



INRA



Dietary behaviours and practices

Determinants, action, outcomes

Executive summary of the Collective scientific expertise conducted by INRA,
commissioned by the Ministry of Food, Agriculture and Fisheries

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INRA Collective Scientific Expertise

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Executive summary of Collective Scientific Expertise report

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Foreword

Dietary behaviours have altered considerably in recent years, as a result of greater consumption of lipids and convenience foods, an increase in meals eaten outside the home, and the expansion of food retailer chains. Diet is important for overall personal well-being, it can be either beneficial or detrimental to health, and the question of diet is crucial in formulating different policies targeting public health. For several decades, research has been very active on the subject of dietary behaviours and how they affect people's health. This collective scientific expertise focuses on dietary behaviours in France. The term "dietary behaviour" covers the physiological dimension of food intake; diet itself which includes the nature, quality, variety and quantity of food consumed and how it is prepared; as well as socio-cultural aspects connected with supply and choice of food products, meal timing and composition. In this executive summary, we use dietary behaviours, dietary habits and dietary practices in the widest sense of the terms.

Dietary behaviours and public policies

The PNNS (National nutrition health programme), introduced by the Government in 2001 and prolonged in 2006, is an important initiative in this domain. The Ministry of Food, Agriculture and Fisheries (MAAP) has developed a plan to provide a reliable, varied and sustainable food supply, and its proposed bill for modernizing farming and fisheries has instituted a national food supply programme (PNA). This programme, which complements the PNNS, aims to ensure that the entire population has access to good-quality palatable and nourishing food at acceptable prices, produced using sustainable methods.

These public policies have been largely taken up by health care providers and food industry professionals. Their action consists of passing on nutritional information (food composition and foodstuff combinations), and guidelines regarding dietary behaviours that safeguard people's health (information campaigns such as "Eating 5 fruits and vegetables per day is good for your health", "Eat and exercise" issued by the PNNS). Action also includes initiatives targeting professionals, such as the voluntary charters signed with manufacturers in which these commit to improving the nutritional value of their products.

Investigating dietary behaviours: the questions addressed to the scientific experts

Although consumers receive an on-going and instant flow of information about how eating behaviour affects health, the Minister in charge of Food, Agriculture and Fisheries required an updated state of knowledge for peer-reviewed literature and thus commissioned INRA to undertake a collective scientific expertise (ESCo) of dietary behaviours (Box 1). The aim was to investigate the multiple determinants of behaviour, and how behaviour forms and changes in individuals according to social class and age, but also collectively over a long period of time. These determinants are numerous and varied. Diet is not just a series of nutrients, but involves combinations of foods; diet reflects psychological and cultural attitudes, has individual and collective implications, and it is important to put it into the context of demographic evolution and changes in lifestyle.

The expertise investigates dietary behaviour of the population in general terms, and refers neither to pathologies and eating disorders requiring medical treatment (malnutrition, bulimia, anorexia, etc.), nor to specific eating practices (vegetarianism, diets prescribed by religious belief, etc.). The expertise does not deal either with the relationship between diet and physical exercise, recently investigated by INSERM.

For the past several years, INRA has developed research on the consumption of food that results from the interaction between consumer demand and production system supply. This issue calls for more detailed investigation, and the collective expertise will contribute to the definition of future research themes by revealing gaps in knowledge and identifying research needs.

Methods and scope of the expertise

The task assigned to an ESCo is to establish an inventory of academic scientific knowledge from which components are extracted and assembled to address matters raised by the commissioning body. The directives given to INRA were outlined in the terms of reference, decided upon after two-way consultation between the ministries of Agriculture and Research as commissioners, and the group of experts, who fixed the scope of the expert report. A monitoring committee, convened on the initiative of the commissioning body, provided an interface between the experts and oversaw progress of the inquiry. The experts were required to sign the report and are responsible for their contribution. INRA undertook responsibility for the conditions under which the expert inquiry proceeded: the quality of the literature research for

updating bibliographic sources, transparency of discussions between experts, work group leadership and writing of ESCo reports in a form that reconciled scientific rigour with intelligibility to a wide audience.

ESCo is based on certified international scientific articles, which explains why there is no information about certain recent phenomena, either in the absence of published research, or due to the fact that published studies had been carried out in contexts that had nothing to do with those observed in France. To take an example, the analysis of meal frequency patterns in France is based on studies of daily schedules carried out by INSEE over ten years ago which is when household behaviours were last examined.

A group of about thirty scientific experts working for various scientific institutions in France (INRA, Institut Pasteur in Lille, University Hospital in Lille, CIHEAM, CNRS...) were involved in this ESCo of dietary behaviours. Their expertise covered areas as diverse as epidemiology, physiology, food physico-chemistry, economics, sociology, marketing, and psychology. Their work drew upon a total of about 1600 articles, essentially scientific papers, in addition to statistical data, books and technical reports. The experts selected all the relevant aspects of these documents, then analysed and assembled them so as to provide insight into the issues in hand.

ESCo does not give opinions or recommendations, nor does it provide any practical solutions for the commissioning body. It does however present a thorough review of the knowledge available regarding the determinants of dietary behaviour, using a multidisciplinary approach combining the life sciences with the social sciences. It also outlines some prospective measures, based on an evaluation of a number of public or private initiatives.

Part One of the executive summary presents the major changes in dietary practices, as well as how these changes affect health. Part Two investigates the determinants responsible for dietary behaviours, and how determinants affect behaviour regulation and/or disruption. Part Three analyses the public or private initiatives which aim to promote dietary behaviours that match nutritional guidelines. The Conclusions summarize the key points identified by the experts, after their evaluation of the articles published in the different disciplinary fields.

Box 1. The Collective Scientific Expertise, principles and methods

Scientific expertise as support for public research policy at INRA

The Research Orientation Bill (2006) affirms that scientific expertise provides valuable support for public research policies. Scientific findings are required input for public policy decision-making, and prove decisive in conducting international negotiations. The ever-increasing volume of scientific knowledge emanates from very diverse disciplines and this raw data is inaccessible as such to policymakers. The expertise procedure has been used at INRA since 2002, and can be defined as a procedure for analysing and putting together knowledge produced in the most diverse fields, and that can be useful in supporting policy decisions.

A Charter for expert scientific assessment at INRA

The expert analyses were conducted according to a charter which ensured the robustness of the assessment produced. The charter is based on four principles of conduct: competence, diversity, impartiality and transparency. INRA applied the principle of competence by only undertaking to report on issues that fall within its field of expertise, the scientific legitimacy of which is guaranteed by its dedication to long-term research. This principle of competence equally applied to the experts who were deemed qualified on the basis of their scientific publications and who rigorously adhered to the assessment process. Diversity implied a multidisciplinary approach to the issues raised, which involved both the life sciences and human and social sciences. Diversity was also reflected by the institutional origin of the experts, since INRA called on outside assistance to complement the range of disciplines available internally. By ensuring diversity in research domains and disciplinary perspectives, the intention was to stimulate debate and encourage discussion on controversial issues thereby developing critical analysis. The principle of impartiality was safeguarded by the many points of view presented, and by requiring each expert to declare any links with stakeholders or groups with vested interests. Finally, transparency is guaranteed by the publication of the summary and the assessment documents which are freely available to all.

Definition and procedure used for the expertise

In order to address the questions posed by the commissioning body, the experts examine the relevant academic scientific knowledge from which they extract and reassemble the most pertinent elements. The questions addressed to INRA are laid down in a statement which is jointly formulated by the commissioning body and the group of experts, and which sets the scope and contents of the expertise. The steering committee, nominated by the commissioning body, acts as an intermediary between the latter and the experts, and makes sure that the procedure goes ahead according to plan.

The experts are required to contribute to the final report, citing all the articles they have examined. All these contributions together make up the overall scientific expertise report for which the experts are jointly responsible and which is available on line through the INRA website.

INRA ensures that the expertise procedure is executed according to directives, i.e. meticulous updating of sources, transparency regarding the discussions between experts, taskforce coordination, writing of executive summary and communiqués in a style which is both scientifically exact and accessible to the general public.

To date, six Collective Scientific Expertises have been completed : "Increasing carbon stocks in French agricultural soils?", "Pesticides, agriculture and the environment", "Drought and agriculture", "Consumption of fruit and vegetables", "Agriculture and biodiversity", "Animal suffering".

Part one: Changes in dietary practices and health

Part One presents the salient facts regarding the recent history of food consumption in France (Chapter 1) and indicates how changes in dietary practices and health are related (Chapter 2). This relationship between food and health, based on clinical physio-pathological and epidemiological studies, has incited the authorities to publish nutritional guidelines encouraging a diet that is more conducive to good health.

These two chapters aim to answer the following questions: what are the most significant changes in food consumption? Is it possible to define a French food typology? Can certain types of dietary behaviour be linked with health indicators? Do current data and assessment methods allow the correlation to be established between evolutions or modifications in dietary behaviours and health?

Sources of data

Food consumption is calculated using:

- food availability data, i.e. food quantities calculated from the economic balance between production + imports – exports. Most of this data has been published by the FAO since 1960.

- description of purchases or the “consumer basket”, based on surveys by INSEE using recorded statements (Food consumption surveys (up until 1991) and Family budget survey), by CREDOC with its survey of Food behaviour and consumption in France (CCAF), by INPES (Health Nutrition Barometer), and by the INCA 1 and INCA 2 surveys carried out between 1999 and 2007 under the aegis of AFSSA; plus, as of the 1990s, the Kantar Worldpanel consumer panels (formerly TNS-Secodip).

The INCA 1 and INCA 2 surveys allow changes in French *individual* food consumption at the dawn of the 21st century to be measured over a relatively short period (8 years). The surveys use representative samples of the French population, and gather dietary data using 7-day notebooks for an entire year in order to account for seasonal variations. To make data comparable, a single table indicating the nutritional composition of foods is used to analyse changes. In 2007, a detailed list of drinks and fatty acids was compiled in order to provide specific consumption data.

The only data available over a longer period are those provided by the INSEE Family budget survey, which unfortunately did not record quantities but only expenditure up until 2006. Between the 1960s and 1991, the on-going INSEE Food consumption survey supplied regular data on quantities purchased, but this was then discontinued. From the 1990s, the Kantar Worldpanel consumer panel has compensated partially for this shortcoming, but gives no information on individual consumption nor on consumption outside the home.

- analysis of household dietary practices through INSEE daily schedule surveys (1986 and 1999). These surveys provide information on the amount of time devoted to various activities throughout the day (sleep, work, meals, household chores) and on when these take place, using self-reported daily schedules. Thus, meal periodicity and the time spent on them can be tracked.

Data is scarce regarding the quality of food bought by households, and a direct link between food manufacturing techniques and dietary behaviours cannot be established. Work is currently underway at OQALI (Food quality observatory) to remedy this problem, by creating food supply data bases which can then be matched up with household purchase data, such as that provided by the Kantar Worldpanel consumer panel.

Epidemiological studies which examine the risks of contracting a pathology through food intake, focus on different dimensions of diet, for example nutrient intake (fibre, anti-oxidant vitamins, omega 3 fatty acids, etc.), consumption of specific foods (e.g. tomato, carrot, etc.), consumption of food groups (e.g. : vegetables, fruits, fish, etc.) or dietary profiles combining multiple factors (e.g. a vegetarian diet). Most of the epidemiological studies analyse the associations between specific dietary factors and nutritional markers (body mass index, blood sugar and cholesterol levels, etc.) or health markers (onset of illness). These studies seek to highlight protective or risky behaviours and their associated nutritional markers, in order to generate or test certain hypotheses regarding the mechanisms involved. The studies are usually based on data provided through the voluntary participation of a sample of the population, which is however not always representative of the national population.

Several methods can be used, although no particular method is fully accredited. Studies into the effects produced by a specific nutrient or foodstuff have encountered certain conceptual and methodological limitations, viz. specific nutrient intake can never be isolated, the effect of one nutrient can be modulated by another, and specific effects can be too minimal to allow detection. Likewise, correlations between various nutritional factors can mask the role played by a specific nutrient. The introduction of numerous adjustment factors aims to improve the comprehension and interpretation of study results, but these should be used with care.

These considerations mean that diet tends to be approached holistically, and study methods can be divided into two main types : *a priori* methods which explore the gap between actual dietary behaviours and predetermined guidelines; and *a posteriori* methods (theoretical or empirical) which establish typologies by matching population data sets. These latter methods encounter the limitations inherent to epidemiological surveys and studies (under-reporting, biases incorporated in food composition tables, etc.).

Chapter 1. Main modifications in diet and dietary practices in France

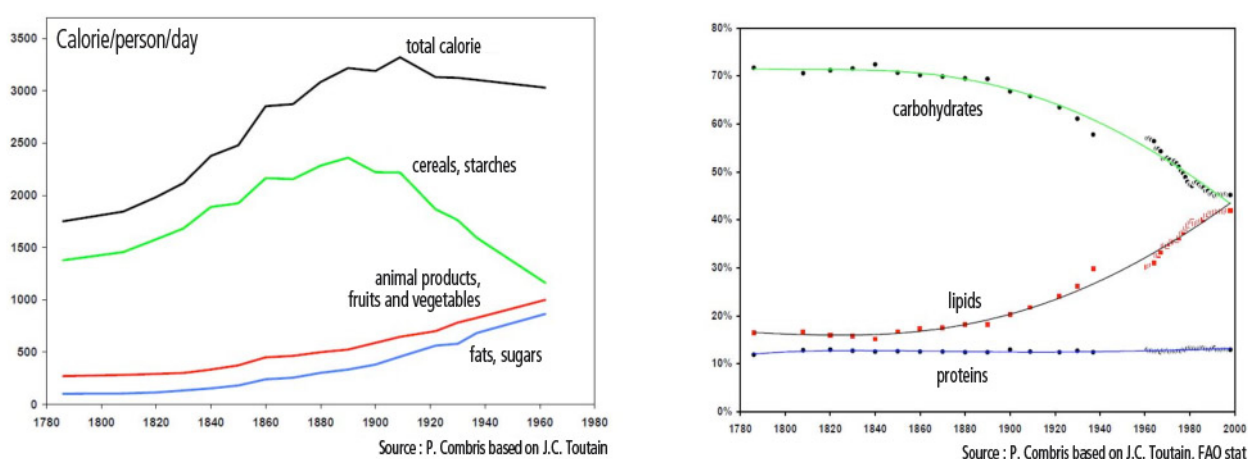
Different conclusions can be drawn from the analysis of the main modifications in diet and dietary practices in France, depending on whether the focus is placed on nutritional intake or on food supply and demand. From a nutritional point of view, France and neighbouring European countries (as well as other developed countries) experienced a transition over the 20th century towards a diet that became much richer in lipids and much poorer in carbohydrates, than over the preceding centuries. Although nutritional intake is similar between European countries, food preferences are much more diverse once consumption of specific foods is examined. Long-term diet changes have been partly driven by food supply, which has undergone two major upheavals over the past fifty years: increased use of technology for processing basic foodstuffs, thus putting convenience foods on the market; and the expansion of supermarket chains which have reshaped supply circuits. These trends towards a mass-produced food supply have not however led to social uniformity regarding food choices; clear differences in behaviour subsist between consumers depending on levels of revenue or education, and social class.

