tr>
<td>Income</td>
<td>Bun or cake</td>
<td>-In my opinion a “proper meal” is a hot meal.</td>
</tr>
<tr>
<td>Physical activity</td>
<td>Pastry</td>
<td>-In my opinion, a proper meal consists of meat, potatoes, and gravy.</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>Sandwich</td>
<td>-I am very concerned with having vegetables to every meal.</td>
</tr>
<tr>
<td>Smoking</td>
<td>Yoghurt or similar item</td>
<td>-For me it is important to eat fruit every day.</td>
</tr>
<tr>
<td>Weight and height for calculation of BMI1</td>
<td>Rice pudding (ready-made food)</td>
<td>-In my opinion, a meal is not complete without meat or fish.</td>
</tr>
<tr>
<td>Who purchases and cooks the food in the household</td>
<td>Pasty, pizza, or similar item</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fruit juice</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soda or lemonade</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sweets/snacks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other food items not listed above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequency of eating the following meal at midday/in the evening1;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dish of the day/Dinner at restaurant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Home-cooked hot food</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pizza</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hamburger, kebab, or similar item</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ready meal purchased in the supermarket</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Salad</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sandwich</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yoghurt or similar item</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other food items not listed above</td>
<td></td>
</tr>
</tbody>
</table>

1 BMI = kg/m²
2 Consumption of in-between meals was rated on a 6-point scale with endpoints at never eat and eat once a day or more.
3 Consumption of lunch and dinner alternatives was rated on a 6-point scale with endpoints at never eat and eat once a day.
4 Extent of agreement was rated on a 7-point bipolar scale with a neutral midpoint and endpoints at strongly disagree and strongly agree.
**Paper IV**

The meal frequency variables and attitude statements were analysed by Principal component analysis (PCA). The aim was to reduce the number of observed variables to a smaller number of variables (components), which together represent the main variation. Varimax rotation was used to obtain simple structures among the factors by minimising the number of variables with high loadings on each factor. Kaiser’s eigenvalue rule was used in defining the number of components (Eigenvalue > 1). PCA was performed separately for the health statements and taste statements in order to validate the predefined factor structures (Roininen et al., 1999; Magnusson, 2004).

In order to reveal latent common patterns among different groups of individuals, an explorative K-means cluster analysis was performed using the descriptive variables, attitude factors, and meal factors. Thereafter, ANOVA was used to evaluate statistical significance on the parametric variables included in the cluster analysis with cluster group as the fixed factor. LSD was used for post hoc analysis. The Kruskal-Wallis test and Pearson’s chi-square test were used for non-parametric variables.

**Paper V**

Qualitative and quantitative content analysis were used to analyse the transcripts of the open-ended question in order to identify core consistencies and meanings as described previous (Bryman, 2004; Tim, 2001; Vazou, Ntoumanis, & Duda, 2005). A grounded theory approach was used (Glaser & Strauss, 1967; Strauss & Corbin, 1990), involving both inductive and deductive processes. Open coding was carried out to discover patterns, themes and categories in the data (Patton, 2001). The first author systematically identified subcategories by quantifying words and sentences (raw data) within the quotes. Subcategories with similar meaning were combined into descriptive categories and core categories. In parallel, the second author let descriptive categories and core categories emerge by sorting together excerpts with similar meaning. The authors thoroughly compared and discussed their analyses, and a second evaluation was performed before agreement was reached. The third author read a random sample of thirty quotations to confirm the relevance of the emergent categories.

When the categories were confirmed, frequencies were calculated for the descriptive categories and core categories of men and women separately. Body Mass Index (BMI, kg/m²) was calculated from weight and height and classified according to WHO standards (WHO, 2003). The respondents were divided into one
group with BMI<25.0 labelled Normal weight and another group with BMI≥25.0 labelled Overweight. The frequencies were thereafter calculated for the two BMI groups respectively in order to determine the distribution of themes across participants.

4.4. Meal environment as a tool to improve health (Paper VI)

This paper was written as part of an international PhD course in Culinary Arts and Hospitality. The study was based on lectures, literature, and discussions during the course. It was motivated both by the author’s interest and by its relevance to the overall aim of the thesis in relation to the content of the course. The literature selection was mainly based on the course literature, but other literature related to the topic was also included. The literature was read and interpreted, and this resulted in a discussion about how the physical and social meal environment could be enhanced within institutional settings such as the caring sector. FAMM was used to structure the findings.

4.5. Ethical considerations

The case-control study, which included patients diagnosed with CHD and a healthy control group, was approved by the Örebro University Hospital Ethics Committee. The ethical rules of the Swedish Research council were also taken into consideration, and all information was treated confidentially. The study was not considered to carry any known risks. The participants signed a written informed consent, and were informed that they were allowed to drop out at any time without giving reasons.

An explanatory letter was included with the postal survey, containing information about the Swedish Personal Data Act (PuL) and assuring participants that all collected data would be handled and presented anonymously, and that it would not be possible to trace any data back to the individual respondent. Initially, there were plans to do a falling-off analysis by contacting any non-respondents and asking them why they had not completed the survey. However, some of the completed surveys included comments indicating that for various reasons some of the respondents felt uncomfortable about being approached via a purchased address database (the source of the addresses was the Swedish Population Address Register Board, and this was evident from the envelopes that the surveys were sent in). In order not to further disturb anyone, the falling-off analysis was abandoned. However, a non-respondent analysis showed that the distribution of age, gender, and housing region were the same as among respondents to the questionnaire.
5. Results

Part one: Sensory properties and responsiveness

5.1. Sensory effect of butter in culinary sauces (Paper I)

5.1.1. Descriptive tests
An increased level of butter increased the butter aroma and flavour and decreased the intensity of chicken and thyme in the chicken velouté, as well as the tomato and garlic aroma and flavour in the tomato sauce. The intensity of acidulous taste decreased with an increased level of butter, while the viscosity increased. The sauces with higher levels of butter (20% and 50%) were significantly more viscous than the sauces with no butter (0%) or with low levels of butter (5% and 10%). In general, at lower butter levels (0-10% added butter), differences became evident when butter levels varied more than 5%. At higher levels of butter (≥15%), significant differences in sensory attributes only emerged when butter levels varied by a larger amount. Analytical sensory analysis also has a descriptive purpose; the characteristic attributes of each of the two sauces are presented in Figure 8. The aroma attributes are not shown, because they were rated similarly to the corresponding flavour attributes.

5.1.2. Consumer test
In terms of appearance, the sauce containing 10% butter was preferred (5.3±1.5) over the sauce containing 40% butter (4.9±1.6), but the difference was only significant among the men (average scores; 5.5±1.3 and 4.3±1.7 respectively). There was no significant difference in liking for the flavour of the two sauces, but there was a tendency to prefer the sauce containing 40% butter (5.5±1.4) over the sauce containing 10% butter (5.1±1.7).

5.2. Taste responsiveness – a risk factor for CHD? (Papers II & III)

5.2.1. Clinical tests and anthropometric data (Papers II & III)
Table 4 shows summary statistics for clinical tests and anthropometric measurements of the participants in papers II and III. The patient group showed statistically significantly higher values for S-triglycerides, fB-glucose, HbA1c, OGTT (t=0), and OGTT (t=120). The control group had higher S-cholesterol,
Figure 8. Sensory profiles of chicken velouté and tomato sauce differing in butter content (Paper I)
Table 4. Summary of blood sample analysis and anthropometric measurements for the patient group and control group in Papers II & III

<table>
<thead>
<tr>
<th></th>
<th>Paper III</th>
<th>Paper II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Patient group</td>
</tr>
<tr>
<td><strong>Lipids (mean±SD)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-triglycerides (mmol/l)</td>
<td>74</td>
<td>1.82±0.63***</td>
</tr>
<tr>
<td>S-cholesterol (mmol/l)</td>
<td>74</td>
<td>5.05±0.85</td>
</tr>
<tr>
<td>LDL cholesterol (mmol/l)</td>
<td>74</td>
<td>3.43±0.71</td>
</tr>
<tr>
<td>HDL cholesterol (mmol/l)</td>
<td>74</td>
<td>1.15±0.29</td>
</tr>
<tr>
<td>Men</td>
<td>1.12±0.26</td>
<td>1.37±0.29**</td>
</tr>
<tr>
<td>Women</td>
<td>1.26±0.39</td>
<td>1.73±0.50*</td>
</tr>
<tr>
<td>LDL/HDL-ratio</td>
<td>74</td>
<td>3.13±0.96</td>
</tr>
<tr>
<td>Men</td>
<td>3.13±0.87</td>
<td>2.91±0.84</td>
</tr>
<tr>
<td>Women</td>
<td>3.11±1.31</td>
<td>2.46±0.73</td>
</tr>
<tr>
<td><strong>Glucose (mean±SD)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-glucose (mmol/l)</td>
<td>73</td>
<td>5.77±1.88**</td>
</tr>
<tr>
<td>OGTT (t = 0) (mmol/l)</td>
<td>66</td>
<td>5.24±0.60**</td>
</tr>
<tr>
<td>OGTT (t = 120) (mmol/l)</td>
<td>66</td>
<td>7.68±2.49**</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>73</td>
<td>5.20±0.89**</td>
</tr>
<tr>
<td><strong>Anthropometrics (mean±SD)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>74</td>
<td>28.06±4.01*</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>74</td>
<td>97.84±11.50*</td>
</tr>
<tr>
<td>Men</td>
<td>101.06±10.03*</td>
<td>94.20±9.07</td>
</tr>
<tr>
<td>Women</td>
<td>86.36±9.14</td>
<td>87.69±9.53</td>
</tr>
</tbody>
</table>

1 Differences between patient group and control group were tested by independent t-test; *** p≤0.001; ** p≤0.01; * p≤0.05.
LDL-cholesterol, and HDL-cholesterol, but the LDL/HDL ratio did not differ significantly between groups. Impaired glucose intolerance (IGT≥7.8 mmol/L) was seen in 17 patients and 1 control, including those with diagnosed diabetes mellitus. Women in the control group had significantly higher HDL-cholesterol than women in the patient group; however, this difference was only significant in Paper III, and not Paper II. The patient group had significantly higher BMI and waist circumference (driven mainly by male patients’ measurements), but again these differences were not significant in Paper II, due to the drop out in the patient group. Additionally, metabolic syndrome was present in more individuals in the patient group (N=8) than in the control group (N=2) (p=0.012).