1.1. From 1900 to 1980 : nutritional transitions

Statistics on food availability, published by the FAO since the beginning of the 20th century, are drawn from economic reports regarding production, imports and exports. They include consumption losses and wastage, which can represent up to one third of total availability, according to studies based on recent American and European data. Therefore not all the food available is actually ingested. Despite this bias, the statistics give some idea of the evolution over the previous century of nutritional intake connected to diet. After a long period of regular growth, total food calorie intake remained stable between 1920 and 1960 (Figure 1). According to FAO statistics, this began to climb again at the end of the 20th century, increasing from 3370 kcal in 1980 to 3600 kcal in 2005.

Although overall energy, availability has remained relatively stable, there has nonetheless been a vast change in diet composition, with a progressive reduction in the proportion of carbohydrates to the advantage of lipids. This situation concerning macronutrients prevailed up until the 1970s and 1980s, then seems to have stabilized and matches the dietary habits characteristic of OECD countries. Thus, calorie intake from carbohydrates and lipids were on the same level at the end of the 20th century (Figure 1). For many authors, this marks the end of the nutritional transition that had been on-going since the beginning of the 20th century.

Figure 1. Long-term evolution of food availability in France



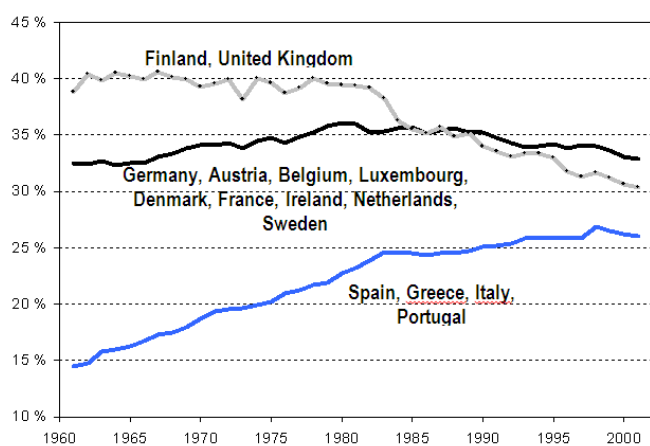
The Figure on the left shows the evolution in total calorie availability per person per day, from the end of the 18th century up until 1960, and the main sources of these calories (cereals, starches, animal products, fruits and vegetables, fats and sugars). The Figure on the right details the total calorie intake per macronutrient between 1780 and 2000, according to whether these calories are provided by carbohydrates, lipids, or proteins.

1.2. Diet in Europe : common trends and national specificities

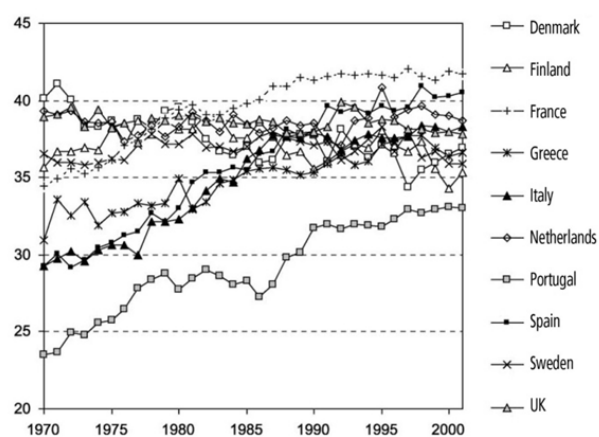
Throughout Europe, a common trend can be observed as regards the proportions of carbohydrates and fats within total calorie availability, which stand respectively at 45-55% and 35-40%. But does this also reflect a convergence among national dietary habits?

Analysis of aggregate data, regarding calorie availability for major European regions, suggests that certain dietary habits have changed in Mediterranean countries, which now show intake levels similar to those found in Northern and Eastern Europe. Thus a high increase in calories of animal origin within total calorie consumption can be observed, and a drop in alcohol consumption (Figure 2). But more detailed analysis reveals that national specificities persist as far as meat preferences are concerned. Also, although wine consumption in Southern Europe has dropped and now stands at approximately the same level as in Northern Europe, beer consumption in Northern Europe remains much higher than in Southern Europe. Numerous foods continue to enjoy consumer preference in specific regions or countries, and in France cheese can be considered as a typical example.

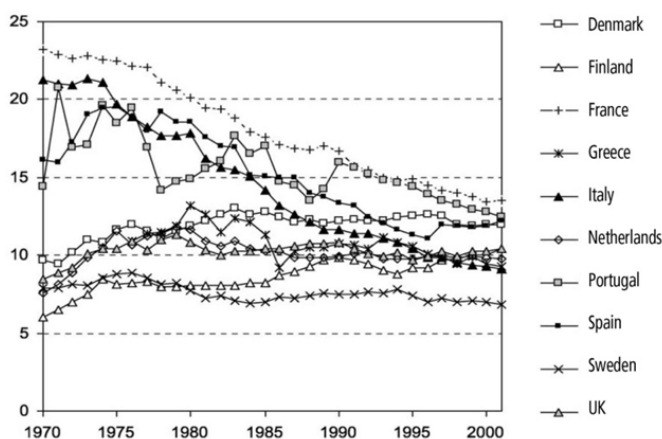
Figure 2. Some examples of common nutritional trends in Europe
Changing ratio of animal-origin calories and lipids to total calorie ration,
and of alcohol, fruit and vegetable quantities to food availability in Europe



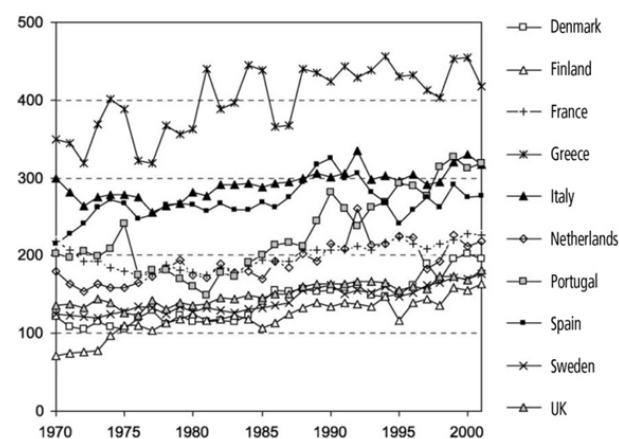
Proportion of animal-origin calories in total energy intake of European diets (%)*
(Source : FAO-Stat)



Percentage of lipids in total energy intake in European countries**
(Source : WHO-HFA (EU) data bank, 2004)



Percentage of pure alcohol availability (litres/person aged over 15 /year) in European countries**
(Source : WHO-HFA (EU) data bank, 2004)



Average availability of fruits and vegetables (kg/person/year) in European countries**
(Source : WHO-HFA (EU) data bank, 2004)

Sources : * Combris Pierre, Le poids des contraintes économiques dans les choix alimentaires, Cahiers de Nutrition et de Diététique, Vol 41, N°5, 2006, 279-284

** E.A. van der Wilka, J. Jansen, Lifestyle-related risks: are trends in Europe converging? Public Health (2005) 119, 55-66

These four examples reveal some convergence between different European diets, when comparisons are confined to the nutritional characteristics of these diets.

A comparison of changing trends in the food supply of each country shows an increase in diversity offered to consumers. Diets found in southern European countries (including France) are more diverse than those in northern European countries.

Data provided by the EPIC study (European Prospective Investigation into Cancer and nutrition), conducted in 10 European countries, allowed the dietary habits of 35,955 men and women aged between 35 and 74 to be statistically analysed. This study made the distinction between the Greek and Italian diets which are high in fruit and vegetables (other than potatoes), and the Dutch and German diets with high quantities of potatoes, processed and refined animal products. The French make more varied food choices that lie between the two.

The joint impact of food availability and diet diversification within these countries are evidence of an important trend regarding food supply, aided by processing and cooking techniques which spread from one country to the next (even from afar: Asian cuisine, wine-making techniques, etc.).

Box 2. Specificities of diet in French overseas territories

Several quantitative surveys carried out over the past decade in French overseas territories, have dedicated a large section to nutrition, which allows comparisons to be made between these findings and surveys undertaken in metropolitan France, such as the National Nutrition Health Survey (ENNS, 2006),

In these overseas territories, the main characteristic of diet is lesser variety in the products consumed, due to the fact that most of these territories are islands and, notably, people consume twice as much fish as in metropolitan France. Distance generates high import costs for dairy and meat products, which are in any case not traditionally common in their diets. On the other hand, starchy foods and cereals including rice are common staples.

Nutritional transitions are underway in these areas, and a "westernization" of dietary practices can be observed among the younger generations, leading to increased obesity, particularly in women (female obesity varies from 26% in Martinique, to 32% in Mayotte, and 40% in Polynesia, compared to 18% in metropolitan France). The under-privileged suffer most from obesity. In the poorer territories like Mayotte, female obesity and infant malnutrition exist side-by-side.

1.3. Changing trends in food supply

Table 1 presents changing consumption trends in France between 1960 and 2006 for certain foods. Basically, certain traditional foods are dwindling, such as bread, in contrast to highly processed products which are increasingly popular, such as manufactured pastries and cakes, chilled dairy desserts, ready-made soups and convenience foods.

Table 1. Increase or drop in volumes consumed over the period 1960-2006

	Drop in volume or stable	Increase in volume
Bread and cereals	Bread, pasta	Rice, corn flakes, couscous, bakery pastries, manufactured pastries, biscuits
Meats	Horsemeat, offal, veal, beef	Rabbit, game
Fats	Butter, corn oil, refined oils, margarine	
Grocery staples	Sugar, flour	Jam, fruit preserves, chocolate bars, sweets, coffee, tea, honey
Dairy products	Concentrated and powdered milk	Cheese, yoghurts, chilled dairy desserts
Fruit and vegetables	Pulses, potatoes	Fresh vegetables, frozen vegetables, canned and dried vegetables, fresh fruits
Convenience foods		Soups (packets, tinned, frozen), convenience foods containing meat, fish, seafood
Drinks	Table wine, cider, beer, port, sweet wines, vermouth	Vineyard-label wine, champagne, sparkling wine, whisky, cognac, rum, fruit juices, bottled water and soft drinks

Source : Herpin & Verger, 2008

These observations hold true for individual consumption, as shown by the INCA 1999 and 2007 surveys. These confirm in particular that consumption is dropping for meat, eggs and dairy products, starch-rich products (bread, biscuits, potatoes), sweets and cakes, but that consumption is increasing for chocolate, ice-cream, fruit and vegetables, and rice.

Back in 1960, processed food products represented 80% of food expenditure by French households. This figure reached 84% in 2000 and has remained stable since (83% in 2006). However, while the proportion of manufactured products in

the food budget has remained stable, volume has increased and so has the degree of processing. The volume of chilled dairy products has multiplied by 25 in 40 years, illustrating the fact that basic foods are being replaced by more elaborate products.

Ready-made meals and ready-to-use preparations considerably transformed dietary habits at the end of the 20th century. This long-term trend towards manufactured products, brought about by a host of technological innovations, responds to and creates demand, to the detriment of basic foodstuffs. Since ready-made meals and convenience foods save time, this is an advantage when a salary more than covers the extra cost of these products compared with the cost of home-cooked meals. Also, the increasing variety of convenience foods on the market allows consumers to eat a varied diet without having to invest time in learning how to cook.

For example, consumption of ready-prepared fish and seafood increased by 5 between 1960 and 2000, and that of canned and frozen vegetables and potatoes increased by 4 (Table 2). While consumption of fresh fruit and vegetables has remained relatively stable over the past few decades, that of processed fruit and vegetables is rising. Data produced by INSEE (National Institute of Statistics and Economic Studies) do not however have an entry for "convenience foods" because this category was negligible back in 1960. Creating an entry would allow the different degrees of food processing to be tracked, up to "ready-to-eat".

Table 2. Consumer index of convenience foods (base 100 in 1995)

Ready-to-eat products	1960	1995	2000
Ready-prepared fish and seafood	19	100	104.6
Canned vegetables and ready-prepared potatoes	26.9	100	108.9

Source: INSEE national statistics

The INCA surveys indicate that this trend is likely to continue, and will be boosted by the younger age groups. A considerable increase in adolescent consumption of ready-to-eat meals, such as snacks, sandwiches or hamburgers, occurred between 1999 and 2007.

It should be noted that these surveys also reveal a drop in energy intake for children between 3 and 14 years, and a stable energy intake for adolescents and adults. While use of processed foods or convenience foods is rising, this is not necessarily associated with a rise in energy intake. On the other hand, the nutritional quality of diet is probably affected, since convenience foods and processed foods often focus more on palatability rather than on nutritional composition. Chapter 3 will demonstrate the importance of the sensory perception of foods and how this affects dietary behaviour.

Food purchasing in supermarkets

Increased processing of manufactured foods is a trend that has gone hand in hand with a move towards supermarket distribution. Households now spend 70% of their food budget in supermarkets, of which 15% in hard-discount stores. This concentration of food supply has taken place in under 40 years. In 1970, superstores held less than 5% of market share for food products, compared to one third at the end of the 20th century. In contrast, market share for local food shops dropped from 20% to under 10%, but bakeries are holding their own.

Two factors have an impact on supermarket purchasing: place of residence and age group. People who live in town centres buy more frequently in markets and local shops. People who live in towns where superstores are more common, shop there more often. In rural areas, the very presence of a superstore boosts purchases in supermarkets, as well as in small and medium-sized food shops. The age of the person responsible for shopping also affects where they shop: younger people tend to shop in self-service outlets, older people prefer local shops which often offer services. The relatively recent development and spread of supermarkets in France (1957 for the first supermarket, 1963 for the first superstore) probably helps to explain why the oldest age groups shop there less frequently.

Lastly, given the trends in food consumption, but above all due to urban sprawl and land management issues, home-grown produce is currently marginal, even if one quarter of households possesses a vegetable garden. Farmers are unsurprisingly the most self-sufficient, producing the equivalent of about 20% of food expenditure. Figures for retirees (6%) and manual workers (3%) are fairly significant.

1.4. Economic and social disparities regarding diet

Mass industrialization of the food chain has contributed to a drop in food prices, which could have resulted in more uniform diets and eating practices. Considerable economic and social disparities do however subsist, related to revenue levels or supply outlets (which depend on place of residence), but also to the persisting social differences in the approach to food.

The overall improvement in standard of living in France between 1950 and 2000 has led to a lower proportion of household budget being spent on food: this dropped from 25% in 1960 to 15% in 2007 (INSEE). However, these average figures conceal high inequalities since food expenditure can represent as much as 50% of the budgets of the poorest households.

Food sociologists, from an analysis of food consumption surveys undertaken by INSEE between 1967 and 19941, have shown that there have been no major modifications in the social hierarchy of foods. These findings have been confirmed by more recent data (Health Nutrition Barometer 2008, Family budget survey 2006). While there are fewer differences between social categories for the consumption of certain products, for others they are marked. The more wealthy and/or educated classes eat less meat compared to the lower classes who eat more meat compared to the average, and this can be largely attributed to pork consumption. Consumption of pork is currently a marker of social standing. Also, senior executives eat more fruit and vegetables, manual workers eat less. The most recent Health Nutrition Barometer has thus revealed that the wealthier and more educated classes have a more diverse diet, comply more readily with PNNS guidelines.

The importance of social class can be observed again in attitudes to nutrition. The wealthier social classes are more sensitive than the lower classes to dietary recommendations published by the medical community. This is particularly true for highly-educated women who adhere more closely to these recommendations. They are more likely to breastfeed their children and to seek advice from their paediatrician, compared to lesser-educated women who usually refer to their mothers. Generally speaking, the higher the education level, the better compliance is with nutritional recommendations: the percentage of people who are aware of, and who implement PNNS guidelines rises with education level (Health Nutrition Barometer 2008). These differences in attitudes and practices may partly explain why the obesity rate is inversely correlated to social status, in France as in most other developed countries. The effect of social class is reinforced by gender: the differences in obesity rates between the lower and upper classes are more pronounced in women compared to men.

Table 3. Studies having modelled *a posteriori* dietary typologies, using French dietary and socio-economic data: characteristics, dietary profiles and correlations updated to account for health risk factors

Study, population	Typology	Results
European fibre-calcium intervention trial 277 men and 165 women with no adenomas before colonoscopy	3 male patterns : "Mediterranean", "Sweets and snacks", "Fats and Protein" 3 female patterns : "Mediterranean", "Western", "Snacks"	No relation between pattern and recurrence of adenomas in men "Mediterranean" pattern is negatively associated with recurrence of adenomas in women
E3N (Epidemiological prospective study in women subscribing to Ministry of Education health coverage) – study of adenomas and cancer Women born 1925-1950. 516 adenomas vs. 4804 without polyps; 172 cancers vs. 67,312 without cancer	4 patterns : - "Healthy" : vegetables, fruit, yoghurt, seafood, olive oil - "Western" : potatoes, pizza and savoury tarts, sweets, cakes, cheese, cereals, cooked meats, eggs, butter, alcoholic drinks - "Drinkers" : sandwiches, snacks, cooked meats, alcoholic drinks - "Meat eaters" : meat, poultry, margarine	The "Western" pattern is positively associated with adenoma risk The "Drinkers" pattern is positively associated with adenoma risk The "Meat eaters" pattern is positively associated with colorectal cancer risk
E3N - link with asthma Women born 1925-1950. 2634 have suffered from asthma, 1063 currently have asthma, 206 have frequent attacks (>1/week). 628 women became asthmatic between 1993 and 2003	3 patterns : - "Prudent" : fruit and vegetables - "Western" : pizza, savoury tarts, desserts, red meat - "Nuts and wine"	After adjustment, no association between 3 patterns and asthma incidence (past or current) The "Western" pattern is associated with increased risk of frequent asthma attack The "Nuts and wine" pattern is associated with a drop in frequent asthma attacks
SU.VI.MAX (Antioxidant vitamin and mineral supplements study) 5194 men and women between 45 and 60 yrs old	4 patterns : - "Alcohol and meat products" - "Prudent diet" - "Convenience foods" - "Starch, sauces and vegetables"	"Alcohol and meat products" pattern is associated with low education level, smoking and overweight (+ abdominal obesity in women, and hyperlipidaemia or hypertension treatment in men) "Prudent diet" pattern is positively associated with age, with high education level and non-smoking "Convenience foods" pattern is inversely associated with age and high education level, and with living alone and in rural areas (in men) "Starch, sauces and vegetables" pattern is associated with high education level and living in towns (in men)
INCA Survey 1998-1999 National study of individual dietary habits 748 children (3-11 yrs old)	2 patterns common to 2 age groups (3-6 yrs and 7-11 yrs) - "Snacking and sedentary", and "Varied food and physically active" 1 pattern specific to children of 7-11 yrs : - "Big eaters at main meals"	"Snacking and sedentary" is positively associated with overweight In the younger group, "Varied food and physically active" is inversely correlated with overweight In the older group, "Big eaters at main meals" is positively correlated with overweight
MONICA (Monitoring trends and determinants in cardio-vascular diseases) Representative sample of 976 men aged 45-64 yrs	2 patterns : - "Western" : sugar and sweets, cereals, butter, added fats, eggs, potatoes, cheese - "Prudent": fruit, vegetables, olive oil, fish, and less fatty meat and potatoes	Association between "Prudent" pattern and region, education level, revenue, leisure physical activity, and smoking status Interaction between region and education level Interaction between region and revenue
3C (3 Cities), cross-sectional study of population ≥65 yrs in Bordeaux, Dijon, Montpellier 1724 subjects in Bordeaux (2001-2002)	"Healthy" profile : fish in men, fruit and vegetables in women Other profiles in men : "Small eaters", "Biscuits and snacking", "Healthy", "Cooked meats, meat, alcohol", "Pasta" Other profiles in women : "Small eaters", "Biscuits and snacking", "Healthy", "Cooked meats and starchy foods", "Pizza and sandwich"	"Healthy" is associated with better overall cognitive performance in men and women, and with more symptoms of depression in women. The "Pasta" profile in men is associated with more symptoms of depression and poorer state of health, compared to "Healthy". Women with a "Biscuits and snacking" profile perceive their state of health more negatively than the "Healthy" profile.

Table interpretation. Taking the example of the first study ("European fibre-calcium intervention trial"), a sample of healthy patients was questioned on their dietary habits. Using the collected data, the authors distinguished 3 dietary profiles for men and for women, some of whom were thereafter diagnosed with an adenoma. Possible correlations between diet and incidence of illness were then identified.

Chapter 2. Dietary behaviours and health

The connection between nutrient or food consumption and health has been established by a great deal of experimental research and epidemiological studies. However, it is difficult in practice to isolate the role of a specific nutrient or food. Also, *in vivo* nutrient absorption, use and metabolism are interdependent (for example, absorption of iron is improved by the simultaneous absorption of vitamin C, and ingesting certain foods or nutrients is compensated by suppressing others). Lastly, certain socio-economic factors determine diet. All these points call for an overall evaluation of dietary behaviours. The relationships between individual foods or nutrients, and health, are therefore not studied in this expertise, which aims to examine diet as a whole using dietary typologies (even though knowledge about the correlations between individual foods and health is essential for elaborating these typologies). Investigations have taken three directions: the first explores food combinations – fruit, vegetables and fish for example – by studying food consumption within a population; the second evaluates the extent to which food consumption complies with guidelines, particularly regarding health; the third studies certain specific practices, such as fragmented meals or portion size...

2.1. Observation of dietary typologies

The first methodological task consisted of pinpointing the “spontaneous” food combinations revealed by general population surveys. Statistical methods are used to measure the correlations between consumption levels of different food groups, and to identify *a posteriori* consumption typologies, which thereafter lead to an evaluation of relationships with health.

Typology characteristics vary according to data and the individuals surveyed (age, ethnic group, social class...). Two patterns crop up in most of the data bases in OECD countries. The first pattern reveals high consumption of low-fat dairy products, fruit, legumes, fish and water, and is qualified as the “prudent pattern” or the “healthy pattern” due to the fact that it is usually more conducive to good health. It is also called the Mediterranean diet since it is similar to the traditional dietary pattern found in southern Europe. The second pattern reveals high consumption of red meat, potatoes, margarine, sauces, soft drinks, and is called the “western pattern” or “standard American diet”, certain components of which are correlated more often with poor health (risk factors for cardiovascular disease, cancers, obesity).

These *a posteriori* typologies have been used in the United States to evaluate the relationships between dietary (or “socio-dietary”) profiles and health indicators. Reviews of methodology have revealed the limitations of these typologies for etiological research. Few have been published in France: some have aimed to describe consumption according to certain determinants (the socio-economic determinants of these dietary typologies are important). A few etiological studies have matched up dietary typologies and health markers: breast cancer, colorectal cancer and adenomas, asthma, cognition and mood (Table 3).

2.2. Diet in relation to nutritional quality index

A second type of method aimed to evaluate the extent to which food consumption matched “health”, “regional”, and “cultural” considerations. These methods define indicators for food quality and food variety, or scores for measuring compliance with nutritional guidelines. These scores are defined from current knowledge or scientific hypotheses regarding nutrition (*a priori* hypotheses or knowledge-based hypotheses). The parameters used in these scores can be individual foods, groups of foods, nutrients, or even other indicators regarding diet variety, dietary supplements, or physical exercise. Certain components are systematically used in elaborating these scores: lipid consumption in various forms (total lipids, saturated or monounsaturated lipids, cholesterol) or fruit and vegetable consumption.

A recent review of the literature has revealed about twenty scores, many of which are derived from the four main scores used internationally (Table 4). These typologies differentiate dietary habits according to dietary guidelines. A high score is the sign that guidelines are properly applied, while a low score means that dietary behaviour is deemed harmful.

Table 4. Main types of score

Score	Components	Values	Score calculation
Diet Quality Index (DQI)	American guidelines (USDA) 9 components = foods and nutrients Total fats, Saturated fats, Cholesterol, Fruit, Vegetables, Seeds and pulses, Proteins, Sodium, Calcium	0 (max) 16 (min)	3 rates : 0,1, 2 points 0 reached 2 not reached 1 intermediate
Mediterranean Diet Score (MDS)	Adoption of traditional Mediterranean diet 8 components = foods and nutrients Seeds, Vegetables, Fruits and nuts, Milk and dairy products, Meat and meat products, Pulses, Alcohol, Ratio of monounsaturated/saturated fats. Fish eaten as well	0 (min) 8 (max) then 9 (max)	1 point per component
Healthy Eating Index (HEI)	USDA guidelines Dietary Guidelines for Americans (1990) 10 components = foods, nutrients, variety Fruit, Vegetables, Seeds, Milk, Total fats (%) Saturated fats (%), Cholesterol, Sodium, Variety USDA 2005 : Dietary Guidelines for Americans (2008) Updated to include an "empty calorie" component	0 (min) 100 (max)	10 points per component In proportion to full reach set at 10
Healthful Diet Indicator (HDI)	WHO guidelines 9 components = foods and nutrients Saturated fats, Polyunsaturated fats, Proteins Complex carbohydrates, Fibre, Fruit, Vegetables, Nuts and pulses, Mono and disaccharides, Cholesterol	0 (min) 9 (max)	1 point per component

Table interpretation. Taking the example of the Diet Quality Index (developed in 2000), this score indicates food quality based on *American Heart Association* and *National Research Council* guidelines. These guidelines are inspired by the "Prudent" diet profile, and its components include saturated fatty acid intake (in % of energy intake), cholesterol, consumption of meat, olive oil, fish, cereals, fruit and vegetables.

In France, three types of score are based on French nutritional guidelines.

- CREDOC (Research centre for studies of standards of living) has developed a healthy diet index (HDI) using data drawn from the INCA 1 study. The HDI combines several parameters, i.e. dietary balance, moderation, variety and meal periodicity. The INCA sample revealed that the average HDI is identical for both sexes. Stable at first, it then increases with age from about 55 years. The HDI is higher in executives than in unemployed people, manual workers and employees. It decreases as body mass index (BMI) rises: the obese have a much lower HDI compared to people with a BMI under 25.
- Two scores have been developed to reflect the PNNS guidelines. The PNNS guidelines score (PNNS-GS) is based on 9 parameters relative to diet and physical exercise. The French score of indicators of PNNS objectives (FSIPO) is based on some ten components relative to food consumption, intake of certain nutrients, and a number of biomarkers, (blood pressure, cholesterol count, body mass index) and physical exercise. These two scores were applied to the data gathered in the SU.VI.MAX study.

The results of the SU.VI.MAX study show that a high PNNS-GS score is associated with lower intake of energy, cholesterol, added simple sugars, and higher intake of certain nutrients and micronutrients (fibre, proteins, β -carotene, vitamin B9, vitamin C, calcium, potassium, magnesium, phosphorus and iron). People with high scores were older, enjoyed higher socio-economic status, were more often non-smokers, and were more likely to have a normal body mass (BMI <25).

The FSIPO correlated the level of compliance between actual consumption of nutrients/micronutrients and PNNS guidelines, with the occurrence of common metabolic syndrome disorders (disorders caused by overweight). The risk of contracting a chronic illness was reduced by 36% (including death, cancer, coronary disease) in people who applied the PNNS guidelines on nutrients and micronutrients more carefully.