5.2.2. Preference for low-fat and full-fat food items (Paper II)

Generally, both patients and controls preferred the full-fat versions of the 34 test foods. For the total group, 27 full-fat items were the preferred choice, along with only five low-fat food items. Preferences reached statistical significance for 16 full-fat and two low-fat items, most of them being from the “Soups and sauces” and “Cakes, snacks and desserts” categories. In the patient group, 23 full-fat and eight low-fat food items were preferred, with preferences reaching statistical significance for six full-fat samples. In the control group, 26 full-fat and seven low-fat food items were preferred, with preferences reaching significance for 15 full-fat and three low-fat samples (Table 5). The pattern of preference responses diverged significantly between patients and controls on only four of the 34 food items; more patients showed preference for low-fat sausage and low fat fish soup while more individuals in the control group showed preference for the full-fat alternatives (p=0.000 and p=0.05 respectively). While just slightly more patients showed preference for full-fat cheese and full fat sponge cake, control group participants generally preferred the low fat cheese but full-fat sponge cake (p=0.036) and p=0.012 respectively).

Figure 9 shows the overall distribution of participants when classified as full-fat, low-fat, or equal-fat responders. There was no significant association between participant group membership and individual fat preference score, and the difference in fat preference index (FPI) between patients and controls was not significant.
Table 5. Summary of preference for full-fat and low-fat alternatives for the total group, patient group, and control group respectively, and association between group membership and fat preference for each food item

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Pooled sample¹</th>
<th>Patient group¹</th>
<th>Control group¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low-fat</td>
<td>Full-fat</td>
<td>Low-fat</td>
</tr>
<tr>
<td>Milk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td>25 (16)</td>
<td>75 (47)***</td>
<td>22 (5)</td>
</tr>
<tr>
<td>Sour milk</td>
<td>41 (26)</td>
<td>59 (37)</td>
<td>50 (12)</td>
</tr>
<tr>
<td>Yoghurt</td>
<td>62 (40)</td>
<td>38 (24)</td>
<td>50 (12)</td>
</tr>
<tr>
<td>Grevé cheese</td>
<td>59 (38)</td>
<td>41 (27)</td>
<td>42 (10)</td>
</tr>
<tr>
<td>Cream cheese</td>
<td>38 (24)</td>
<td>62 (40)</td>
<td>39 (9)</td>
</tr>
<tr>
<td><strong>Staples and vegetable dishes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broccoli timbale</td>
<td>43 (28)</td>
<td>57 (37)</td>
<td>46 (11)</td>
</tr>
<tr>
<td>White cabbage salad²</td>
<td>66 (43)*</td>
<td>34 (22)</td>
<td>71 (17)</td>
</tr>
<tr>
<td>Creamed macaroni</td>
<td>61 (39)</td>
<td>39 (25)</td>
<td>58 (14)</td>
</tr>
<tr>
<td>Potato purée</td>
<td>41 (28)</td>
<td>57 (37)</td>
<td>46 (11)</td>
</tr>
<tr>
<td>Potatoes au gratin</td>
<td>36 (23)</td>
<td>64 (41)*</td>
<td>50 (12)</td>
</tr>
<tr>
<td><strong>Meat, fish, and poultry</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver paste</td>
<td>40 (25)</td>
<td>60 (37)</td>
<td>29 (7)</td>
</tr>
<tr>
<td>Meat balls</td>
<td>51 (33)</td>
<td>49 (32)</td>
<td>42 (10)</td>
</tr>
<tr>
<td>Falun sausage</td>
<td>35 (23)</td>
<td>65 (42)*</td>
<td>67 (16)</td>
</tr>
<tr>
<td>Chicken paté</td>
<td>39 (25)</td>
<td>61 (39)</td>
<td>54 (13)</td>
</tr>
<tr>
<td><strong>Soups and Sauces</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asparagus soup</td>
<td>29 (19)</td>
<td>71 (46)***</td>
<td>25 (6)</td>
</tr>
<tr>
<td>Fish soup</td>
<td>43 (27)</td>
<td>57 (36)</td>
<td>58 (14)</td>
</tr>
<tr>
<td>Thai-style soup</td>
<td>36 (23)</td>
<td>64 (41)*</td>
<td>46 (11)</td>
</tr>
<tr>
<td>Cream sauce</td>
<td>34 (22)</td>
<td>66 (42)*</td>
<td>38 (9)</td>
</tr>
<tr>
<td>Tomato sauce</td>
<td>49 (32)</td>
<td>51 (33)</td>
<td>38 (9)</td>
</tr>
<tr>
<td>Hollandaise sauce</td>
<td>26 (17)</td>
<td>74 (48)***</td>
<td>25 (6)</td>
</tr>
<tr>
<td>Rhode Island sauce</td>
<td>43 (28)</td>
<td>57 (37)</td>
<td>54 (13)</td>
</tr>
<tr>
<td>Chicken velouté</td>
<td>29 (19)</td>
<td>71 (46)***</td>
<td>25 (6)</td>
</tr>
<tr>
<td>Béarnaise sauce</td>
<td>33 (21)</td>
<td>67 (43)**</td>
<td>46 (11)</td>
</tr>
<tr>
<td><strong>Cakes, snacks, and desserts</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pancake with jam³</td>
<td>29 (19)</td>
<td>71 (46)***</td>
<td>42 (10)</td>
</tr>
<tr>
<td>Sponge cake</td>
<td>28 (18)</td>
<td>72 (47)***</td>
<td>46 (11)</td>
</tr>
<tr>
<td>Cinnamon bun</td>
<td>12 (8)</td>
<td>88 (57)***</td>
<td>12 (3)</td>
</tr>
<tr>
<td>Lemon mousse</td>
<td>43 (28)</td>
<td>57 (37)</td>
<td>33 (8)</td>
</tr>
<tr>
<td>Orange mousse</td>
<td>44 (28)</td>
<td>56 (35)</td>
<td>54 (13)</td>
</tr>
<tr>
<td>Vanilla pudding</td>
<td>34 (22)</td>
<td>66 (43)*</td>
<td>25 (6)</td>
</tr>
<tr>
<td>Chocolate mousse</td>
<td>41 (26)</td>
<td>59 (37)</td>
<td>42 (10)</td>
</tr>
<tr>
<td>Vanilla ice cream</td>
<td>31 (20)</td>
<td>69 (45)**</td>
<td>42 (10)</td>
</tr>
<tr>
<td>Custard sauce</td>
<td>29 (19)</td>
<td>71 (46)***</td>
<td>42 (10)</td>
</tr>
<tr>
<td>Chocolate⁴</td>
<td>65 (42)*</td>
<td>33 (23)</td>
<td>58 (14)</td>
</tr>
<tr>
<td>Potato crisps</td>
<td>36 (23)</td>
<td>64 (41)*</td>
<td>38 (9)</td>
</tr>
</tbody>
</table>

¹ Binomial test; *** p≤0.001; ** p≤0.01; * p≤0.05
² Low-fat sample: Acetic acid based dressing. Full-fat sample: Mayonnaise based dressing.
⁴ Low-fat sample: Dark chocolate. Full-fat sample: Milk chocolate.
5.2.3. Taste sensitivity (Paper III)

Basic taste thresholds

The patients had lower group detection levels than the control group for all basic
tastes, except for sour taste where detection levels were the same. The control
group had lower group recognition level for sour taste than the patient group. No
other tastes were recognised at group level (Table 6). Best estimated threshold
(geometric mean) levels did not differ between patients and controls for any of
the basic tastes.

Table 6. Group threshold levels for the patient group and control group respectively (Paper III)

<table>
<thead>
<tr>
<th>Group thresholds 1 (g/L)</th>
<th>Patient group (N=31)</th>
<th>Control group (N=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sour detection</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>Bitter detection</td>
<td>0.11</td>
<td>0.14</td>
</tr>
<tr>
<td>Salty detection</td>
<td>0.48</td>
<td>0.69</td>
</tr>
<tr>
<td>Sweet detection</td>
<td>4.32</td>
<td>7.2</td>
</tr>
<tr>
<td>Umami detection</td>
<td>0.24</td>
<td>0.34</td>
</tr>
<tr>
<td>Metallic detection</td>
<td>0.0007</td>
<td>-</td>
</tr>
<tr>
<td>Sour recognition</td>
<td>0.31</td>
<td>0.25</td>
</tr>
<tr>
<td>Bitter recognition</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Salty recognition</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sweet recognition</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Umami recognition</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Metallic recognition</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1 The concentration where ≥75% of the assessors detected/recognized the actual taste (Abbot’s
formula), i.e. 50% significant above chance.
2 Less than significant 50% detected or recognised the taste
Correlations between CVD risk factors and taste perception
Where appropriate, correlation was examined between geometric means and clinical and anthropometric data for the pooled participant group (N = 69); that is, sourness detection and recognition thresholds and bitterness, saltiness, sweetness, and umami detection thresholds. Low detection threshold for bitter taste was significantly correlated with low HDL-cholesterol (r=0.306; p=0.012) and high LDL/HDL ratio (r=-0.336; p=0.006). Low detection threshold for bitter taste was significantly correlated with high BMI (r=-0.315; p=0.010) and abdominal fat (r=-0.280; p=0.023). Finally, low recognition threshold for sour taste was significantly correlated with low BMI (r=0.302; p=0.014) (Figure 10).

Figure 10. Schematic illustration of the correlation between sensitivity for bitter and sour tastes in relation to HDL-cholesterol and BMI (Paper III).

PROP (6-n-propylthiouracil) sensitivity
No significant difference in PROP sensitivity was found between the patient group and the control group (p=0.537); they scored 36.5±25.4 and 32.7±27.6, respectively on the LMS scale (range 0-100). Additionally, the participants were classified as non-tasters (≤7.8), tasters (>7.8 and <74.7), and super-tasters (≥74.7). There were more tasters in the patient group while there were more non-tasters and super-tasters in the control group, but the association was not significant (p=0.580) (Table 7).

<table>
<thead>
<tr>
<th></th>
<th>Patient group (%) (N=32)</th>
<th>Control group (%) (N=42)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-tasters</td>
<td>25.0</td>
<td>33.3</td>
</tr>
<tr>
<td>Tasters</td>
<td>62.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Super-tasters</td>
<td>12.5</td>
<td>16.7</td>
</tr>
</tbody>
</table>
Part two: Food attitudes and eating context

5.3. Association of gender, BMI, eating habits and attitudes (Paper IV)

The two genders differed significantly in BMI, SES, income, physical activity, and alcohol consumption, as well as in who was responsible for purchase of food and cooking in the household. Men had significantly higher BMI, higher income, and more frequent alcohol consumption. Women had higher SES, performed physical activity more frequently than men, and were more responsible for the purchase and cooking of food in the household. There were no significant differences in civil status, smoking, or frequency of breakfast, lunch, and dinner consumption. Along with attitude and food frequency variables, these demographic and socioeconomic variables were included in a cluster analysis which resulted in three clusters; a male-driven group, a female-driven group, and an overweight-driven group.