Other scores have been devised using international nutritional guidelines (Table 5). The SU.VI.MAX study, for example, is based on a French cohort to whom the American HEI score has been applied. Food intake was recorded over 24-hour periods for a sample of 5000 men and women, then correlated with the risk factors causing cardiovascular disease. For this population, a good HEI score was associated with age, couple relationships, high education, high physical exercise and the fact of never having smoked. In men alone, a high HEI score was associated with a lower BMI and lower blood pressure.

Table 5. Examples of French epidemiological studies exploring the relationships between health indicators and diet typologies

Study, population	Scores used	Main results
Val-de-Marne 837 adults living in Val-de-Marne area	Several scores tested : food variety, variety-pace, diet quality	63% of respondents had diets which conformed hardly or not at all to guidelines 90% of respondents had maximum scores for food variety
SU.VI.MAX 5000 respondents (women:35-60 yrs, Men:45-60 yrs)	HEI (American nutritional guidelines)	Scores identical to those observed in Americans. Guidelines for total fats, saturated fats and cholesterol are rarely achieved. Scores are higher for those in couple relationships, who are older, more active, have never smoked. In men alone, score is associated with BMI and blood pressure.
3C (3 cities) 1410 adults over 65 yrs	Mediterranean score	Inverse association between one-point increase in score and cognitive decline No association found with incidence of dementia
Languedoc 964 representative respondents in Hérault area	Mediterranean score : Med-DQI	In men, higher Med-DQIs are associated with older age, lower education, overweight, manual worker, living in rural area. In women, results are similar, except that respondents from more privileged classes also have higher scores.
INCA 1 1440 respondents 15 yrs and older	HDI	HDI increases with age, is associated with socio-economic class. It decreases with BMI.
SU.VI.MAX 4976 respondents (women:35-60 yrs, men:45-60 yrs)	FSIPO	In men, the FSIPO is negatively associated with risk of chronic illness (including death, cancer and cardiovascular disease).
SU.VI.MAX 5500 respondents (women:35-60 yrs, Men:45-60 yrs)	PNNS-GS	High PNNS-GS is associated with lower intakes of energy, cholesterol, added simple sugars, and with higher intakes of certain nutrients or micro-nutrients (fibre, proteins, β -carotene, vitamin B9, vitamin C, calcium, potassium, magnesium, phosphorus and iron), and with higher β -carotene and vitamin C values. Older respondents, from higher socio-economic classes, non-smokers, and with normal BMI have a higher PNNS-GS.

Table interpretation. Taking the example of the “Val-de-Marne” study, the food intake of 837 adults was evaluated using a questionnaire tracing dietary history. A dietary quality index, based on USDA guidelines, was designed as well as two other scores relative to food variety (number of different foods consumed) and to variety-pace (number of different foods consumed over a given time). Within this population, 63% of respondents had scores of 0 or 1 (diet which conformed barely or not at all to guidelines), while almost 90% respondents had “good” scores for food variety. Food variety is not therefore a guarantee of nutritional quality.

The scores presented in Table 5 associate stricter compliance to nutritional guidelines with weight control, with lower BMI increase and with better cognitive performance... These studies also demonstrate that food variety does not guarantee nutritional quality (Val-de-Marne study).

2.3. Investigating dietary practices

Some studies investigate specific dietary habits in the general population. Several clear trends have particularly drawn the attention of the health authorities or the scientific community. In North America, studies have focused on snacking between meals, meals eaten outside the home, size of food portions, increased consumption of soft drinks (flavoured mineral water, colas, fruit juices, nectars and cordials).

In France, several recent studies have addressed the issue of fragmented meals (INCA, E3C..., see Table 5). The dietary profile of “snackers” means a high daily number of snacks (these fragmented meals can lead to certain “proper” meals such as breakfast being skipped). Snacks are often eaten outside the home, in a restaurant.

Binge-drinking is also a matter of concern, since this practice is becoming more frequent among young people in France. Studies have shown that in adults, binge-drinking is associated with an excess death rate from cardiovascular disease.

Consumption of refreshing soft drinks which cover a wide group of products (soft, sweetened and flavoured drinks, colas, fruit juices, nectars and cordials) has rocketed over the past few decades. The INCA 2 study on food consumption, undertaken in 2006-2007 by AFSSA (French Agency for Health Security of Food), showed that young people consume soft drinks more frequently. Over 90% of children aged 3-17 (boys and girls) and boys aged 18-34 reported having

consumed these products at least once a week, with an average consumption of 200-250 ml per day. In the 3-17 age group, soft drinks account for 21-23% of water intake, whereas tap or bottled water represents 52-56%. Yet, research has shown that, for the same sugar content, energy regulation is less efficient for the sugar in soft drinks than for solid sugars. The sugar content of these drinks (saccharose, fructose, cordials containing various proportions of glucose and fructose) is the subject of scientific debate. In the United States, parallel curves have been observed between increased consumption of fructose-rich drinks (these are common in the United States but regulated in Europe by quotas) and prevalence of obesity. These findings do not necessarily prove that fructose intake is responsible for increasing obesity in the United States, but they have sparked a debate on its impact on health.

Box 3. Typologies according to food intake strategies

Other typologies highlight certain food intake strategies. Two typologies are described below.

INPES has built a typology of French diets based on combinations of foods and practices, reported by a sample of the population. This typology distinguishes:

- "Hedonists" (14% of the French population) associate eating with an enjoyable tasting experience. This category is mainly composed of men between 30-39 years old, who consume more alcoholic drinks, more ready-made meals, more cooked meats and bread. Their consumption of fruit and vegetables is low.
- "Rational eaters" (14%) for whom eating is necessary for survival. This profile is more common in young men who report having eaten meat, cooked meats and ready-made meals more frequently than the other categories over the past two weeks.
- "Sensible eaters" (18%) who are more likely to consume average quantities, with no specific overeating. This category is primarily made up of married women with children, who compose meals according to household routine, meal preparation time, budget and health considerations.
- "Practical eaters" (10%) are young (18 to 39 years old) and typical of the Greater Paris area, with a poorly balanced diet, and who report eating ready-to-eat pasta and packet cereals more often than the other categories.
- "Traditional eaters" (12%) are more likely than other categories to have a diet composed of potatoes, wine, bread, cooked meats and meat. They are over 60 years old and often live in small towns.
- "Diet-conscious eaters" (17%) are the most assiduous in following PNNS guidelines. They report eating fish, fruit and vegetables more than the other categories. They are more likely to be women over 50 years old, and attentive to health considerations when composing their meals.
- "Small eaters" (15%) have low intake of all the foods included in this study.

The **CREDOC** regularly defines new typologies in order to keep track of changes in dietary behaviours. The consumer strategy typology was built using statistics from 2004, and this revealed some new groups of consumers who were attentive to the health implications of diet (Figure 3). "Nutrition adepts" (21% of adults) aim for a healthy and balanced diet based on fresh foods, without neglecting their taste buds, and "Bathroom-scale freaks" (5%), who nonetheless have their contradictions, since they consume low-calorie products, but indulge more than average in cakes and pastries. The "Innovators" (7% of adults) is another new typology: these are young adults who are attracted to new products and, although aware of dietary risks, they cannot resist trying them.

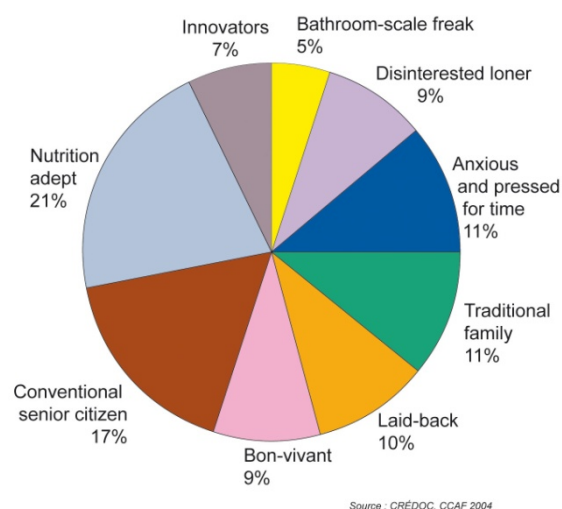


Figure 3. Typology of dietary behaviours.

2.4. Limitations regarding study interpretation

Research into the long-term outcomes of dietary habits on health is mostly based on the above-mentioned epidemiological studies, which endeavour to match changing dietary practices with health indicators. Diet typologies allow the relationships between overall diet and health to be explored. Thus, research quality depends on how precisely diet typologies can be identified. However, a certain degree of subjectivity is bound to be involved in building these typologies (interpretation is investigator-dependent), especially as regards selection of source data-sets, and how data

are grouped into dietary variables and subsequently interpreted. This subjectivity is evident in the terms chosen to qualify diet types: Prudent, Western, Mediterranean..., which echo the personal hypotheses of the investigator.

Also, result interpretation is limited by the degree of expertise in gathering dietary data for population-wide surveys, and by the length of follow-up which must be sufficiently great in order to obtain satisfactory statistical power regarding outcome. For food consumption, the degree of variability explained by typologies is relatively low in most studies, between 5% and 30%.

Lastly, the variety of dietary behaviours and their constant changes, as well as the complex nature of the factors which cause them, make typology identification a difficult task. Over and above the nutritional variables, interpretation of how diet affects health can be blurred by social, economic and psychological factors.

In spite of these limits, several studies have evaluated the reproducibility of *a posteriori* methods and the validity of the identified diet typologies, and have shown that results are reasonably stable.

In order to identify the characteristics and particularities of a specific country, it is simpler and more precise to compare consumption of different foods. A number of European studies have thus compared the main food groups, but few have gone as far as to compare diet typologies, since this entails the use of a common methodology, particularly when gathering dietary data. However, the "Prudent" and "Western" types appear in most of the studies, suggesting that these profiles are recurrent in both French and foreign data sets. There is not enough data to properly address the specific connections between the "French" diet and health.

2.5. Changes in diet and prevalence of major health disorders

Given the changes in dietary practices and variations in mortality rates for certain health disorders, it appears legitimate to query their possible links. To assess this eventuality, epidemiologists match up changes in dietary practices with health indicators, such as incidence rates of a certain illness within a population. But annual incidence of most chronic illnesses within the general population is relatively low, especially in young people who are the most likely to adopt new dietary behaviours. Since incidence is rare, this directly affects reliability, or can even render detection of causal relations impossible. Low variations in food intake over time are also a limitation. Lastly, changes in health indicators are affected by multiple factors, such as improved screening or prevention practices, and by new therapies. For example, the MONICA project showed that the drop in coronary disease mortality observed between 1985 and 1995 could be put down in 70% of cases to improved therapy applied at the acute stage of infarct, and in 30% of cases to beneficial changes regarding risk factors. All these factors render interpretation of correlations, between dietary changes and health indicators at the population level, a delicate task.

Cancers and cardiovascular disease remain the two main causes of death in France and in most industrialized countries, accounting for two thirds of deaths annually. Among risk factors for health, obesity probably represents the least encouraging trend over the past 40 years. These three major pathologies – cancers, cardiovascular disease and obesity – are impacted by well-known nutritional determinants: excessive salt and saturated fatty acids, insufficient fruit and vegetables, etc. Hence, public health campaigns have recently focused on them. Having said this, the combination of small changes in nutritional determinants and major progress in medical diagnoses affecting health indicators, means that correlations can be revealed by analysis, but not causal inference.

Case of cancers

Over the past 25 years (1980-2005), cancer incidence in France (Figure 4) has considerably increased, but mortality has dropped. Cancer incidence, all types together, has practically doubled in men (+93%) and has greatly increased in women (+84%). These increases are mainly connected to improvements in screening techniques, to population growth, and population aging. Disparities between mortality and incidence can be explained by diverging trends for types of cancer : incidence of the more aggressive tumours (oesophagus, stomach, upper respiratory and upper digestive tracts) has fallen over the past few years in men due to a drop in alcohol and tobacco consumption, while cancers with a more favourable prognosis or diagnosed early (prostate, breast) have increased in incidence.

In the report on cancer surveillance in France, the InVS (Institute for Public Health Surveillance) points to a possible correlation between falling rates for liver cancer and the upper digestive tract, and the considerable drop in alcohol consumption in France, given the well-known strong connection between neoplastic disease location and excessive consumption of alcohol.

Figure 4. Evolution in mortality from cancer in France since 1950



Case of mortality from coronary disease

Between 1985 and 1995, the incidence of heart attack, and the deaths that occur during the regression phase of acute episodes, dropped in most western countries, contributing to the considerable drop in overall coronary mortality. In France, the number of heart attacks decreased on average by 24% in men, and 33% in women, and reached 45% for coronary deaths in both sexes. These trends can be explained in two-thirds of cases by improvements in therapy, and in one-third of cases by improvements in cardiovascular risk factors (less smoking, less alcohol). At the end of the 1990s, the drop in incidence stabilised in both sexes in France, while hospital mortality continued to drop by 4% per year. Total mortality from coronary disease (in hospital and outside) dropped in men and stabilized in women. These improvements in cardiovascular preventive therapy over the past 30 years mean that interpretation of correlations, between changing diets and cardiovascular illness rates, is particularly difficult.

Obesity

Obesity and its metabolic complications (diabetes and dyslipidaemia), its vascular complications (hypertension, heart attack), and its osteoarticular and neoplastic complications, are a major public health problem.

In the OBEPI survey, reported obesity prevalence in France increased from 8.5% in 1997 to 14.5% in 2009, i.e. an annual increase of 0.5%. This increase applies to men and women alike, in all age groups, irrespective of town size and geographical location of residence. This increase affects most professional categories, but seems slightly lower or stable in shopkeepers and artisans, senior executives and the more wealthy households. Massive obesity prevalence (BMI >30) increased from 0.3% in 1997 to 1.1% in 2009.

European data is rare and disparate. Table 6 tends to show that obesity prevalence in France is among the lowest in developed countries for adults, but not for children.

In North America, obesity was stable at around 15% up until the end of the 1960s, (figures for France are currently comparable), then increased to reach 35% of the population at the beginning of the 2000s. Since then, obesity prevalence seems to have stabilized. In France, measured obesity in children also remained stable between 1999 and 2007.

The fact that obesity prevalence has recently stabilised should not incur underestimation of a possible future deterioration in the population's state of health. Indeed, a time lag has been observed between the appearance of obesity and the onset of associated complications (diabetes, hypertension, etc.), which means that certain health indicators are likely to get worse, especially in North America. Hence, models forecasting life expectancies for the American population foresee that expected gains from other risk factors (less smoking), will be attenuated by the effects of obesity.

Table 6. Aggregate data for obesity and diet by country and by year

Country	Obese adults (prevalence in %)		Overweight adults but not obese (prevalence in %)		Overweight or obese children 7-11 yrs (prevalence in %)	Calorie count (kCal/pers/day)	% calories from fats	Calorie count (kCal/pers /day)	% calories from fats
Year	1980	2006	1980	2006	2000	1980		2005	
Australia	8.3	18.7	28.0	34.4	26.2	3 051	33	3 084	39.1
Canada	13.8	23.1	35.4	36.1	25.1	2 946	37	3 552	37.1
France	6.5	11.5	26.9	31.5	19.0	3 376	39	3 603	40.7
Germany	-	13.6	-	36.0	16.0	3 338	37	3 510	35.9
Greece	-	16.4	-	41.3	31.0	3 216	35	3 700	35.7
Italy	7.1	10.2	27.4	35.0	36.0	3 589	32	3 685	38.4
Japan	2.0	3.4	15.6	21.8	17.8	2 720	23	2 743	28.0
Netherlands	5.1	11.3	28.2	35.2	12.0	3 071	38	3 240	38.2
Norway	-	9.0	-	34.0	18.5	3 350	40	3 478	37.4
UK	7.0	24.0	29.0	38.0	20.0	3 159	39	3 421	36.5
USA	15.0	34.3	32.4	33.0	15.2	3 155	36	3 855	39.4

Figures for obesity presented here are drawn from OECD data. For France, in 2006 the OECD reported obesity prevalence measured in 2002-2003 by the INSEE Health survey, based on weight and height.

Sources : Data provided by OECD, FAO and others. See Etilé F., 2010, "Food Consumption and Health". in J. Lusk, J. Roosen and J. Shogren (Eds.), *Oxford Handbook of the Economics of Food and Agricultural Policy*. Oxford, UK: Oxford University Press, in press.

Obesity is generally the result of an imbalance between energy intake and energy expenditure. For some people, the main cause is a change in lifestyle with increased motorization, urban living, sedentary jobs, and the development of sedentary leisure activities for children. Some authors hold, using statistical models formulated from survey data on energy intake, that the increase in energy intake between 1970 and 2000 can be held largely responsible for the increase in weight of North Americans.

These issues, which fall outside the realm of this expertise, have been addressed by two collective expertises published by Inserm, one on physical exercise, the other on adolescent obesity. They focus on the drop in physical exercise and the increase in sedentary behaviour due to changing leisure activities (television, video games, internet) and the ubiquity of computers in the workplace. Numerous articles examine the connection between sedentary behaviour and body fat, and the connection between sedentary behaviour and television viewing.

Yet another metabolic disorder connected with diet: malnutrition

Malnutrition in the elderly is considered as a public health problem by many geriatric specialists. Between 4% and 10% of elderly people living at home suffer from denutrition (depending on the studies, age groups and markers used), between 30% and 75% of those in retirement homes, and 50% of elderly people hospitalized in an emergency (in 40% of cases for malnutrition-induced complications). Malnutrition has many detrimental effects, and can also cause illness. For example, osteoporosis is a result of reduced bone density which makes bone structure fragile. In Europe, for upper hip fractures alone, costs are estimated at over 9€ billion. It is however an established fact that prevention of physiological and functional damage to bone structure relies on food intake. Also, sarcopenia, or loss of muscle mass, is a normal physiological aging phenomenon affecting about 40% of people between the ages of 20 and 70 (attributed to a negative protein balance). In the elderly, sarcopenia is accentuated by a sedentary lifestyle, less appetite for animal protein, and aging of the signalling pathway for ingested proteins. After a certain point, sarcopenia reduces mobility, entails dizziness and falls, which all lead to loss of independence.

New research themes

New hypotheses are coming to light, particularly the developmental origins of health and illness hypothesis which has been studied for the past 15 years. Based on epidemiological studies in humans, and experimental data in animals, this hypothesis suggests that infinitesimal changes in the environment of the foetus or new-born can affect how good the person is in coping with new environments later on in life. Epigenetic mechanisms (modification of gene expression without impairing DNA sequence) could even, in certain cases, transmit this susceptibility to later generations, via modifications in genome expression not affecting genetic inheritance. Stress and pollution are known to alter the enzymes involved in these epigenetic modifications. Recent research tends to show that genome programming early in

life can have an impact on a wide variety of illnesses (metabolic illness, cancer, neurodegenerative disease), on behaviour, on reproduction, on the immune system (asthma, allergies) and so forth. Recent findings suggest that the mother's nutrition and behaviours can play an undeniable role in the later prevalence of these pathologies, via epigenetic phenomena. Toxic substances found in the environment, particularly endocrine disruptors (phytoestrogens, pesticides, veterinary medicines...) ingested in food in very low quantities over time, can also interfere with development mechanisms and upset homeostasis mechanisms such as weight control. Most of the studies so far have been conducted on animals, and are currently underway in humans.

Other studies focus on Alzheimer pathologies. The causes of the onset of Alzheimer disease are not yet known. Prevalence is growing in France (an estimated increase of 150,000 people per year) and could represent in the immediate future half the cases of senile dementia in the elderly. Studies have shown that lower prevalence is associated with fish consumption (rich in omega-3) and that higher prevalence is found in people eating foods rich in saturated fats and cholesterol. Another research field is exploring the correlations between increased depression in the elderly and their diet. Among the physio-pathological mechanisms possibly involved could be the low grade gut inflammation which increases with age and obesity. Experimental studies have shown that this inflammation can be attenuated by a diet rich in polyunsaturated fatty acids such as omega-3, and liposoluble vitamins (A,E). Further connections between pathologies and diet are being examined (macular degeneration...). These different hypotheses and research themes will need to be validated by controlled trials in humans.

2.6. Relative impact of diet on public health

Certain WHO (World Health Organisation) models should allow better understanding of the relative impact of various determinants on state of health. These models are based on the analysis of prevalence within the population (exposure to determinants) and outcome on state of health (risk). The proportion of risk attributed to the determinant depends on prevalence, and on how serious the connection is with the pathology. Thus, a minor risk factor which is very prevalent can be responsible for more deaths than a major risk factor that is rare.

Figure 5 shows for the American population the number of deaths from cardiovascular disease and, to a lesser degree, cancer, by descending order of risk factor. Smoking is followed by high blood pressure, overweight-obesity, physical inactivity, and high blood glucose. Direct dietary factors come just afterwards in the list of risk factors, but it should be noted that they indirectly affect high blood pressure, obesity, glucose intolerance and dyslipidaemia, and thus contribute to most of the risk factors listed here. The secondary importance of nutrients compared to the main risk factors can be explained in part by their lower risk status rather than rare exposure.

Figure 5. Proportion of risk attributed to modifiable risk factors (USA)

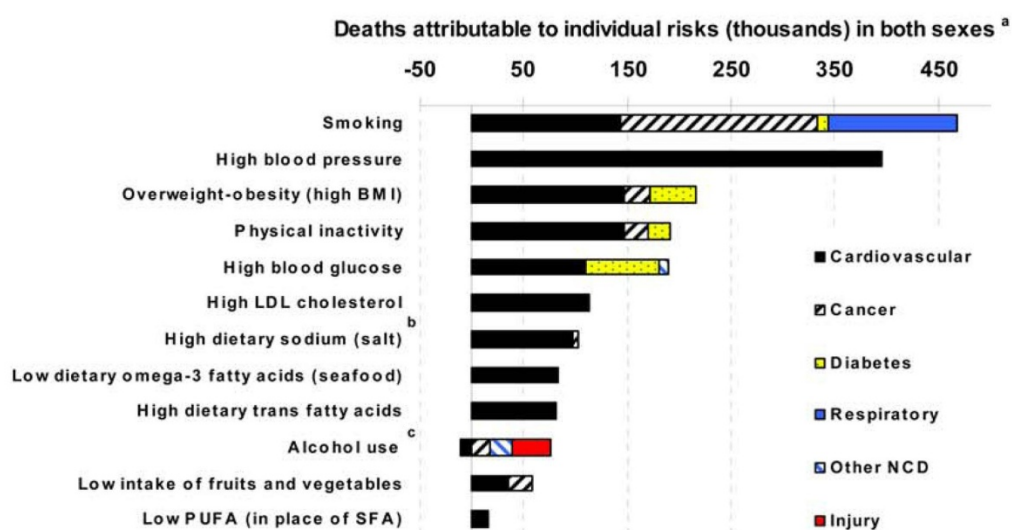


Figure interpretation : Smoking is the primary risk factor since it is very prevalent and is correlated with fatal illness (cancers). Obesity and overweight comes in third place, and is highly correlated with cardiovascular disease, followed by diabetes, then by cancers.

Source: Danaei G, Ding EL, Mozaffarian D, Taylor B, Rehm J, Murray CJ, Ezzati M. The preventable causes of death in the United States: comparative risk assessment of dietary, lifestyle, and metabolic risk factors. *PLoS.Med.* 2009.

The WHO has published similar diagrams on the international scale, which reveal large differences according to continent, and according to how developed the countries are. Malnutrition is the primary risk factor for mortality in poor countries.

Part One: Conclusion

In Europe, dietary energy availability rose over the course of the 20th century, and the proportions of lipids and sugars in energy intake reached similar levels. Food choices tended to converge on certain foodstuffs, but geographical specificities remain, illustrating the fact that regional cooking traditions endure. The ubiquity of processed foods (over 80%) and the development of food retailer chains have probably been behind this gradual dietary convergence. Also, diet differs according to social classes, which themselves seem to change little (the most recent statistics date from the 1990s). Fruit, vegetables and fish, which are characteristic of “prudent diets” or “diets conducive to health”, are more often purchased by the wealthier classes and less often by the more under-privileged sector of society.

The impact of dietary changes on health indicators remains difficult to fathom, since a global approach to diet would also need to cover dietary behaviours together with lifestyles (including physical activity and medical care), since lifestyle affects type of diet too. The recent and rapid increase in obesity is hence associated with major simultaneous modifications in patterns of physical exercise and dietary practices, illustrating how societal changes affect the state of health of the population at large.

Part two: Determinants of dietary behaviours

Part Two examines the determinants which interact to form dietary behaviours, either related to personal factors, or to individual living conditions.

Certain determinants are physiological, others connected with food supply, or yet others related to social interactions and cultural traditions. These determinants come into play on different time scales. Also, while dietary behaviours are specific to the individual, they can be observed on the population level.

Given that these determinants are responsible for regulating or disrupting dietary behaviours, this section aims to reveal the underlying mechanisms, plus possible levers for limiting dietary disruption and stimulating dietary regulation.

Human food intake is sporadic and regulated by a complex physiological network of detectors and signals that have extremely varied natures and functions (Chapter 3). How much do we know about the functioning of these metabolic mechanisms? How does food intake interact with the psychological characteristics of the eater?

Among the external factors behind the regulation and disruption of dietary behaviours, we have distinguished those with long-term outcomes generally caused by social norms (Chapter 4), from those having short-term outcomes during meals and food purchasing (Chapter 5). These short-term factors have gained importance in recent years, especially with the development of marketing and advertising. Which factors in the eater's environment have an influence on his or her dietary behaviour? Is it possible to estimate the relative importance of these different determinants?

Chapter 3. Human physiology, food properties and food intake

Physiological signals activated by food characteristics come from within the body or from the surrounding environment, and can be perceived consciously or subconsciously. They allow food intake to be finely adjusted in order to satisfy energy needs, or metabolic needs, and thus contribute to the regulation of energy intake. This chapter examines the physiological determinants of dietary behaviour that can be used as levers in prevention strategies.

3.1. Hunger and satiety, two fundamental notions of dietary behaviour

Physiological regulation of dietary behaviour allows intake to be adapted to needs. This regulation which affects both ingested quantities during food intake, and the length of time between two meals, is governed by sensations of hunger and satiety. Hunger reflects the mental need to eat, and causes a conscious physical sensation reflecting this need.

Satiety is the state in which hunger is inhibited. Appetite satisfaction is the process which controls amount of food intake and puts an end to it. The term intra-meal satiety is also used, as opposed to post-ingestion satiety or inter-meal satiety described above.

Hunger and satiety result from peripheral signals received by the brain, particularly the hypothalamus.

3.2. Physiological and neurobiological regulation of food intake during and between meals

During a meal, food intake is controlled by the volume of ingested food, but not directly by the energy content of the meal. Hence, a small portion of high energy-dense food (quantity of energy per gram of food) activates the physiological regulation mechanisms to a lesser degree than a large quantity of low energy-dense food (vegetables for example).

It is important to note that the energy compensation of one meal over another is asymmetrical, in the sense that it is easier to compensate an energy deficit (when the preceding meal is light) than an energy surplus (when the preceding meal is rich). This asymmetry explains why it is more difficult, when food is plentiful, to control weight gain, than to regain weight after a period of fasting.

The mechanisms behind energy regulation require more research, particularly regarding signal (endocrine and nerve) pathways involved in hunger and satiety.

Initiation of food intake used to be considered as the behavioural answer to a perceived energy deficit by the brain. The nature of the signal has now been identified, firstly in rats then in humans, as a transitory drop in blood sugar, reaching on average 10 to 12% of the basal level. Hunger is felt within minutes of this drop in blood sugar.

From the start of the meal, the nervous system receives peripheral signals which interact and which are collectively referred to as the satiety cascade. Ingestion of nutrients into the digestive system triggers a succession of signals relayed to the hypothalamus and brainstem by the vagus nerve. This brain-to-digestive tract pathway includes hormonal and neuronal components which interact with each other.

The humoral pathway and its neurotransmitters such as insulin and ghrelin, are scientifically well-researched, as are the neurons and specific regions of the brain involved in food intake regulation. The factors which trigger secretion of these signals are also known. Arrival of food in the stomach stimulates mechanoreceptors in the gastric wall which transmit information to the central nervous system. This effect is however transitory and recent studies suggest that this signal does not function well in obese people. Another trigger factor is the detection, on different levels (peripheral and central) by different organs (head and neck, intestine, hepatic portal vein, liver...), of the nature of food components and their energy content. On the other hand, less is known about the physiological importance and effects of the hormones and peptides secreted along the digestive tract and by adipose tissue.