The male-driven group was characterised by a relatively higher number of men, most of whom lived with someone else. They had moderate BMI and performed physical activity less often than the average in this population. This group also had lower SES but higher income, included relatively more smokers, and had a higher than average frequency of alcohol consumption. It was relatively more common for someone other than themselves to purchase and cook the food in the household. This group reported a high frequency of breakfast, lunch, and dinner consumption and a moderate consumption of in-between meals. Overall, their health interest was low to moderate (Table 8).

The female-driven group was characterised by a relatively higher number of women. Their frequency of living with someone else was average. They had lower BMI than average, and performed physical activity more often than average in this population. This group also had higher SES but lower income, included relatively fewer smokers, and had a lower than average frequency of alcohol consumption. It was relatively more common for them to purchase and cook the food in the household by themselves. This group reported a high frequency of breakfast, lunch, and dinner consumption and a high fruit consumption, but low frequency of other in-between meals. Overall, their health interest was high (Table 8).

The overweight-driven group was evenly distributed between genders, and included a relatively higher number of people living in single households, as well as more entrepreneurs. They had higher BMI and performed physical activity less often than average in this population. This group also had lower income, included
Table 8. Description of meal frequency and attitudes to health and food consumption for the three clusters obtained in Paper IV

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meal frequency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Almost everyone in this group ate breakfast every day, and the frequency of having lunch and dinner was high.</td>
<td>Almost everyone in this group ate breakfast every day, and the frequency of having lunch and dinner was high.</td>
<td>The frequency of having breakfast as well as having lunch or dinner was lower compared to the other groups.</td>
</tr>
<tr>
<td>Moderate fruit consumers and moderate consumers of breakfast-type snacks between meals as well as sweet/fat foods between meals.</td>
<td>High fruit consumers, moderate consumers of breakfast-type snacks between meals, and very low consumers of sweet/fat foods between meals.</td>
<td>Low fruit consumers, as well as low consumers of breakfast-type snacks between meals and sweet/fat foods between meals.</td>
</tr>
<tr>
<td><strong>Types of meal eaten</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most individuals had a cooked meal for lunch; alternatively they had a cold lunch or ate fast food.</td>
<td>Most individuals had a cooked meal for lunch, alternatively they had a cold lunch. Fast food for lunch was rare.</td>
<td>When they did have lunch, it was most often a cooked meal or a cold dish, even though the frequency of lunch consumption was quite low. Fast food for lunch was rare.</td>
</tr>
<tr>
<td>They usually had a home-cooked meal for dinner. Sometimes they had a cold meal for dinner, but it was rare for them to eat fast food or visit a restaurant.</td>
<td>They usually had a home-cooked meal for dinner. Sometimes they had a cold meal for dinner, but it was very rare for them to eat fast food or visit a restaurant.</td>
<td>When they did have dinner, the most frequent alternatives were a home-cooked meal and occasionally a cold meal. Having fast food for dinner or visiting a restaurant was very rare within this group.</td>
</tr>
<tr>
<td><strong>Attitudes to health and food consumption</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low to moderate interest in general health and light products, and a slightly lower interest in natural products.</td>
<td>High interest in general health and natural products, and a moderate interest in light products.</td>
<td>Individuals in this group had a low to moderate interest in general health and natural products and a lower interest in light products.</td>
</tr>
<tr>
<td>The importance of pleasure, using food as reward, and craving for sweet food were all moderate.</td>
<td>The importance of pleasure when eating was high, while the interest of using food as a reward was low. Craving for sweet food was moderate.</td>
<td>The importance of pleasure when eating was high, while craving for sweet food and interest in using food as a reward were moderate.</td>
</tr>
<tr>
<td>Individuals in this group considered that a hot dish containing meat or fish was necessary for a proper meal, and had a moderate craving for fat-rich and savoury foods. The importance of fruit and vegetables every day was moderate.</td>
<td>This group felt it was of great importance to eat fruit and vegetables everyday. They had low craving for fat-rich and savoury foods, and they did not consider it necessary for a proper meal to consist of a hot dish containing meat or fish.</td>
<td>This group considered that a hot dish containing meat or fish was necessary for a proper meal, and had a moderate craving for fat-rich and savoury foods. The importance of fruit and vegetables every day was low.</td>
</tr>
</tbody>
</table>
relatively more smokers, and had an average frequency of alcohol consumption. It was relatively more common for them to purchase and cook the food in the household by themselves. This group reported a lower frequency of breakfast, lunch, and dinner consumption and a low frequency of in-between meals. Overall, their health interest was low (Table 8).

5.4. Health and taste attitudes in relation to gender, BMI and CHD

The following results are additional material exclusively presented in this thesis; they are not reported in any of the included papers.

Among the respondents in the postal survey (N=455), women scored significantly higher than men on general health interest, natural product interest, importance of pleasure, and craving for sweet foods, whereas there were no significant difference between genders regarding light product interest and using food as a reward (Table 9). About 50% of the respondents in the survey were overweight or obese, while very few were underweight. In order to obtain equally-distributed groups for comparison of the HTAS sub-scale means between normal weight and overweight individuals, the respondents were divided into one normal weight group (BMI<25.0) and one overweight group (BMI≥25.0). Due to the differences between genders, health and taste interest in relation to BMI was analysed separately for men and women. Overweight men scored significantly higher on light product interest than normal weight men (p=0.046). Normal weight women scored significantly higher on general health interest than overweight women (p=0.045), and significantly lower on using food as a reward (p=0.002) (Table 9).

A comparison of the patient group and the healthy control group from the CHD study (N=74) showed that there were no differences between the groups regarding either the sociodemographic variables or the frequency of meal consumption (including in-between meals, and lunch and dinner alternatives), except for BMI, income, frequency of lunch intake, and the opinion that ‘a proper meal is hot, and contains meat or fish’ (data not shown). The patient group had higher BMI than the control group (p=0.041). The patient group included more individuals that were low or high income earners, while the control group included mainly moderate income earners (p=0.018). The frequency of lunch intake on more than five days a week was similar in both groups (about 80%), while more individuals in the patient group consumed lunch on one to two days a week, and more individuals in the control group consumed lunch on three to five days a week (p=0.013).
Table 9. Mean and standard deviation for HTAS sub-scales, and significance levels between genders, gender-divided BMI groups, and patients and controls in the CHD study

<table>
<thead>
<tr>
<th>Gender</th>
<th>Men</th>
<th>Women</th>
<th>CHD-study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal Weight</td>
<td>Overweight</td>
<td>Patient Group</td>
</tr>
<tr>
<td></td>
<td>N=89</td>
<td>N=134</td>
<td>N=32</td>
</tr>
<tr>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General health interest</td>
<td>4.3±1.2</td>
<td>5.0±1.2***</td>
<td>4.4±1.2</td>
</tr>
<tr>
<td>Natural product interest</td>
<td>4.0±1.0</td>
<td>4.5±1.1***</td>
<td>4.0±1.0</td>
</tr>
<tr>
<td>Light product interest</td>
<td>3.9±1.1</td>
<td>4.1±1.2</td>
<td>3.7±1.1</td>
</tr>
<tr>
<td>Importance of pleasure</td>
<td>4.8±1.0</td>
<td>5.2±0.9***</td>
<td>4.7±1.1</td>
</tr>
<tr>
<td>Using food as reward</td>
<td>3.5±1.2</td>
<td>3.5±1.3</td>
<td>3.5±1.3</td>
</tr>
<tr>
<td>Craving for sweet foods</td>
<td>3.5±1.0</td>
<td>3.9±1.4***</td>
<td>3.4±1.3</td>
</tr>
</tbody>
</table>

1 T-test; *** p≤0.001; ** p≤0.01; * p≤0.05.
Finally, individuals in the patient group considered a proper meal as more important than did the control group (p=0.001). In terms of HTAS scores, the only significant differences between groups were seen in light product interest, where the patient group scored significantly higher than the control group (p<0.001) (Table 9).

5.5. Food and context: The essence of a good meal (Paper V)

Two high-order core categories emerged from the data. Table 10 shows the core categories and their specific descriptive categories and subcategories, as well as the percentage of men and women who included the categories in their statements of the idea of a good meal in each descriptive category and core category respectively. A good meal was described by the respondents via one or more of the descriptive categories in either food demands or contextual demands, or both.

Table 10. Core categories, descriptive categories, and subcategories within the essence of a good meal, for men and women separately, and significance levels between genders (Paper V)

<table>
<thead>
<tr>
<th>Core category</th>
<th>Descriptive category</th>
<th>Subcategory</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food demands</td>
<td>A restaurant-type meal</td>
<td>A proper meal, “a proper meal”, homely fare, home-made, complexity, and time for preparation</td>
<td>83.2</td>
<td>91.6*</td>
</tr>
<tr>
<td></td>
<td>Pleasant drink (wine/beer), a hot or cold dish, vegetables/salad, restaurant food, menu description</td>
<td>34.2</td>
<td>38.9</td>
<td></td>
</tr>
<tr>
<td>Sensory experience</td>
<td>Pleasant flavour, pleasant appearance, pleasant food, colourful food, taste/flavour combinations, pleasant smell</td>
<td>26.5</td>
<td>41.4**</td>
<td></td>
</tr>
<tr>
<td>Satisfying and nourishing</td>
<td>Nourishing food, Lots of vegetables/fruit, Satisfy one's hunger (just right), Energy (necessary intake of), The body feels good (not tired or bloated), Food for special health needs</td>
<td>29.0</td>
<td>37.9</td>
<td></td>
</tr>
<tr>
<td>Primary product quality</td>
<td>Fresh primary produce, cultivation/breeding systems, place of origin, season</td>
<td>8.4</td>
<td>14.8</td>
<td></td>
</tr>
<tr>
<td>Contextual demands</td>
<td></td>
<td></td>
<td>60.6</td>
<td>59.1</td>
</tr>
<tr>
<td>Spirit of community</td>
<td>Being together with family and friends, warmth and hospitality, conversation, ceremonial occasions, cooking together</td>
<td>32.9</td>
<td>35.5</td>
<td></td>
</tr>
<tr>
<td>Aesthetic experience</td>
<td>A well-laid table, beautifully served food, pleasant environment, candles, music, smoke-free environment</td>
<td>11.6</td>
<td>36.5***</td>
<td></td>
</tr>
<tr>
<td>Tranquility</td>
<td>Eating in peace and quiet, relaxing, relaxed environment, absence of stress, having plenty of time</td>
<td>18.7</td>
<td>20.2</td>
<td></td>
</tr>
<tr>
<td>Frame of mind</td>
<td>Enjoyment (pleasure), comfort and well-being, happiness, quality of life, food a negligible ingredient, a sensuous experience</td>
<td>23.9*</td>
<td>14.3</td>
<td></td>
</tr>
</tbody>
</table>

1Associations between genders were tested by Pearson's chi-square test; *** p≤0.001; ** p≤0.01; * p≤0.05.
The core category of **food demands** covered the different demands that the respondents placed on the food included in a good meal. These demands were associated with primary products, preparation, dishes and menus, the sensory aspects of foods, and nutritional requirements. These demands fell within the categories of a restaurant-type meal, a proper meal, sensory experience, satisfying and nourishing, and primary product quality. The core category of **eating context** covered the different contextual aspects associated with a good meal. Many of the participants described these aspects in terms of company, aesthetics, time, mood, and ambience. These demands fell within the categories of spirit of community, aesthetic experience, tranquility, and frame of mind.