It has recently been demonstrated that the two bacterial phyla that usually compose over 85% of gut flora do not exist in the same proportions in obese mice and in normal-weight mice. This study also highlighted the fact that weight loss in obese subjects restored a profile identical to that found in normal-weight subjects. The exact nature of the connection,

between bacterial micro flora and the factors regulating food intake, needs to be more fully examined and this is a research priority for the food industry.

There are numerous signals and they can either work together or work against each other. The same signal, for example a sensory signal, can both stimulate (craving) and put an end to (alliesthesia or diminished pleasure derived from food) food intake depending on the physiological state of the subject.

It has been demonstrated that the regulation of food intake can be upset by signal deactivation or weakening: the obese suffer from lower sensitivity to insulin, weaker perception of gastric distension or reward dysfunction; the elderly experience inhibited stomach emptying due to detection of lipids after a lipid-rich diet, and diminished detection of amino acid intake. So, while physiological regulation of energy intake were observed to diminish with age and obesity, the reason why this happens remains unclear.

Understanding how these physiological mechanisms allowing organs to function regularly in spite of fragmented food intake, interact, is still at the analysis stage. The challenge before us in coming years is the systemic understanding of how energy homeostasis is maintained and to create the appropriate models.

3.3. Food as a trigger for sensory signals

Sensory signals are often mentioned, among other signals, as major determinants of dietary behaviour, due to their influence on food preferences. There are many different kinds of signals, especially tactile, visual, auditory, taste, smell, pain. They are activated at different times during food intake:

- a cascade of anticipatory responses is set off at different stages of the digestive process when food is chosen and bought, due to perception of anticipated pleasure. This prepares the organism for eating and affects the size and length of the meal. The role of sensory signals at this stage is well-known: they stimulate the cephalic phase and cause appetite, which is a sensation partially independent from hunger (appetite can occur without true hunger, but hunger reinforces appetite);
- before and during ingestion, sensory signals trigger physiological responses (secretions, bowel movements) and allow each food to be precisely identified thanks to memorization. During the meal, they help to detect appetite satisfaction.

Sensory signals interact with the other physiological signals, including those associated with appetite satisfaction and satiety. The effects of sensory signals on dietary behaviour, other than those associated with the head and neck, have yet to be fully examined.

The sensory image of the food is memorized automatically and holistically. It is given by both interoceptive information (probably relative to appetite-satisfaction and satiety, energy, and digestive upset), and information relative to cognitive or affective context which considerably reinforce memorization.

Perception of taste

Perception of taste is modulated by physiological state (hunger for example), and taste triggers secretions which precede and accompany digestion (saliva, gastric juice...);

Adding aroma to food is often used to increase acceptability. Some research work has already shown that recognition of certain target smell molecules can contribute to curtailing or increasing food intake. In the elderly, this could be an efficient way to stimulate food intake.

Generally speaking, few studies examine the impact of aromas on satiety or appetite satisfaction. Experiments prolonging the perception of aromas through the retro-nasal pathway (aroma is perceived when the food is in the mouth), thanks to small, long chewed, mouthfuls (greater aroma is released over time), can elicit appetite satisfaction and thus reduce short-term food intake.

The advantages of cutting back on sugar and salt in order to improve health are well-established. However, low salt or sugar content significantly affects the taste of foods and can rapidly lead to lower consumer acceptability. An aroma that is congruent with sapid perception is an odorous molecule whose perception is usually associated with the flavour that it seeks to enhance. Hence, adding aromas congruent with sugary and salty flavours to foods that have low sugar and salt content, can be used to increase acceptability without altering palatability.

Palatability and reward

An innate preference for sugar and fat may exist (or be learnt in utero) thanks to their energy value. The sweet flavour is enjoyed directly after birth, but no research on fat has yet determined whether a newborn has an innate preference for this taste.

During food ingestion, sensory signals activate “reward systems” (the striatum in the brain), especially when food is palatable. These signals trigger a sensory pleasure which increases short-term food intake. Food palatability is increased by sugar, fat, and to a lesser extent, salt.

During ingestion of highly palatable foods, reward pathways seem to supplant energy regulation pathways (decoupling and/or crossed inhibitions) reinforcing the desire for this type of food. Ingestion of fatty foods and sweet foods seem to stimulate the desire to eat, where perceived pleasure activates craving, and attenuates appetite satisfaction signals, leading therefore to overconsumption of these high-energy foods.

Although originally disputed, certain neuroadaptive mechanisms, similar to those caused by drug consumption, have recently been proven in obese rats, confirming the activation of an addiction phenomenon in cases of obesity. In humans, the long-term consequences of this phenomenon on weight gain have not yet been investigated, but for certain obese or overweight people, research has revealed dopamine receptor dysfunction in the part of the brain involved in reward.

Specific sensory satiety

Specific sensory satiety (SSS) entails diminishing enjoyment of a food while it is being ingested during a meal, compared to foods that have not been eaten. This phenomenon is mainly linked to the sensory properties of foods, and depends little on their energy or nutritive value. Geared to omnivorous diets, SSS means that pleasure diminishes during food intake, but that taste intensity does not. The structure of French meals, with several different courses, is an answer to this physiological need. When a meal is composed of several high energy-dense foods, this appetite for other tastes can entail a sequence of food (and calorie) overconsumption. The SSS could go to explain why monotonous diets are effective over the short term, but not over the long term, because this type of diet is usually only followed for a short time.

3.4. Impact of nutritional content of food on satiety

Macronutrients with equivalent calorie intakes do not all have the same effect on satiety: proteins are known to be most effective in inducing satiety followed by carbohydrates, then lipids.

Proteins

Protein ingestion affects stomach emptying, absorption by the intestine of amino acids, and the production of gastrointestinal hormones, thanks to pre- and post-absorption signals. These different factors influence appetite satisfaction and satiety, but also the course of bolus metabolism.

Certain research works have shown that the very nature of proteins (whey, soy, albumin) could affect how powerful they are in inducing satiety. Also, a review of research underway on the link between macronutrient structure and appetite has revealed that modifications in protein structure during manufacturing processes can lower the speed of amino acid release and absorption, and hence have a possible effect on satiety.

Lastly, impaired signals for protein absorption can upset the proteosynthesis-proteolysis balance, which is common in elderly people.

Carbohydrates

Foods containing carbohydrates are classified according to the glycaemic index (GI), which measures the physiological effects of foods on blood sugar levels. Experiments have shown that a high-GI diet stimulates appetite and thus higher energy intake, which has not been observed for slow-sugar (low GI) diets. However, a diet incorporating many low-GI foods does not effectively control satiety and long-term food intake.

Even though guidelines encourage the consumption of low-GI foods rather than high-GI foods, it is difficult to categorise foods without taking preparation method into account. Manufacturing and cooking processes affect the GI, in particular by modifying fibre texture and structure. It is thus possible to take advantage of these processes to obtain lower-GI

foods: for example, modification of bread-making and/or inclusion of fibres (complex carbohydrates) which produces denser bread, and significantly reduces the GI of this food.

Fibre-enrichment requires more chewing effort and slows down the speed of ingestion due to effects on food texture and structure. This could therefore lead to lower food intake and contribute to weight control thanks to a variety of mechanisms which remain largely unexplained. Long-term weight loss does however remain modest when adult healthy subjects following a fibre-rich diet are surveyed. Fibre consumption is also associated with lower risks for cardiovascular disease, diabetes, and certain types of cancer (dietary guidelines recommend an intake of 25-35g fibres/day/adult). So the benefits of enriching foods with fibres appear to be confirmed. However, while numerous fibre-enriched products have been put on the market to diversify food supply, these fibres must be whole-grain if they are to preserve their actual nutritional benefit.

Sugar substitutes are low-calorie sweetening substances that can be used to replace simple sugars that have a higher calorie count. They can be used for health reasons (less calories, less tooth decay), but also for cost reasons. The effect of sugar substitutes on energy intake depends on the energy density of the food in which they are incorporated. Replacing sugar with aspartame reduces the energy intake of drinks but does not seem to affect the sensation of hunger. While the use of aspartame during monitored dieting does not lead directly to rapid weight loss, research has shown that use in a weight control programme had positive effects on weight loss that were maintained over the long term.

Lipids

Lipids contribute to increasing the energy density of food. High energy density is associated with high obesity prevalence. A drop in energy density is achieved by a lower proportion of lipids and a higher relative proportion of carbohydrates. The most effective way of limiting energy intake from lipids is to substitute them with low-calorie ingredients such as polysaccharides and water.

The kinetics of lipid transformation and absorption can be modulated by playing on droplet size and the stability of lipid emulsion, or on the physical state of the lipid phase. The finer the emulsion is, the quicker lipid hydrolysis takes place. Nevertheless, the consequences of kinetic modification of the plasma lipid level remain unexplored, neither on satiety, nor on weight control.

3.5. How food texture and structure affect ingested quantity

Food texture is essential to product acceptability. The link between texture and food intake has not however been greatly explored, except for viscous products. It is a known fact that increased viscosity of drinks and semi-liquid foods leads to lower food intake, and increased satiety. To increase viscosity, food composition can be modified by adding certain soluble food fibres to liquid foods, the thickening effect depending on which fibres are added. Added β -Glucans from oats and barley have proven effective, but carrageenans or guar gum do not change appetite or food intake.

It is a fact that, the easier a food is to eat since it requires little chewing effort, the higher the energy intake is. To counteract the trend towards overweight or obesity in adults and children, preference can be given to lower energy-dense food requiring a more intense chewing effort. Added dietary fibre, combining lower energy content and greater chewing effort, can contribute to achieving this objective.

Lastly, diet regulation is more effective when solids and semi-solids are ingested, rather than liquids. This may be explained by bite size, which is itself determined by food viscosity: increased bite size has been correlated with a more acute ulterior sensation of hunger, with a drop in appetite satisfaction and a greater desire to eat.

Impact on molecule availability

Foodstuff structure affects aroma release and thus perception of flavour. For example, when food viscosity increases, aroma release in the nasal cavity (retro-nasal pathway) diminishes. It is generally observed that sensory perception drops along with the speed of aroma release.

Foodstuff structure has an impact on the availability of biologically-effective molecules, either nutrients such as lipids, or micronutrients such as aromas and polyphenols. At present, the effects of structure on molecule signalling and their use are not well-known. As far as sugar is concerned, it has been demonstrated that, for the same composition, energy regulation is less effective for soft drinks than for sugar present in a more solid form. When solid foods lack structure, this can affect long-term weight control. There has been to date little research into this subject.

3.6. Psychological factors and consequences on dietary behaviour variability

The psychological state of the eater is important in explaining behaviour variability, which then affects the physiological regulation of energy intake. Firstly, mood and reward are connected. The neurosciences have demonstrated that when someone eats a food, the pleasure is greater when the food is talked about positively. Knowing this can help in understanding why the French talk so much about food during meals (considered very rude in the Netherlands), but also in understanding the impact of advertisements stressing the pleasure connected with eating a certain food.

Also, the need to cope with mood swings sometimes leads to compulsive eating, which is also known to compensate a lack of affection or to diminish emotional stress. This behaviour can lead to weight gain, and in the case of diabetics, to alter their blood sugar balance. Permanent stress incurs overeating. However, sometimes the reverse is reported and stress can also induce loss of appetite and even the desire to eat.

When overeating does occur, palatable foods are chosen most of all because these are more likely to provide the reward needed to reduce stress. This reward will be even greater since stress tends to deactivate the reward pathway. The pleasure derived is relatively lower in stressful situations than in the absence of stress. This is more common when people are already overweight.

Lastly, certain psychological factors increase vulnerability to risky dietary behaviours. For example, people who are emotionally sensitive and generally show a lower capacity to anticipate the food reward, people who succumb easily to the temptation to overeat, and also children who are sensitive to food rewards. When psychological vulnerability is acute, this is associated with a higher risk of contracting an illness caused by dietary behaviour.

One of the lessons that can be drawn from the studies undertaken in this field is that individual responses are extremely diverse. If the literature leaves no doubt as to the decisive effect of psychological factors, it should be noted that the other characteristics of each eater should also be taken into account. Individual variability means that proving any connection between cause and effect is a difficult task.

3.7. The genetic dimension is currently being explored

New doors are currently being opened by genetics, as regards understanding of food intake control, and more generally, dietary behaviours. Genetic specialists suspect a link between genetics and dietary behaviours, but this has been difficult to quantify, on a population level given the other factors affecting behaviours, or in percentage of people affected by genetic predispositions.

The search for inherited characteristics is carried out through studies of families, which consists of comparing phenotype frequencies between monozygotic twins and dizygotic twins, together with the dietary intakes of the family. These studies indicate a proportion of genetic variation estimated between 20% and 40% of total food intake (meal size 28%, meal frequency 34%). Genetic impact appears higher for lipid consumption than for proteins or carbohydrates. Nevertheless, the specific family context (body norm, basic diet) can introduce a bias into these studies, which reveal highly diverse outcomes.

Study of the genome has identified which genes are correlated with obesity, satiety or with the mechanisms implicated in the regulation of dietary behaviour. The main genes implicated in taste and smell perception are beginning to be explored. However, exactly how these genotypes influence dietary preferences and nutritional status is not currently evident.

Chapter 4. The impact of social environment on food perception and eating behaviour

The physiological mechanisms that shape dietary behaviour, are modulated by constraints and information connected with individual environment. First and foremost, social norms govern dietary preferences and practices, especially meal periodicity and structure (food intake complies with societal habits, and is triggered independently of physiological needs). The consumer receives information from many sources, both actively and passively, e.g. from the business world (advertisements, point-of-sale marketing campaigns, nutritional labelling, claims), from peer groups (friends, family), from health care professionals (doctors, general or group-targeted information campaigns).

4.1. Dietary culture is shaped collectively over time

The history of diet in France can be divided into at least four successive stages. During the Middle Ages and up until the beginning of the 17th century, the social elite had diets that closely followed medical recommendations, regarding food choice, cooking methods, seasoning and order of courses.

In the 17th century, gastronomy became popular. "Eating plenty" which gave strength or implied opulence, was supplanted by "eating well" which implied prestige, and the meal became a convivial and elegant occasion. Meals focused on eating pleasure, variety and presentation.

With the French Revolution of 1789, meals became a sign of middle-class prosperity. Where receptions had previously taken place in a private mansion, now people dined at inns that became high-quality restaurants. People showed how grand they were by what they ate, by how important eating was to them, and by the time devoted to it. During this period, the national myth regarding gastronomy emerged, and eating was transformed into a culinary tradition. The notion of eating enjoyment on a daily basis spread throughout society.

At the beginning of the 19th century, a trend towards hygiene developed. Medicine and science started to produce knowledge, followed by recommendations, about how to remain in good health thanks to better hygiene and a wholesome diet. Food poisoning was shown to be caused by germs introduced by rotten food and the link between public health and diet was established. From the end of the 19th century, while public policy focused on the problems of regulating food supply (speculation and hoarding, health security), a slim body became fashionable and set the wealthier classes apart. Social differentiation of dietary choices was reinforced by the importance given to the body by a number of social classes. The robust and corpulent bodies typical of the lower classes contrasted with the supple and graceful bodies of the upper classes. These ideas are still valid today. Social dietary behaviours seem to have stabilized at the beginning of the 20th century, and even became entrenched through periods of deprivation during the Great Depression or the Second World War. These social norms, diverse though they may be, have at least three things in common, which are the signs of a collective dietary culture: conviviality, the primacy of taste, how meals take place.

According to certain authors, this approach to food is the result of the cultural model found in catholic Mediterranean countries, where a meal is to be enjoyed with others, and where a certain dietary balance is achieved from this collective experience of "eating together". On the other hand, "eating well" in protestant countries is an individual responsibility. Analysis of how food is currently perceived in France and in the United States has pointed to this cultural gap. Recent studies undertaken by the CREDOC have shown that these historical dietary norms are gradually merging. For the past few years, the French have indeed been putting dietary balance before pleasure and conviviality in their perception of "eating well" (see Box 5).

4.2. Meal structure is maintained

A relatively rigid approach to meals is associated with this dietary culture, particularly meal companionship (with whom?), eating frequency (when?) and structure and content of meals (type?). The question is, does this model remain pertinent for describing current dietary practices?

Meals are the scene of social relationships. Little data exists on changes in meal companionship. Meals eaten at home with the rest of the family often remain the most common type of meal: 8 out of 10 French people dine with their families according to the Health Nutrition Barometer 2009.

According to the French model, a "proper" meal is composed of three courses, and preferred periodicity is three or four meals per day. A debate began in the 1980s about how French meal structure was being upset, to the benefit of "snacks" with no fixed timing or place, and which no longer brought members of the family together. The structure consisting of three main meals – breakfast, lunch, dinner – does however continue to be adopted by nine people out of ten in France, while snacking only concerned 5.4% of the population according to the Health Nutrition Barometer 2009 (Box 4). Meals remain concentrated for the vast majority within short time slots which vary little. The meals themselves have been simplified to two or three courses at lunch, two courses at dinner, and involve the increasing use of ready-made products. The French however have remained faithful to the traditional French meal composed of three or four courses.

But, even if these standard attitudes continue to exist, all the meals of the week do not have to be "proper meals". People living alone, who unsurprisingly make less effort, go to town when they have guests or when they eat out. Families eat many types of meals. Real meals, snacks, celebrations, or even impromptu meals (TV dinners, takeaways or pizza deliveries, food eaten in cafeterias and fast-food restaurants) can all be a family moment. Family meals (who cooks, who is present, how old are they?) now entail an effort to bring everyone together. From this point of view, the changes in food supply mentioned in Chapter 1 have increased the number of meal types, meaning that deviations from meal norms are more common.

The debate around the permanency of the family meal is not specific to France and has been investigated in many international studies. For households in Scotland, America, Scandinavia and France, for whom information exists, the smallest common denominator, for a meal to be called a "real" family meal, is that all the family members eat the same meal. A hot cooked dish seems to be a minimum requirement on the menu, but the degree of preparation varies according to country and social class. A "proper" meal in the UK is prepared by the mistress of the house, and eaten by the whole family at a fixed time every evening. As in France, a proper meal is defined as opposed to a "second-rate" meal (snacks, frozen pizzas, etc... depending on the country). These "second-rate" meals are nonetheless consumed regularly, or reserved for specific occasions: busy work timetables, solitude, or illness. In the end, observations tend to show that this casual approach to meals is neither obvious nor widespread, and that people seem to idealise the past rather than actually report a specific change for the worst.

Box 4. Defining snacking

Even though the Health Nutrition Barometer indicates on average a decline in snacking, this does remain more frequent among the younger age groups.

Snacking and how it affects weight regulation is the subject of a scientific controversy, as is meal periodicity and optimum number of meals. The role of breakfast for example is under debate; experiments have shown that total energy ration is lower for people who eat more during the first part of the day, and is higher for those who eat most of all in the afternoon or evening. Also, energy ration depends above all on number of meals, and the more often one eats, the higher the ration.

As far as snacking is concerned, epidemiological studies investigating people in their daily lives come up against the difficulty of defining what snacking actually consists of. A child's afternoon snack is not on a par with binge eating of fatty salty products in front of the television, or a snack after intense physical activity. Eating food between meals can have a completely different impact in health terms according to context. As a general rule, the data available do not allow differentiation of these three contexts. But these methodological difficulties are partly inherent to imprecise definition of dietary practices, because these practices vary according to individual and population. Other limits are the small sample used in most of these studies and the time span which is too brief for a true evaluation of impact on health. Hence, the data currently available concerning snacking does not provide a clear answer regarding consequences on health.

Unstructured diets in adolescents

Unstructured diets can be observed most of all in adolescents. They give the impression of wanting to make their own dietary decisions, but at the same time family meals give them the opportunity to enjoy being with adults, and to enjoy being part of a family: so they go along with it and say that they intend to do likewise with their own children. Research on the diet of adolescents highlights the social dimension of meals eaten with friends in school canteens or other places outside the home. Eating becomes an exercise in trial and error, in the way one eats (with fingers, in the street...) and in how one eats (inverting the order of courses, playing with food).

These “unconventional” practices are frequent in young people especially students. There is a debate as to interpretation: certain research points to greater flexibility in their daily timetables and organization of meals, while other research concludes that their dietary habits are highly structured. But these studies do not define the target population precisely, and lack consistency in the methods used, which can help to explain these different results.

Qualitative work on diet and cooking practices in young people reveals that, even if these practices do not necessarily reflect those inculcated by their parents, they follow a certain pattern and have their own conventions. The traditional model is memorized and even if it is not used all the time, it is reactivated when these young people grow up, when they start living as couples and above all when they have children.

4.3. Relationship between dietary norms and nutritional guidelines

Consumers are targeted by numerous guidelines concerning the way they set their diets, particularly through public health campaigns. These campaigns communicate guidelines on the dietary behaviour conducive to good health, and are important in encouraging the adoption of nutritional norms (Box 5). These campaigns are appraised in Chapter 6.

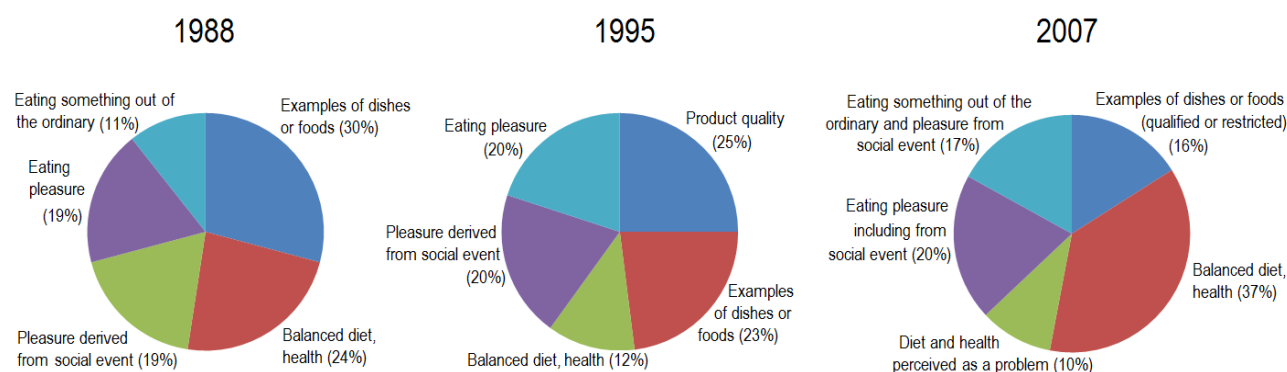
Over and above the state-sponsored campaigns for nutritional health, the consumer is also subjected to a torrent of information from his or her social circle, from doctors, from the media, from marketing strategies, indicating the best way to eat in order to avoid certain health risks and to remain in good health.

Box 5. Changes in attitudes towards diet

For the past few years, the French have put “balanced diet” before pleasure and conviviality in their perception of “eating well” (CREDOC surveys). In 2007, 10% of answers to the question “what does eating well mean?” were connected with health, and 37% with “balanced diet” (compared to only 12% in 1995). The functional aspect of diet, where health comes before eating pleasure, has become more important especially among young people. This shows a greater awareness of nutrition but also could mean that the young are changing their attitudes towards diet.

A collective awareness of the importance of diet for health has apparently caught on, and has initiated some purposeful nutritional policies, particularly the National Nutrition Health Programme (PNNS 1 in 2001). The authorities – and the manufacturers – have since then stepped up the dissemination of nutritional slogans. This encouragement to make the right choices has put health at the top of the list. The Diet Barometer of July 2008 showed that 41% of French people quoted the “Eat at least 5 fruits and vegetables a day” slogan as the one that had impressed them the most.

Figure 6. Changes in consumer typologies in answer to the question “What does “eating well” make you think of?”



Source: CREDOC, CAF 1988, 1995 and 2007

Recent marketing studies have pointed to an important cognitive limit regarding the appropriation of dietary information. Consumers tend to evaluate food in a two-dimensional way: “nice/nasty” or “healthy/unhealthy”, which does not match nutritional guidelines and skills. Thus, consumers consider a mini-snack (47 calories) to be more fattening than a helping of low-calorie soft cheese, 3 carrots and 3 pears (569 calories). This line of reasoning is intensified by a “halo effect”, which limits the capacity to appreciate the nutritional quality of a complex dish. If a food considered to be unhealthy such as a hamburger, is accompanied during a meal or within a recipe by a food deemed to be healthy, such as lettuce or broccoli, then the negative perception of the first food is minimized, as well as the energy content of the overall dish, while in fact, the lipid ration of the hamburger has been increased by the salad sauce and by the energy content of the broccoli.

Given this cognitive bias, it is clear that when information is ubiquitous – “information overload” – this is not conducive to the appropriation of dietary norms by consumers. There is a huge difference in the way nutritional messages are received according to education level and socio-economic category. Lastly, it should be noted that “information overload” leads to learning by word of mouth, especially within the cultivated sector of the population.

4.4. Perception of risk

Does a wealth of information allow people to become more aware of risks to health, and does this modify dietary behaviours? Much research in sociology, economics and psychology has been carried out on risk perception and dietary behaviours. Analyses are based on representative samples of the population, and on laboratory experiments. Also, field experience allows real household consumption to be recorded, while the flow of dietary information is tracked.

During health crises, consumers are swamped with information, which is often controversial and echoed by the media. The analysis of the European “mad cow” crisis showed that individuals changed their behaviours to varying degrees, over short periods of time, and contrary to popular belief, in a rational way.

Public policies regarding risk prevention and health claims are based on the hypothesis that risk/benefit perception will influence and induce behaviour to the level of risk established by the experts. Yet, results of experimental work have generally shown that higher awareness of risks is not sufficient to change behaviours. The impact is even lower when risks and benefits are presented in the same informational message.

Field experience and laboratory experiments, regarding the impact of consumer guidelines on the consumption of fish by pregnant women, can be taken as an example. An ideal ration is proposed which accounts for risks of exposure to methylmercury and for the benefits enjoyed from the omega 3 contained in the fish. These experiments have proven that pregnant women measure the risks but continue to consume fish as usual, because the contamination phenomenon is difficult to understand, and in contradiction with guidelines that present fish consumption as beneficial for health.

Field trials have yielded mixed results when people are alerted to possibly misleading health claims. An example is the increased willingness to buy yoghurt enriched with vegetable sterols which claims to reduce cholesterol, in spite of scientific uncertainty as regards the effectiveness of these sterols and their long-term health consequences.

Also, studies in experimental economics have sought to evaluate whether or not consumers are ready to pay more for a product if it can help to limit certain risks, or if it respects certain environmental, moral, ethical or health precepts. Results are inconclusive. A meta-analysis has revealed wide variations in willingness to pay extra in order to diminish the risks linked to pesticides: this extra amount ranges from 26\$ to 1375\$ per year per person. This wide range can be put down to the methods used and the nature of the risk involved. Few articles make the distinction between willingness to pay for reducing an environmental risk (public benefit), and a health risk (private benefit). This distinction is important for analyzing preferences for organic produce (Box 6).

The review of references indicates that the correlation between risk perception and behaviours is not clear-cut, since this depends on numerous other factors and also changes over time.

Box 6. Organic food consumption is also driven by health concerns

Since the year 2000, CREDOC opinion polls have revealed a clear link between consumer practices and their consequences on the environment. Food is beginning to be considered by consumers as an area requiring virtuous behaviour.

Although consumption of organic foods is still marginal (1.7% of French household consumption, Agence Bio, 2009), this has grown steadily since the year 2000 (+15% per year since 2005). In 2008, 44% of the population sample reported having consumed organic food at least once a month (compared to 37% in 2003, CSA Barometer/Agence Bio, 2008). The development in organic food consumption is linked to wider marketing strategies embracing supermarkets (42% of organic purchases) and the creation of store brands. Price differences remain high (usually 40%). Health is the primary reason for purchases, followed by quality and taste, and then by environmental preservation which is growing as a product choice factor.

Traditional ‘ascetic’ organic food eaters are few and far between and these have been joined by new converts, whose preoccupations revolve around diet, risk prevention, or a hedonistic outlook on life. These occasional purchasers are from the middle classes, their choices are not set in stone and focus on specific organic foods (as opposed to a range of products). These choices reflect a desire to be closer to the land, and to minimize the impact of their consumption on the environment which explains their attraction for short producer-consumer distribution circuits.