The analysis resulted in a theoretical framework reflecting ideas about what should be included in a good meal; this framework was labelled the **essence of a good meal**. A description of a good meal might start with the quality of the raw ingredients and finish off with the feeling of comfort and well-being. Thus, within our model for the *essence of a good meal* (Figure 11), the emergent categories were sorted into demands related to the food and demands related to the context, but also according to chronological development, beginning with raw product quality (top left) and ending with frame of mind (bottom right). As a result, food demands and contextual demands could be seen as separate demands, but also in part reflecting and overlapping each other. Many of the respondents referred to several of the different categories within food demands and contextual demands, reflecting the idea of a good meal in everyday life as well as during more festive occasions. The following quotations illustrate different aspects of the *essence of a good meal*:

- The food tastes good, is well presented visually, and as nourishing as possible, allowing an atmosphere of peace and quiet with family/friends around the table. An important meeting place for the family once a day.

- A beautifully laid table with candles and flowers. A small and tasty starter. A well-cooked meat course, preferably Italian, with nice trimmings, and good Italian red wine. The company of my husband and a few good friends.
Figure 11. The overall dimension of the essence of a good meal with the two core categories and their descriptive categories.

Food demands

Primary product quality
- A proper meal
- Sensory experience
- Tranquility

Contextual demands

Aesthetic experience
- A restaurant-type meal
- Spirit of community

Sensory experience
- Satisfying and nourishing

Frame of mind

The essence of a good meal
5.5.1. The essence of a good meal in relation to bodyweight

More normal weight than overweight respondents included descriptions in aesthetic experience (p=0.034) and tranquility (p=0.002). However, when men and women were analysed separately, the overweight men seemed to include descriptions within a restaurant-type meal more often than normal weight men (p=0.017), while the normal weight men included descriptions within spirit of community and tranquility more often than overweight men (p=0.011 and p=0.015, respectively). The normal weight women included descriptions within tranquility more often than overweight women (0.049) (data not shown).

5.6. The meal environment – a tool to improve health? (Paper VI)

The situation and the context can influence the acceptability of a meal as well as the amount of food eaten. Contextual factors can be at least as important as sensory factors in determining acceptance of food and beverages. Variables such as location, the physical and social environment, expectations, description of foods, and choice can all have an impact on the acceptance of a meal. In addition, proper responses to guests’ needs and requests can lead to satisfaction. Improvement of the eating environment has been shown to be a meaningful way to stabilise health and nutritional status, as well as having an impact on patients’ energy intake. When the food and beverages meet certain expectations, the physical and social environment can enhance the atmosphere, and therefore the entire quality of the meal experience.
6. Discussion

The experience of food, the eating context, and individual attitudes are all related in some way to individuals’ health conditions, including bodyweight, CHD, and metabolic factors such as blood lipids, glucose levels, and abdominal fat tissue. The reasons behind why a food is consumed or rejected, and the frequency and amount consumed, are determined partly by individual biological and psychological systems and partly by the social systems that interrelate with the individual systems (Sarafino, 1998, p 17).

While the sensory qualities of food are of great importance in how a food is experienced, there are also large individual differences (Mela, 2001). This provided the motivation to study sensory properties as well as sensory ability and preferences among individuals suffering from CHD and a healthy control group. However, preferences alone are insufficient as an explanatory variable for food choice (Schutz & Martens, 2001; Shepherd, 2001).

In addition to the food itself, attitudes to food and health as well as the context in which food and meal consumptions occur are also of great importance for how a food or an entire meal is experienced (Meiselman, 2008), as well as for frequency and amount of consumption. Thus, the studies comprising this thesis also investigated eating patterns and attitudes to health and eating, including contextual facets of the meal experience, which further revealed different aspects of how food and meals are experienced, which might influence eating habits and thus health outcome in everyday life.

6.1. Dietary fat content – properties and preferences

It is known that fat contributes to the texture of food (Drewnowski, 1987; Mela, 1988). The ability of fat to reduce the impression of other flavours has also been demonstrated (Crehan, Hughes, Troy, & Buckley, 2000; Godshall, 1997; Rust & Olson, 1988); and, conversely, when less fat is used, other flavour and aroma intensities increase (Guinard, Wee, McSunas, & Fritter, 2002) while viscosity decreases (Wendin, 2001). Thus, reducing fat in food might result in flavour imbalance (Shamil, Wyet & Kilcast, 1991). The main effect of solid butter in the tomato sauce and the chicken velouté (Paper I) was to increase the intensity of butter flavour and increase the viscosity, as well as suppress other flavour, aroma, and taste attributes. Thus, the generally held belief that butter enhances the perceived flavours of sauces was not confirmed, but its use might still be necessary in order to balance the flavour, taste, and texture attributes. It has also previously been shown that doubling of fat content may sometimes elicit only small changes
in perceived creaminess or oiliness (Mattes, 1993), and the extent of these perceived differences seems to vary across products (Tepper, Shaffer, & Shearer, 1994). This was also the case in the present study, and it seems reasonable to expect that the effects of fat on flavours depend on fat concentration, type of fat as well as the specific flavour compound that is being evaluated (Kinsella, 1989; Tuorila, Sommardahl, Hyvönen, Leporanta, & Merimaa, 1995).

6.1.1. Preference and consumption in relation to CVD risk factors

Hedonic judgements may sometimes vary little over wide ranges of fat content (Mattes, 1993). The small perceived differences were also reflected in preference for food items with low versus high fat content (Paper II). Only four of the food items differed between the CHD patients and the healthy control group. Moreover, for about half of the food items, including the sauces evaluated in Paper I, there was very little difference in preference between full-fat and low-fat alternatives. This result might be partly due to the relatively small sample sizes, and partly related to differences across food items in the effect on taste and palatability produced by varying levels of dietary fat. Furthermore, the ability to perceive fat in foods might not be related to liking (Tepper et al., 1994). However, overall, the full-fat food items were generally preferred to the low-fat alternatives by both patients and control participants (Paper II). This result supports the general view that increased fat content often improves the sensory properties of foods (Drewnowski, 1997a; Drewnowski & Schwartz, 1990; Kähkönen et al., 1995; Richardson-Harman, 2000; Tuorila et al., 2001). However, the effect of fat on preference varied across foods and consumers, in line with previous studies (Hamilton et al., 2000; Mela & Sacchetti, 1991; Tuorila et al., 1994).

Even though preference for high versus low fat content did not differ much between patients and control, except for a few food items (Paper II), the patients did show more unfavourable fB-glucose, S-triglycerides levels, and HDL-cholesterol levels as well as an increased prevalence of BMI and abdominal fat, though the latter difference did not reach significance; taken together, these would indicate a higher intake of fat-rich and energy-rich foods and a lower intake of fruit and vegetables (Reddy & Katan, 2004; Swinburn, Carterson, Seidell, & James, 2004; Åkesson, Weismayer, Newby, & Wolk, 2007). Other studies have also found that percentage of energy intake from fat was not a significant determinant of sensitivity to and/or liking for fats (Guinard, Sechevich, Meaker, Jonnalagadda, & Kris-Etherton, 1999), and that habitual food selection was not related to fat preference in young adult males (Cooling & Blundell, 2001). A possible partial explanation of these findings may be that the reason for a greater food intake in these patients
may be a greater liking of foods in general, rather than an increased preference for higher fat content specifically. This has previously been shown among obese people who experience greater overall liking for foods, including high fat foods (Bartoshuk et al., 2006; Rissanen et al., 2002; Roefs & Jansen, 2002). Overall, this strengthens the hypothesis that it is not the fat content per se in specific food items that is the major determinant for food preference, but a preference for energy-dense food in general.

Hedonic expectations, which might be lower for low-fat foods than for regular foods, may determine actual liking, and therefore possibly affect consumer choice (Tuorila et al., 1994). However, dietary restraint has been shown to influence preference; information about a reduced fat content may alter liking in favour of low-fat products (Bowen et al., 2003; Hamilton et al., 2000; Tuorila et al., 2001). The participants in the affective studies (Papers I & II) had no expectations about fat content. The lack of perceived difference in preference between some of the low-fat and full-fat samples (Papers I & II) might also have been because some foods are more commonly seen in low-fat versions, and may therefore be more accepted in general. A study of consumer preferences for different formulations of Ranch salad dressing found no differences in liking between low-fat and high-fat samples, but the consumers preferred those samples containing higher flavour concentrations (Yackinous, Wee, & Guinard, 1999), again suggesting that a low-fat product might in some cases might be preferable.

6.1.2. The role of dietary fat in a healthy diet?

While a doubling of fat content may create only small perceived changes in a food (Mattes, 1993), it will also produce a great change in energy content, which will in turn influence energy intake. However, different items have different effects on energy intake, partly due to fat intake per serving and partly due to frequency of consumption. The different food items used in Paper III varied in fat content not just between low-fat and full-fat samples, but also between products; for example, milk and sauce béarnaise. Thus, an individual who is planning dietary changes must take his or her own eating pattern into consideration when identifying the specific foods which it would be of value to replace or modify.

However, current dietary guidelines (NNR, 2004; SNR, 2005) have been questioned in terms of their relevance in preventing overweight and CVD. There is an ongoing debate about the role of dietary fat in the development of obesity and CVD (e.g. Marcus, Hallmans, Johansson, Rothenberg, & Rössner, 2008; Shai et al., 2008; SLV, ; Sundberg & Hedbrant, 2008), specifically about the amount and quality of fat that is recommended by traditional dietary guidelines in com-
parison to, for example, low-carbohydrate/high-protein diets. This latter type of diet has been shown to result in less perceived hunger and a greater weight loss than a traditional low-fat diet (e.g. Nickols-Richardson, Dean Coleman, Volpe, & Hosig, 2005; Shai et al., 2008). Moreover, the absence of an association between fat intake and CVD has recently been confirmed in a large Swedish population study which showed that CVD mortality did not increase when consuming more than the recommended 30% of the daily energy intake from fat and more than 10% from saturated fat (Leosdottir, Nilsson, Nilsson, Månsson, & Berglund, 2005). Furthermore, an eight-year intervention that reduced total fat intake and increased intakes of vegetables, fruits, and grains did not reduce the risk of CVD in postmenopausal women (Howard et al., 2006). According to a systematic review, there is only limited and inconclusive evidence for the effect of alteration of fat intake on CVD morbidity and mortality; nevertheless, the authors concluded that reduction or modification of dietary fat intake leads to a small but potentially important reduction in CVD risk (Hooper et al., 2001). Moreover, a recently-published review still recommends a diet low in saturated fatty acids and trans fatty acids, and states that dietary advice regarding both qualitative and quantitative aspects of fatty acid intake is needed to maximise blood cholesterol lowering (van Horn et al., 2008); this provides further support to the findings of clinical studies on dietary fat and intake, for example (Katan et al., 1994; Sandström, Marckmann, & Bindslev, 1992; Vessby et al., 2001). Therefore, since there is still no general consensus about the role of dietary fat, the present results, mostly including saturated fats, still contribute to the assembled knowledge within this subject field.

6.2. Taste sensitivity in relation to CVD risk factors

We also studied taste sensitivity as a mediating risk factor for CHD. However, we found no significant differences in basic taste perception between the group suffering from CHD and the healthy control group (Paper III), though there were some interesting correlations between separate important risk factors and perception of bitter and sour tastes.

Growing evidence suggests that low HDL-cholesterol is a powerful predictor of cardiovascular disease, and low values are associated with lifestyle factors such as being overweight (Bruckert & Hansel, 2007). Unfavourable HDL-cholesterol and LDL/HDL ratio were both correlated with a heightened sensitivity to bitter taste. It has previously been shown that diets rich in vegetables and fruit decrease the risk of cardiovascular diseases (Åkesson et al., 2007), partly due to their content of various functional, bitter-tasting compounds (Drewnowski & Gomez-
Thus, more favourable HDL-cholesterol might be the result of higher consumption of fruit and vegetables, including those with a bitter tone, by those individuals who are less sensitive to bitterness, and who therefore perceive them as more palatable. Moreover, high BMI and waist circumference (abdominal fat) were correlated with a heightened sensitivity to bitter taste, a result which has previously been found in older individuals (≥ 65), though for younger individuals the opposite relationship was obtained (Simchen, Koebnick, Hoyer, Issanchou, & Zunft, 2006). Rather than avoid bitter foods, one may choose to suppress or mask bitterness through the addition of dietary fat and other flavours (Lesschaeve & Noble, 2005; Ly & Drewnowski, 2001; Mattes, 2004). These culinary modifications may contribute to increasing energy intake, which in turn adds to weight gain over time.

A heightened sensitivity to sour taste was significantly correlated with low BMI, a result which supports previous findings by (Simchen et al., 2006). It has been suggested that preference for fruit is the most important determinant of fruit consumption, and preference for sour taste in a sweet context has been shown to be correlated with fruit consumption among boys (Liem et al., 2006). However, it is not clear whether preference for sour taste is related to perceived sourness intensity (Liel, Westerbeek, Wolterink, Kok, & de Graaf, 2004), and there is little evidence for heritability of sour threshold sensitivity (Kim et al., 2004). Nevertheless, it is possible that the observed correlation between BMI and low sensory capability for sour taste might derive from low fruit consumption in favour of other more energy-dense food items.

We found no correlations between sweet, salty, and umami tastes and the risk factors investigated. Previous results have been mixed (Bartoshuk et al., 2006; Bhatia & Sharma, 1991; Drewnowski, Ahlstrom Henderson, Driscoll, & Rolls, 1996; Hardy, Brennand, & Wyse, 1981; Málaga et al., 2003; Smith & Gannon, 1991; Tepper, Hartfiel, & Schneider, 1996). We also found no correlation between fat preference and the sensory capability for basic tastes. This result supports the theory that taste function plays a subordinate role to other determinants of food and nutrient intake, as suggested by (Keast & Roper, 2007; Mojet et al., 2005), although sensitivity to bitter tastes may facilitate the prediction of preferred tastes of diet (Mattes, 1985). Taste memory seems to be tuned to detect novel and potentially dangerous stimuli, such as bitter taste; this indicates that bitter foods might be rejected on the basis of feelings of “not knowing” in terms of beyond recognition, rather than preference per se (Köster, Prescott, & Köster,
Thus, the present findings contribute some important information about sensory taste cues in relation to CVD risk factors.

6.2.1. PROP sensitivity

It has previously been suggested that insensitivity to PROP might be an indicator for CVD risk (Duffy, 2004; Duffy, 2007). However, we found no significant difference in PROP sensitivity between patients and controls, nor any correlations with CVD risk factors (Paper III), and so our results do not support these hypothesis. Furthermore, previous studies have found that individuals who are more sensitive to PROP are better able to discriminate between different levels of fat content (Tepper & Nurse, 1998), an ability which will in turn affect the preference for high-fat foods (Duffy & Bartoshuk, 2000). A relationship between PROP sensitivity and BMI has also previously been obtained (Tepper, 2004). Again, our findings did not support these results, as we found no correlation between PROP sensitivity and preference for fat levels in food (Paper II). Instead, the present results support studies reporting that PROP taster status had no measurable influence on health outcome (Timpson et al., 2005; Drewnowski et al., 2007).

6.3. Meal pattern and attitudes to health and eating

According to the extensive postal survey, meal patterns and attitudes to health and eating differed between genders as well as across BMI (Paper IV). A cluster analysis of the data revealed three clusters; male-driven, female-driven, and overweight-driven. The overweight-driven group was evenly distributed between genders, reported the lowest frequency of physical activity, and included the most smokers and the most single households in comparison to the other groups. In Sweden, those at risk of an unhealthy lifestyle are more likely to live alone than to cohabit, and they are also often low-income, less-educated people (Socialstyrelsen, 2005). Furthermore, the overweight-driven group consumed breakfast, lunch, and dinner less often than the individuals in the other two groups. Breakfast consumption has been identified as an important factor in nutritional well-being, and skipping breakfast has been related to both being overweight and an increased overall fat content in the diet (de Graaf, 2000; Schlundt, Hill, Sbrocco, Pope-Cordle, & Sharp, 1992; Wyatt et al., 2002). Thus, the temporal distribution of meals during the day may play a role in nutritional well-being, since a regular meal pattern including breakfast, lunch, and dinner is also recommended by Swedish nutrition recommendations (SNR, 2005).

The overweight-driven group reported low consumption of in-between meals; fruits, breakfast-like meals, and sweet/fat in-between meals. This result contra-
dicts those of previous studies showing that overweight individuals are more frequent snack eaters than normal weight individuals, and furthermore relating snacking to sweet and fat food choices, but this is probably due to underreporting among the individuals in the present study (Bertéus Forslund, 2006; Sarafino, 1997). The overweight-driven group reported a higher interest in using food as reward than the female-driven group, but this result also contradicts the meal frequency reported by the overweight-driven group. However, this type of food consumption might be linked to negative emotions (Dubé, LeBel, & Lu, 2005), and therefore may be repressed.

Individuals in the male-driven group were more likely than those in the female-driven group to consider a proper meal to be a hot meal including meat or fish, and they were also more likely to report cravings for fat-rich and savoury foods; the group including those individuals with highest BMI did not differ significantly from the other two groups in these respects. These differences are probably due to a gender difference in preference for different types of food, with protein/fat-based food being generally more preferred by men, and women preferring sweet/fat items (Drewnowski, 1997a). We found no significant differences between groups in cravings for sweet foods, which was a surprising result; such cravings have previously been reported to be a good predictor for behaviour, that is, food choice and frequency of consumption of sweet food (snacks) (Roininen & Tuorila, 1999). However, women reported higher interest on the craving for sweet foods scale than did men, which is in line with previous findings (Roininen et al., 1999).

The female-driven group reported a higher interest in general health, natural products, and light products, a result which has previously been demonstrated by others (Roininen et al., 1999). The sub-scale general health interest has also previously been shown to be a good predictor for behaviour in terms of food choice and frequency of consumption of healthy snacks (e.g. fruit) (Roininen & Tuorila, 1999); this was confirmed by our results, as the female-driven group had lower BMI and the highest frequency of fruit intake, as well as considering it very important to eat fruit and vegetables every day (the overweight-driven group placed the least importance on this last aspect). Additionally, a high consumption of fruit and vegetables is seen as important in maintaining a healthy body weight (WHO, 2003). The female-driven group also included individuals of higher SES; although the difference from the other groups was not significant, this supports previous studies showing that women and more educated individuals are more likely to adopt health messages (Auld et al., 2000; SKOP, 2004).
Eating patterns and attitudes to health and food consumption diverged between the three cluster groups. However, there were also some common patterns. The overweight-driven group and the female-driven group both demonstrated a high interest in getting pleasure from food, and both groups mostly purchased and cooked their food themselves; in both of these aspects they differed from the male-driven group. Thus, the gender-mixed overweight group seemed to consist of those women who were less interested in health than general and those men who were more interested in getting pleasure from food than general, indicating different reasons for unhealthy eating between genders. Individual differences in influences on food choice related to health and taste have previously been obtained, and show that women, in general, are more health orientated, and men, in general, are more taste orientated (Hamilton et al., 2000; Roininen et al., 1999; Saba, 2001). So, the present result is interesting, and might be of importance in health promotion as well as in intervention; when trying to steer people’s eating habits in a healthier direction, different approaches might be needed for overweight men and overweight women.

6.3.1. A common interest for light products

Another interesting finding was that overweight men reported a higher interest in light products than did normal weight men, and moreover men suffering from CHD reported a higher interest in light products than did the healthy control group (unpublished material). This heightened interest among the CHD group might be the result of a heightened perceived CVD risk, explained by psychological factors (Auld et al., 2000), but might also be associated with the greater light product interest among the overweight men in Paper IV, as the participants in the CHD study were mostly male, and also of higher BMI than the healthy control group. It has previously been suggested that an overconfidence in the effect of light products might enhance overeating and thus energy intake (Geyskens, Pandraeere, Dewitte, & Warlop, 2007; Wansink & Chandon, 2006); this is an important aspect to take into consideration when recommending overweight individuals to reduce their intake of dietary fat.

6.4. Demands placed on a good meal, and its relevance for health outcome

Within our model for the essence of a good meal (Paper V), the emergent categories were sorted into demands related to the food and demands related to the context. The categories within food demands can be seen as the foundation of the meal; there will, of course, be no meal at all unless food is present. However, something more than food might be needed for the meal to be seen as a good
meal. Thus, the categories within *contextual demands* can be seen as the cement which attaches the essential parts of food demands together. These categories also partly reflect and overlap each other (Figure 11).

6.4.1. Food demands

Two major meal types were described as essential parts of a good meal. Firstly, the desire for a good meal was mainly expressed by the idea of a menu, in particular an à la carte menu, which might consist of foods and beverages associated with special occasions; a *restaurant-type meal*. Secondly, well cooked, home-made and preferably Swedish homely fare, a *proper meal*, reflected the longing for familiar food; this emphasises the importance of cooking skills, cultural symbols and taste, a result also described by (Jonsson, 2004; Mattsson Sydner & Fjellström, 2006). People carry idealised images with them into their present lives. Positive memories emerge in people’s life stories, sometimes carrying regret and longing and at other times carrying pride and satisfaction (Bisogni et al., 2005). Hence, familiar food might be of great importance for a good meal experience.

Conversely, elements of surprise in terms of new flavours might also be of relevance. In addition to familiar dishes and menus, *sensory experience* in terms of flavour and appearance was included in the essence of a good meal, as well as new flavours and combinations. However, familiarity and cultural flavour principles might overrule, or at least go along with, sensory perceptions and preferences. This may provide a partial explanation for some of the negative findings in Papers II and III, and thus confirm that sensory experience is just one part of how a meal is experienced (Meiselman, 2008; Schutz & Martens, 2001; Shepherd, 2001). This result may also reflect some of the observations made in Paper II, where three of the food items actually differed in more than just fat content, and so the resulting judgements might have also been affected by, for example, differences in familiarity and symbolic values.

A good meal should also be *satisfying and nourishing*; it should satisfy one’s hunger, it should be healthy, and it should produce physical contentment, as well as fulfilling individual desires to make the right choices. Most often articulated was the need to cut down fat and sugar intake, increase dietary fibre, and include plenty of vegetables in the meal, in line with national food guidelines (SNR, 2005). This might reflect the fact that nutritional advice has some impact, at least when people are thinking about food and meals: the notion of ‘balance’ in terms of eating from a variety of food groups represents a central point of healthfulness, reflecting a long-standing component in public nutritional education, (Murcott, 2002). It was, at least, revealed that people do keep in mind how a meal should
be composed. Moreover, individual needs were expressed in terms of raw product quality, which also included environmental concerns (Magnusson, 2004). In consequence, information about a particular food might influence expectation, which is an important component in how we eventually perceive the quality of a meal (Cardello et al., 1996). Thus, for some individuals a meal may be perceived as tasting better if, for example, the raw ingredients were organically grown (Haglund, 1998).

6.4.2. Contextual demands

The idea of sharing food with others has been cited as essential for the concept of a meal occasion (Mäkelä, 2000). This was articulated in spirit of community, by the importance of the social environment, having the meal together with family and/or friends, but also cooking together and the importance of conversations and discussions about everyday things, as well as joining in at festive occasions. Such expressions might be interpreted as demands for a sense of coherence. Central to this are comprehensibility, manageability, and meaningfulness (Antonowsky, 1991). Healthy eating patterns have also been associated with a high sense of coherence; that is, the personal way of grasping and handling life situations (Lindmark, Stegmayr, Nilsson, Lindahl, & Johansson, 2005). Furthermore, in terms of caring for each other, a social gathering is required in order to get the feeling of being treated hospitably, through feelings of generosity and a desire to please (Lashley, 2000). These facets of a meal can also be seen as reflecting the idea of familiar food, which as discussed above is expressed as essential to a good meal. Another aspect of eating together might be an increased energy intake, increasing as the number of co-eaters increases, which is related to the time spent on eating (Bisogni 2007). One explanation for this might be that the communal eating situation includes a number of distractions from the actual food intake, and that eating may continue as long as food is available (Wansink, 2004), which might have positive as well as negative consequences for different individuals.

Variables such as the setting have also been shown to have an impact on the acceptance of the food within a meal (Cardello et al., 1996; Edwards et al., 2003; Hersleth et al., 2003; King et al., 2004; Meiselman et al., 2000). The aesthetic experience of a meal was stressed, including the physical setting, the table, the decorations, the china, and how the food is served, as well as intangible factors such as pleasantness of the environment, the presence of music, and the absence of smoke. This aspect is further related to the appearance of the food, which was expressed as important within the category of sensory experience, and moreover
might be important in terms of digestion (Mattes, 1997). As discussed in Paper VI, improvement of the atmosphere in the eating location during the meal has also been shown to be a meaningful way to stabilise health and nutritional status, as well as having an impact on patients’ energy intake (Edwards & Hartwell, 2004; Elmeståhl, Blabolil, Fex, Küller, & Steen, 1987; Mathey, 2001). Thus, when the food and beverages meet certain expectations, the physical environment can enhance the atmosphere, and therefore the entire quality of the meal experience. *Tranquillity*, that is, the importance of eating the food in peace and quiet and having plenty of time without stress in a relaxed environment, was also considered as an essential part of a good meal. It has previously been shown that stress and negative emotions might both increase and decrease food intake as well as decrease the pleasantness of the food eaten, while joy and other positive emotions increase the pleasantness of the food and consumption of more healthy foods (Macht, 2008). Finally, *frame of mind* expressed the importance of enjoyment and satisfaction and a meal as an event giving comfort and well-being. After finishing a meal, mood as well as satiety might be affected by the meal consumed. Post-meal mood is partly affected by physical state, which depends on the amount of food as well as the type of food eaten (e.g. if it is energy dense or light). Mood might also be affected by factors such as positive and negative emotions, for example feeling relaxed or guilty (Dubé et al., 2005). *Tranquillity* and *frame of mind* are both related to the category of *satisfying and nourishing*, and might well top all the other categories since both body and mind are pleased by a good meal. Overall, the importance of the eating context was evident, especially in the light of the context in which the open ended question was asked, where the main focus was on the food. This supports the idea that meals provide meaning not only in terms of the foods eaten, but also in terms of the entire meal situation, by means of social communication and symbols, as well as behaviours symbolising people’s identity and feeling of belonging (Mattsson Sydner & Fjellström, 2006).

### 6.4.3. Individual differences in meal demands

Overall, these findings demonstrate that a good meal occasion includes a time for rest and recovery as well as providing physical, social, emotional, and intellectual pleasure (Dubé & Le Bel, 2003), and this might be a partial determinant of individual well-being. However, individuals seem to differ in the degree and type of hedonic eating as well as in their preferred environmental and social circumstances (Macht, Meininger, & Roth, 2005); this was also seen in the present study, in terms of both food-related and contextual demands. In addition to the categories which emerged, we found that both normal weight men and normal
weight women included *tranquility* in their description of a good meal more often than overweight men and women. Moreover, normal weight men included the category *spirit of community* as an important part of a good meal more often than men who were overweight, reflecting the importance of sharing meals in order to remain healthy. In contrast, overweight men included statements within the category *a restaurant-type meal*; this may indicate a heightened interest in restaurant food, which often includes food high in dietary fat and total energy content (Callmer & Friedl, 2001; Guthrie, Lin, & Frazao, 2002). These findings support the necessity of tailored advice for different individuals in both health promotion and intervention.

6.5. Implications for dietary change

It has been suggested that general recommendations to people who need to lose weight are not sufficient, for example by (Bertéus Forslund, 2006; Gibney & Sandström, 2001; Shai et al., 2008). Thus, personal needs must be considered, in terms of meal pattern and frequency, attitudes towards health, and personal preferences and habits. The history of an individual’s food habits is closely related to their life history. Patterns of eating are influenced by childhood, residential history, school and employment history, relationships within the household, composition of the household, and skills and resources related to cooking (Mäkelä, 2000). Thus, past and current ways of managing food and eating are linked to personal, social, and environmental circumstances in life (Bisogni et al., 2005). It has also previously been shown that satisfaction with food-related life correlates with overall satisfaction with life and with physical and mental health (Grunert, Dean, Raats, Nielsen, & Lumbers, 2007).

6.5.1. Culinary knowledge and cooking skills

Food management skills (i.e. cooking skills including domestic economy) have previously been stated to be durable resources that help people meet their personally-constructed food choice goals, adapt to changing circumstances, and provide self-esteem (Bisogni et al., 2005). This definition can be further expanded into the concept of culinary knowledge and cooking skills. This expression also includes knowledge about the raw materials and products used in cooking, the sensory properties of food, individual perceptions and preferences, and the aesthetic aspect of cooking and serving foods.

People develop their culinary knowledge and cooking skills in different ways and for different reasons, and people continue to develop cooking skills over their lives as they have multiple experiences (Bisogni et al., 2005). Good culinary
knowledge and cooking skills may make it enjoyable to develop one’s dietary habits. Socialising and talking about the food eaten are also enjoyable. All of these are made easier when you can evaluate the quality of raw produce and food products, when you know how to cook, and when you have the vocabulary to discuss the food eaten (Andersen, 2000). On occasions where a person does not want to cook, there is a growing supply of ready meals as well as meal components (Prim, 2007), and it is easier to make good choices if one has knowledge about what is eaten including the nutritional content. However, traditional culinary rules direct what we actually eat. In everyday life we buy the things that are familiar to us, that we know how to prepare, and that we know the family will enjoy (Jonsson, 2004).

Since the eating situation seems to be an essential part of life, it might be a useful approach when trying to implement a healthier lifestyle. There is a generally held belief that it is not enjoyable to cook for and dine by oneself, and so this is an important issue when considering how to change eating habits. Paper IV showed that the overweight-driven group included relatively more single households that the other two groups. Since we have also shown that factors other than food are also important, related to the social and physical environment, including time for eating (Paper V), it might be an idea to pay attention to how it would be possible for these individuals to enhance their meal situation in everyday life.

As discussed in Paper VI, when the food served reaches the basic level necessary to be considered as acceptable, the meal environment, including both social and physical aspects, can have either a positive or negative effect on the total meal experience. Similar findings have also been shown in patients with dementia (Mamhidir, Karlsson, Norberg, & Kihlgren, 2007). Furthermore, as concluded, a good meal environment as well as presentation of food and choice might have a positive influence on individuals’ health status in institutional settings (Paper VI); this may also be applicable in a private setting. It has previously been shown that overweight individuals have reported eating more than other weight groups when they experience negative emotions and situations, whereas underweight individuals reported eating more when experiencing positive emotions and situations (Geliebter & Aversa, 2003). Thus, stress and negative emotions might both increase and decrease food intake as well as decrease the pleasantness of the food eaten, while joy and other positive emotions can increase the pleasantness of the food and consumption of more healthy foods (Macht, 2008). Since the mood at the time of eating can influence the amount of intake, a good meal environment might be used to raise positive emotions in the presence of a meal occasion. Thus, eating environments that produce positive emotions seem to be of importance in
keeping up a healthy diet in both overweight and underweight individuals. However, the specific factors that create a positive eating environment are highly individual, and need further attention.

Food and contextual demands might either be seen in a positive way, as a resource helping to create good meals, or in a negative way, where the demands become a burden in everyday life. These might be related to food choice capacity, where individuals with a high capacity convey pride, satisfaction, or contentment with the ways that they acquire or prepare foods, the types of foods eaten, the timing and regularity of meals, and the settings in which food is consumed. On the other hand, individuals with low food choice capacity struggle with food choice, and feel that their foods and meals are not what they should be, either because they do not have the skills to achieve their goals, or because their circumstances do not allow them to do this, or both (Bisogni et al., 2005). Paper IV also revealed that people differ in their attitudes to health and food consumption. A dietary change should therefore start with what one can cope with in everyday life, and turn it to something enjoyable. Our model, the essence of a good meal, might be a help in identifying individual preferences and ideas about a good meal, and further which essential parts are neglected or less well represented and so should be taken into special consideration when helping individuals to acquire a new angle on how to handle food and meal issues in everyday life; that is, to turn a burden into a resource, starting with one’s own familiar taste and context.

6.5.2. Sensory training to broaden one’s individual “taste library”

Many individuals are not aware of their own fat intake, since it is the result of consumption of various food items in different combinations and prepared in different ways (Brug & van Assema, 2001; Glanz, Brug, & van Assema, 1997); this might be one possible partial explanation for overconsumption. Moreover, it is likely that it is the preference for certain fat-rich foods which is important rather that the total fat content in a product when it comes to actual consumption (Paper II). It has previously been shown that a greater liking for high-fat foods and lower liking of low-fat foods, both alone and, importantly, combined with a reduced availability of low-fat foods in the home, are predictive of higher fat intake (Rainor, Polley, Wing, & Jeffery, 2004). Thus, changed behaviour might be a consequence of a reduced fat diet in combination with restrained, non-compensatory eating behaviour (van Strien & van de Laar, 2008; Westertorp-Plantega et al., 1998).

Since a shift in hedonic ratings has only been reported to occur under conditions of reduced exposure to fat-associated sensory attributes, it could be argued that a complete dietary change to a reduced-fat diet, without regular exposure to
these sensations, is required to establish a change in measures of “fat preference” (Mattes, 1993). Furthermore, one study has shown that consumers with a high fat intake ate a constant weight of food and could not distinguish between high-fat and low-fat foods, whereas consumers with a low fat intake ate a constant level of energy and were sensitive to fat in food (Cooling & Blundell, 1998). This strengthens the suggestion that genetic variation may contribute to the heterogeneity in lipid responsiveness (Masson et al., 2003). Thus, if consumers with a high fat intake are unable to distinguish between high-fat and low-fat foods, one might think that culinary knowledge and practice about low-fat food provided along with health awareness information might be a useful intervention method among this consumer group. In addition, the ability to sense bitter taste could be one reason for rejecting certain fruits and vegetables or masking the bitter taste with fat. Thus, the variation in sensitivity to bitter taste might be related to overconsumption and/or underconsumption of foods which contribute to a less healthful diet in relation to overweight and low HDL-cholesterol values.

Even if it is difficult to change food habits (Brug & van Assema, 2001), consumers very often come to like food or beverages that are initially perceived as unpalatable. A previously neutral or even unpleasant taste can become preferred, provided it is linked with a suitable mechanism of reward (Drewnowski, 1997a) and repeated exposure (Zandstra, De Graaf, Mela, & Van Staveren, 2000). Furthermore, it has been shown that repeated exposure and enhancement by peer pressure and consumption under positive conditions can be helpful when learning to like new flavours, as has been shown in the case of astringent red wines (Lesschaeve & Noble, 2005). This could also provide a useful way to learn to appreciate less-liked foods, as well as to learn to appreciate novel foods which are not included in one’s everyday eating habits. Previous findings have shown that sensory training and exposure to novel foodstuffs enhance the willingness of children to try new foods (Loewen & Pliner, 1999; Mustonen & Tuorila, 2007; Reverdy, Chesnel, Schlich, Köster, & Lange, 2007), and taste acuity has been shown to mediate behavioural changes in weight reduction (Monneuse et al., 2008). In addition to trying to change the preference for dietary fat, it might be a more efficient intervention to create familiarity with a broader range of tastes, flavours, and previously unfamiliar foods by sensory training via experiences (Loewen & Pliner, 1999; Mustonen & Tuorila, 2007; Reverdy et al., 2007). It could, therefore, be useful to introduce and repeatedly consume different fruits and vegetables, since it is known that repeated exposure can alter preferences (Zandstra et al., 2000), as well as helping people learn how to prepare these vegetables.
The use of seasonings or cooking techniques to mask the less-liked bitterness and enhance positive sensations (e.g., sweetness) may also facilitate conditioning a preference for vegetable flavour (Dinehart et al., 2006; Drewnowski & Gomez-Carneros, 2000). Preventive intervention with sensory training to broaden one’s individual “taste library”, with the aim of facilitating long-term changes in food habits, could therefore be a useful tool for changing food habits among overweight or obese individuals, and those at risk for CVD.

On the other hand, when eating, satiety will occur with time. Satiety may develop in two discrete stages; satiety to a specific food, and the general satiety for the meal, and it has been shown that judgement of pleasantness decreases as a food is eaten, a phenomenon known as sensory specific satiety (Hetherington, 1996; Rolls, J, 1985). This might lead to overconsumption if a wide range of food stuffs are available, for example at a buffet, and so these types of meals are not recommended if one wishes to restrict energy intake. Thus, even if it is favourable to like and eat a great variety of foods, this is not to be recommended within a single meal occasion, since this could result in consumption of larger portion sizes and hence a higher energy content, and has previously has been suggested as one of the main reasons for overeating (Kral, Roe, & Rolls, 2002; Wansink, 2004).

6.5.3. Health promotion and intervention

It has previously been suggested that post-intentional processes such as planning need to be incorporated in order to explain how people change their behaviour. The health action process approach (HAPA) is one such model which is aimed at helping to bridge the intention-behaviour gap. This approach distinguishes between the pre-intentional motivation processes that lead to a behavioural intention and the post-intentional volition processes that lead to actual health behaviour (Schwarzer, 2008). Several ways of achieving this, in terms of food and context, have been discussed above. In the motivation phase, one needs to believe in one’s capability to perform a desired action (Schwarzer, 2008). We have shown that the essence of a good meal includes demands on both food and context, and so it might be of relevance to take these different facets into consideration in health promotion and intervention. This could provide a starting point for identifying individuals’ opportunities for and requirements of good meals, and further serve as a guideline through the different stages in a process for dietary change.

Self-efficacy influences the processes of planning, taking initiative, maintaining behaviour change, and managing relapses (Schwarzer, 2008). When applied to nutrition and health, the concept of self-efficacy focuses on achieving practices recommended by experts. In contrast, food choice capacity focuses on the indi-
individual’s view of achieving the standards that she or he constructs; the extent to which one feels able to and tries to eat properly, according to one’s own definition of proper. This is both dynamic and evolving. Thus, individual food choice capacity includes a feeling of one’s ability to meet one’s own expectations for what and how one should eat in terms of how to choose, purchase, prepare, and cook foods (Bisogni et al., 2005; Furst et al., 1996). Therefore it is of importance to start with one's own familiar taste and context. One new way to do this could be to supplement dietary advice by adding culinary knowledge and cooking, including training in sensory acuity to provide new perspectives on how to acquire better food and meal habits. In the subsequent volition phase, which occurs after a person has developed a tendency toward adopting a particular health behaviour, it is necessary to construct a detailed plan of how to perform the desired action (Schwarzer, 2008). FAMM (Figure 2), as described in the introduction, is used as a tool when creating meals in commercial settings (Gustafsson et al., 2006), but has potential to be developed as a useful practical tool for structuring ways of achieving good meals in everyday life. Moreover, this approach might also be useful as a tool to enhance acceptance, satisfaction, and health outcomes in institutional eating locations.

6.6. Methodological considerations

The interdisciplinary approach of Culinary Arts and Meal Science offers a wide variety of research methods. However, one major problem that might arise in interdisciplinary research is achieving a balance between the depth given by a disciplinary focus and the breadth given by input from a range of disciplines. Still, from synthesis comes creativity, and it is creativity which should overcome disciplinary limitations (Gustafsson et al., in press). So, despite some methodological shortcomings, it is to be hoped that the present findings have given some new useful perspectives on food and meals in relation to health.

6.6.1. Part one: Sensory properties and responsiveness

In Paper I, analyses were performed on two different types of sauces, both of which were specifically developed to minimise the risk of variation between batches. A limitation is that the hedonic evaluation was performed only on the tomato sauce, among a population which was not in the direct target group for this type of sauce. A more appropriate approach might have been to use a stratified population sample according to gender and age, as well performing the hedonic rating with both sauces in order to be able to draw more general conclusions, due to the different characteristics of the tomato sauce versus the chicken
velouté. However, the same sauces in the same concentrations were used in the preference test (Paper II), and no differences in preferences were seen between the low-fat and high-fat versions.

A major strength of the case-control study (Papers II & III) was the inclusion of CHD patients in the period immediately following the infarction and comparison with a matched control sample. The patient group showed less favourable values for anthropometrics and clinical tests, which confirmed the expected differences between the two groups. The primary limitation within this thesis is probably the low sample size, which was mainly due to difficulties in recruiting participants in the study group, and this might be a contributory factor to the negative findings.

Moreover, there was a major falling off in the patient group during the time between the sensitivity tests and the preference test. A further consideration is the possibility of general impairment of taste perception after the infarction, or due to medication. However, none of the patients reported any apparent taste impairment.

The intention in this study was to include individuals of working age, and so there were considerably more male participants than female, since women generally fall ill later in life than men (SBU, 1997). Thus, it was not possible to make comparisons between genders, and so we still do not know whether men and women differ in their taste perception and preference for low-fat versus high-fat food items.

One limitation is that only threshold values were measured (Paper III), rather than intensity ratings or preferred concentrations of the basic tastes in real products, which according to recent studies would have been a more appropriate approach (Mojet et al., 2005). In addition, and significantly, half of the participants did not recognise the tastes at the levels presented (ISO, 1991), possibly because taste thresholds increase with age (Ng et al., 2004) For further work in this area, it will be more suitable to continue presenting samples in increasing concentrations until participants are able to detect/recognise the tastes. Another, more time-efficient procedure is to use intensity scaling with supra-threshold levels.

A major strength of the preference study (Paper II) is that rather than using simple model foods or a questionnaire based approach, we used a variety of real foods with fat levels within realistic limits. Furthermore, in order to achieve a “meal-like” situation and reduce sensory specific satiety, the food was served in menus. These included some of the major food sources, both sweet and savoury, both home made and industrially produced, contributing to fat intake in Sweden. However, mostly dairy fat was used in the foods, thus excluding several common vegetable fat sources. Another limitation might have been that it was difficult for
some of the participants to discriminate between samples, possibly because genetic variation may contribute to the heterogeneity in lipid responsiveness (Masson et al., 2003). However, the participants’ comments on the score sheets showed that some of the participants were able to discriminate while others were not. It would therefore have been useful to examine the individual perception of fat content using a ranking test or simple discrimination tests in addition to the tests performed. Prior to the test, bench tests were performed in order to prepare food pairs with perceived differentiated fat content. However, perhaps it would have been better to have performed paired comparison tests (ISO, 1983) in order to obtain more distinct differences between low-fat and full-fat samples.

One other possibility to be considered is that the patients’ preferences for fat content in food may have changed after admission, as they may have changed their eating habits following dietary advice. However, using real products, it has previous been shown that habitual consumers of full-fat products showed no consistent shifts in hedonic ratings of reduced-fat products compared to full-fat products over a 12-week period (Mattes, 1993; Mela, Trunck, & Aaron, 1993; Stubenitsky, Aaron, Catt, & Mela, 1999).

6.6.2. Part two: Food attitudes and eating context

The postal survey was answered by a relatively large sample (N=455) representing the same age group from the same geographical area as the case-control study. The distribution of socio-demographic variables, as well as, BMI, smoking habits and frequency of exercise among the respondents were comparable with the distribution within the Swedish population (age 41-65) (SCB, 2004). However, the most of the respondents were born (90.1%) and grew up (94.3%) in Sweden. Thus, the findings are limited to reflecting the culture and habits among a middle-aged Swedish population. Moreover, the sample was a limited age group, and so it is not possible to generalise the results to other age groups.

A small pre-test of the questionnaire was performed before it was sent out. However, the questionnaire was extensive, including several types of questions; this made it complicated to interpret, but the problem was solved by conducting a cluster analysis (Paper IV). The part including the HTAS scale was validated, while the other questions were not. However, they were constructed by inspiration from other food-related questionnaires. When looking back, it would be of interest to include validated food preference and food frequency questionnaires (Karlsson, Persson, Sjöström, & Sullivan, 2000; Lediwke et al., 2007; Ozier et al., 2007; Segovia-Siapco, Singh, Jaceldo-Siegl, & Sabaté, 2007; van Strien et al., 2007).
The open-ended question was analysed by content analysis (Paper V). Two researchers read all the statements and performed the qualitative analysis, while a third researcher looked at a random sample of quotes to validate the findings. Thus, the interpretation could be considered as reliable. Furthermore, the study resulted in a comprehensive amount of material even though only one question was asked, probably due to the size of the study (N=358). One limitation is that there were more internal missing values for the open-ended question, which is not surprising per se. This resulted in more women than men answering the open-ended question, but the difference was not significant. Other measured background variables were similar. Hence, the constructed model can be considered as trustworthy, as long as the results are not generalised to people living in different areas or within other cultures.

Finally, Paper VI was written as part of a PhD course, and was not intended to be a comprehensive study. The literature overview would have been more generally applicable if it had included a systematic literature search, but it does still contribute to the field while capturing the author’s knowledge and ideas in relation to relevant literature in the field.
7. Conclusions

The purpose of this work was to increase our knowledge and understanding of individuals at risk of obesity and developing cardiovascular disease (CVD), in particular coronary heart disease (CHD), in relation to food and meals, in order to be able to guide people towards a healthier diet on the basis of their own preferences, attitudes, and habits. The overall results described in this work reflect some of these interrelationships between the individual and the food, as well as the food context, as important factors in the experience of the meal.

*Sensory properties and responsiveness*

There were no significant differences in basic taste perception or PROP sensitivity between the group suffering from CHD and the healthy control group. However, in the pooled sample, heightened sensitivity to bitter taste was correlated to unfavourable HDL-cholesterol, BMI, and abdominal fat, while heightened sensitivity to sour taste was correlated to favourable BMI. More unfavourable HDL-cholesterol might be the result of lower consumption of fruit and vegetables, including those with a bitter tone.

Preference related to total fat content per se was not confirmed as a significant risk factor for CHD. Overall, full-fat food items were generally preferred to low-fat alternatives, both by the group suffering from CHD and by the healthy control group. However, for about half of the food items there was no significant difference in preference between full-fat and low-fat alternatives. Additionally, more unfavourable values of HDL-cholesterol levels, S-triglycerides levels, blood glucose measurements (fB-glucose levels, OGTT levels and HbA1C), and body-weight (abdominal fat and BMI, marginally significant) were seen in the patient group; this might be related to a higher intake of a fat-rich and energy-rich diet and a lower intake of fruit and vegetables.

Overall, increasing butter content in the two sauces examined (chicken velouté and tomato sauce), resulted in a decreased intensity of the evaluated flavour attributes, while the butter flavour and the viscosity increased. However, liking for the overall flavour did not differ between two levels of added butter (tomato sauce; 10% and 40%). Thus small sensory differences are achieved only through large differences in energy content. Higher fat content is therefore not always justified, unless it is the flavour and texture of butter itself that is sought, since those attributes were perceived as more intense at higher levels.
Food attitudes and eating context

Attitudes to health and food consumption differed by gender, BMI, and CHD status. In comparison to men, women showed a greater health interest, a greater interest in getting pleasure from food, and a greater craving for sweet foods. Overweight women showed less health interest than normal weight women, but a greater interest in using food as a reward, while overweight men showed a greater light product interest than normal weight men. In addition, the group suffering from CHD showed a greater light product interest than the healthy control group.

BMI and gender were both related to differences in eating pattern as well as attitudes to health and food consumption. The emergent overweight-driven group, which was gender-mixed, was associated with a high frequency of individuals who lived in single households, who consumed breakfast, lunch, and dinner less often than those in the other groups, and who showed a low interest in fruit and vegetable consumption. This group of individuals seemed to consist of those women who were less interested in health than general and those men who were more interested in getting pleasure from food than general, indicating different reasons for unhealthy eating between genders.

The essence of a good meal was found to include demands on both food and context. Food demands included dishes and menus, sensory attributes, product quality, and nutritional values. Contextual demands included the physical and social environment, peace and quiet, and enjoyment during the meal. Moreover, some differences were found between genders as well as between normal weight and overweight individuals. Thus, it might be of relevance to take these different facets into consideration in health promotion and intervention by using them as a starting point for identifying individuals’ opportunities for and requirements of good meals, starting with one’s own familiar taste and context.
8. Future outlook

This thesis has shed some light on the complex area within the intersection between gastronomy and health and more research is needed, especially when it comes to a meal’s contextual dimensions in relation to health outcome. As discussed — but not studied — in the present thesis, there is a need for research which addresses satisfaction and health outcome in institutional eating situations. Controlled studies within this area are needed, where the presentation of food and the physical and social environment are studied with the aim of finding solutions that work in institutional eating environments.

The model for the essence of a good meal was constructed from a comprehensive amount of material, even though only one question was asked of a middle-aged group of individuals. It might have the potential to be a useful supplementary tool in health promotion and intervention, with the aim of identifying individuals’ opportunities for and requirements of good meals, starting with one's own familiar taste and context. However, more research is needed in order to validate the present findings, as well as to include individuals in all age groups as well as other cultural and ethnical groups. Moreover, it would be useful to identifying groups of individuals with different preferences, attitudes, and ideas within the separate food-related and contextual categories in the model. This would then be an aid to individualised health promotion and intervention.

It may be of interest to develop a method of integrating taste lessons in intervention groups, as well as adding cooking classes and instruction in the culinary arts including aesthetic aspects of the meal situation, in order to evaluate possible effects in comparison to conventional intervention practices.

The present results indicate that it may be primarily bitter taste perception that is related to health outcome. It would therefore be of interest to further evaluate the significance of taste perception in relation to risk factors for CVD and its possible influence on food and meal habits. It would be of value to include more individuals, both men and women in all age groups, using real foods, and to supplement the data collection with food frequency and food preference questionnaires. This might also be included in a prior step for intervention with integrated taste lessons.

The present findings are not just of interest for research, intervention, and health promotion purposes, but also for educational purposes within the field of Culinary Arts and Meal Science, as well as other related areas, such as, home economics. The aim should be to broaden the concept of food-related and meal-related health to include not just nutrients, but also the relevance of how the food is prepared and served, including the eating environment. These aspects might be taken into consideration and be developed to fit curriculums at different levels.
"I do not think we live in order to be healthy. We should stay healthy in order to live rich, varied and meaningful lives...

- You should eat not just for cardiovascular health, but also to your heart's delight.
- You should exercise not just for staying fit, but also dance to your heart's beat.
- You should search not just for scientific facts, but also find meaning listening to your heart's song."

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Figure 12. The low-fat and full-fat food samples included in the paired preference test (Paper II).
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