4.5. Lifestyle constraints and dietary behaviours

Constraints due to consumer time schedules

Consumer choices are defined by budget and social class, but also by work commitments, time available for shopping, meal preparation and even eating.

Hence, the increase in female employment is correlated with increased eating outside the home and purchasing of convenience foods. The development in manufactured ready-made meals has been responsible for a greater drop in the price of processed products compared with that of basic foodstuffs, which has in turn encouraged the use of convenience foods. People have little control over the nutritional and energy quality of convenience foods compared to meals cooked in the home, and this goes to explain, according to American research, why the BMI of working women in the USA is growing quicker than that of non-working women, and why the children of working mothers are more likely to be obese. This theory has not been validated in France. Also, lower unemployment in the USA has apparently worsened both the BMI of the population as a whole and the nutritional quality of food choice, while diminishing on average the time available for cooking and eating at home. Fundamental transformations of the job market have therefore had an impact on dietary practices and on health problems due to dietary behaviour.

Constraints due to consumer budget

Chapter One pointed to the social inequalities regarding food consumption in France, both in quantity and in expenditure.

The most energy-dense foods are also the cheapest (1 kcal of tomatoes is 7 times more expensive than 1 kcal of vegetable oil). Research based on simulations indicates that the poorest households have little choice when confronted with the triple constraint of eating sufficient food, at a reasonable cost, while respecting social norms regarding food tastes. So they adopt a diet composed of high-calorie foods that have a high fat and added sugar content, but are relatively poor in micro-nutrients. It is theoretically possible for a poor household to have a low-cost diet that follows guidelines regarding macro- and micro-nutrient content, while meeting standard energy needs. However, this type of diet does not match the dietary habits observed in France.

Using household purchase data, it is clear that, when the average price of products in a given food group varies, the proportion of budget is affected, and this induces purchasing changes in other food groups, meaning that there is a move towards other foods that have similar hedonistic and nutritional qualities. When the price of a food increases, consumption drops, and vice versa. This simple mechanism explains why a drop in the price of fresh fruit (low-fat product) offered in school vending machines leads to a significant increase in sales, as shown in an American field experiment.

Underprivileged populations (poor and/or less educated) are particularly affected by budget constraints, and more generally by difficult living conditions. Their diet suffers from this. Box 7 defines their diet and offers some explanations.

4.6. Age groups and generation effects

Childhood

Once established, dietary habits become very resistant to change, even for health reasons. Dietary behaviours – practices, food choices, time schedules, etc. – are learned during early childhood.

If they are given balanced meals, very young children up until the age of one or two, are naturally able to control their food intake. This ability diminishes around three years old, with wide individual differences. One explanation put forward is that, upon weaning, external signals become predominant, such as encouragement to eat, high availability of food, etc. These signals override physiological signals, and this has been verified as regards food portions and encouragement to finish the plate. Research into the self-regulation of food consumption has as yet been insufficient, and, in France, most of the current findings are the work of a sole research team.

Box 7. Diet adopted by underprivileged populations

Diet is an indicator of social inequalities, whether from a financial point of view (revenue, standard of living) or from a socio-professional point of view (education level, profession). From an epidemiological standpoint, in the USA as in Europe, obesity is linked more often to social class, education level, and socio-economic status, than to revenue. Hence, the risk of obesity in women manual workers is multiplied by 4 (16% compared to 4% in women executives or intermediary professions). The most underprivileged social classes are particularly prone to serious obesity (3.8% instead of 1%, OBEPI 2006). The ABENA study (2005) also revealed this trend for food aid beneficiaries in France. Given the high number of people considered to be poor in France (over 6 million in 2010 according to INSEE), their nutritional profile is a serious issue and a priority in the public health domain.

Dietary characteristics in underprivileged populations:

Proportion of food expenditure in overall budget: food is a major expense for underprivileged households: 22% on average for households living below the poverty line in 2006. Consumption in these households is more reactive to revenue variations and to commodity prices for most food groups. This can mean that products are substituted (e.g. sunflower oil for butter).

Diet content: shopping surveys (family budgets) and INCA consumption surveys show that low-revenue and/or less-educated households eat less fruit and fish, and more fatty foods. Nevertheless, meal content according to revenue or education levels differs even more by food type and quality within the same food category. Average purchasing prices for foods, measured by unit values, are lower for the poorer households.

Explanatory factors:

Social isolation and inhibitions: poverty often prevents food from fulfilling its role in ensuring daily meal periodicity and conviviality, especially if one cannot "return the invitation". Poverty creates difficulties: irregular sleep patterns (insomnia, irregular time schedules) are responsible for irregular meal times and meal-skipping. Isolation caused by family unit break-up can lead to disinterest regarding meals. As diet deteriorates, social relationships suffer and isolation is incurred.

Economic considerations statistics and simulations comparing the cost of high-fat foods with that of fruit and vegetables have shown that high energy-dense foods are much cheaper. However, the economic barrier is not the only obstacle to eating food deemed to be "good for your health", since habits that form around certain tastes are also frequently mentioned. This explains the relative failure of one-off measures lowering the cost of a certain category of products.

The health lever is less effective: behaviours conducive to health appear to be strongly linked with education level. Also, the nutritional information displayed on packaging is poorly understood or negatively perceived by underprivileged populations.

A lack of self-esteem and plans for the future: underprivileged populations usually are less confident in their ability to control their diet and their health, and have low self-esteem. They feel incapable of making the necessary modifications for adopting a healthier dietary behaviour, which is thus not their problem. This point is often neglected and contributes to the rejection of media messages, which encourage behaviours that are a far cry from their habits. Underprivileged people have difficulty in planning for the future due to the immediate difficulties of daily life. Health is considered in relation to illness, about which they are fatalistic given that individual behaviour matters little.

Higher exposure and receptiveness to advertising: underprivileged populations are exposed more frequently to advertising and are more receptive to the marketing messages relayed by it. Television viewing is higher, especially in children. Pressure is further increased when the products advertised (soft drinks, fatty foods) offer access to the consumer society.

As a result of these obstacles, the usual prevention programmes are less effective for underprivileged populations. Interventions specifically targeted towards certain groups, especially mothers, have been more encouraging (cf. Chapter 6).

Parental influence on children's diets

When a child reaches the age of 5, the stricter the parental control on food intake is, the less the child is able to self-regulate his or her consumption. Certain educational styles such as threat ("you cannot leave the table until you have eaten your spinach"), or reward ("if you eat your spinach, you can have a dessert"), or substitution ("if you do not like spinach, you can have potato chips") or postponement ("you will have spinach tomorrow"), explain why 20% of young children are fussy eaters. Results comparing education styles used at table (permissive, democratic, authoritative) are open to debate. The democratic style does appear to be more effective for fruit and vegetable consumption, followed by the authoritative style. The permissive style appears less effective because it does not provide repeated tasting opportunities, nor does it offer variety. The atmosphere created by each style also plays a role: the more relaxed context of the democratic style increases appreciation of foods that were initially rejected. Although study results do not always match, forbidden foods seem to be consumed in large quantities when children have free access to them.

Box 8. Children prefer sweet foods

An innate preference doubtless exists for sweet foods, maybe acquired in utero. This preference lasts throughout the growing period. For aromas, preferences may begin via breast milk. There is therefore a connection between the mother's diet and her child's preference for certain aromas after weaning.

Neophobia begins around 2 years old in 50% of children (France and USA). It usually increases until the age of 5, and then remains stable until about 8 years old. Consequences are diverse on the satisfaction of nutritional needs. The negative impact on fruit and vegetable consumption is undisputed. Certain food rejections persist over time (particularly for cheese products). Rejection of vegetables changes over time, with increasing acceptance in adults. In children, repeated tasting increases appreciation of all foods and tastes, even those initially rejected. Parental attitudes are crucial in familiarizing their children to different foods. Sensory education, particularly at school, allows children to try a greater variety of food (see Chapter 6).

As for the issue of children's preferences, there are insufficient studies on observed consumption as opposed to self-reported consumption. It should be noted that children can bias their responses according to their knowledge about "proper eating" (e.g. they can overestimate their fruit and vegetable consumption).

Education

A 6-week educational programme could improve the ability of 3-4 year-old children to self-regulate their diet. An OECD report, cited in the report issued by the French *Centre d'Analyse Stratégique* (March 2010) on new approaches for safeguarding public health, indicates a lasting effect of preventive programmes 40 years after implementation.

Sensory learning improves the ability of children to describe what they are tasting, and has a slight effect on reducing neophobia, especially in children 7 to 9 years old. Sensory learning also increases eating pleasure and encourages social contact. How lasting this learning is on reducing neophobia remains to be confirmed. Effectiveness of dietary education is greater if the learning context is formal and theoretical, and if it lasts throughout childhood. Also, parents have to persevere in the home.

In children, as in adults, nutritional information leads to improved knowledge but not necessarily to improved behaviour over the long term.

Ageing

The number of people over 60 will triple by 2050, and will represent a third of the French population. The over-80 demographic group will grow the most by 2050. The diet of elderly people is already a public health challenge, for their personal well-being and for reducing the social costs of dependency. This issue is addressed in the PNNS.

Ageing is biologically inevitable but takes very different forms, between organs for the individual, and between people of the same age. Healthy ageing and long life depend on how biological, psychological, and environmental factors interact. Two thirds of elderly people age well, i.e. enjoy good health and are independent. Solitude, poly-medication and dental problems are the most frequent explanations for changing dietary habits. Diminishing sensitivity to odours and flavours is a secondary problem.

Factors that upset dietary behaviours

- Factors upsetting lifestyle: according to recent UNIOSS surveys, poverty increases in the elderly, particularly in elderly women living on their own. The relative proportion of budget devoted to food is higher in elderly people. Life events during ageing upset the lives of elderly people: retirement, death of spouse, mobility within the home, loss of autonomy... Dietary practices change as these events occur. Living as a couple or with the family is conducive to maintaining meal structure and conviviality. According to INSEE, one woman in four and one man in six, between 60 and 74 years old, live alone. After the age of 75, these figures increase, notably in women: one in two live alone compared to one in five for men. It is difficult to determine the precise impact of losing one's spouse on dietary behaviour. In spite of this, several studies have shown that, overall, the diet of men living alone suffers more from modifications in lifestyle than that of women. Energy deficiencies are more evident in elderly people living in towns than in rural areas.

- Loss of autonomy: diet and physical exercise can preserve personal autonomy. Once physical or psychological dependency is established, this usually leads to dependency regarding shopping and/or meal preparation. The extent to which diet actually changes is connected with the sex and status of the person responsible for assisting the elderly person, and changes less when this person comes from outside the house: their children or a social worker. When an elderly person is no longer in charge of food choice or meal preparation, enjoyment associated with food formerly eaten and remembered dwindles.

- Chewing problems: chewing deteriorates with age. Sixty per cent of those over 60 years old have lost some of their teeth, and over 30% have few teeth left. Perception of taste diminishes when a tooth is removed due to the fact that denervation affects taste buds. Also, chewing can be hampered by pain caused by dentures, by poor oral hygiene, and by swallowing difficulties. These problems have been studied, but information is difficult to come by, while they could be dealt with ergonomically (better head posture) or by using technological aids. These problems diminish eating enjoyment, and cause a drop in consumption of fruit, vegetables and fibre while consumption of saturated fatty acids increases, together with cholesterol level.
- Poly-medication: over the age of 65, people take on average 3.6 medicines per day. It is a known fact that at least 250 medicines modify taste (metallic taste), and can even induce ageusia. One sole category of medicines is enough to modify taste (anti-depressants, psychoactive drugs...).
- Deterioration of sensory capacity: diminished olfactory sensitivity is often observed after the age of 60, but epidemiological findings have shown that this has no effect on either weight or dietary preferences. From a taste point of view, perception of different flavours diminishes while a preference for sweet tastes remains and becomes predominant.

Box 9. Nutrition in the elderly is often deficient

The role of nutrition in maintaining health is more important for elderly people than for younger adults. Between the ages of 20 and 90, the calorie ration of meals diminishes regularly and food diversity drops after the age of 60. Yet, contrary to conventional wisdom, the nutritional needs of the elderly remain unchanged, due to the fact that nutrient use is less effective. Physiological ageing alters the nutritional yield of meals which entails deficiencies, particularly for vitamins. Nutritional deficiency is qualified as food intake under 1500 kcal per day. Elderly people have more trouble in absorbing proteins, and protein imbalance causes loss of muscle mass (sarcopenia) thus leading to increased risk of falls and injury. In experiments, ingestion of rapidly-absorbed proteins (such as globular milk proteins) at certain times of the day helps to re-establish organism response. This solution is currently being tested in humans.

On top of these problems, it is hard for people over 70 to cope with weight fluctuations: either less weight gain after weight loss, or difficult return to normal weight after overeating.

Behind the average figures, great differences exist between the diets of elderly women and elderly men, between geographical areas, and between individuals. There are few dietary and sociological surveys on healthy elderly people living at home, and few on the diet of those living in residential homes. Among disorders and illnesses correlated with changes in the diet of elderly people are : malnutrition, sarcopenia, depression, Alzheimer type illnesses, and all the bacterial infections which spread due to physical weakness (tuberculosis...).

Means of action

According to the literature on geriatrics, it is inappropriate to impose diets that are hard to follow on the elderly. The best preventive action is to maintain sufficient food intake, and to fight against deficiencies.

Sociological findings have shown that when nutritional norms and guidelines (PNNS) are communicated to elderly people, this has a positive influence on their dietary practices and seems to be more effective than in other age groups. Purchases of vitamin supplements when people go into retirement suggest that they are more receptive to nutritional messages. Men are particularly sensitive to health messages and to their doctor's advice, while women tend to modify their diet following information from their friends.

In retirement homes, the content of collective meals, and meal organisation and assistance should be more flexible to cater for individual nutritional needs. The lack of personnel for serving and helping residents to eat hot dishes, plus meal quality (insipid and monotonous food that they are not used to, pureed food...) are factors that contribute to the risk of malnutrition.

As far as shopping is concerned, marketing research has shown that shop layout could be more elderly people-friendly (impaired vision, products out-of-reach or difficult to handle...) and certain services could be offered more systematically (shopping delivery, meals prepared and delivered to the home...). Future generations of elderly people will be more used to shopping via the internet.

Generational factors

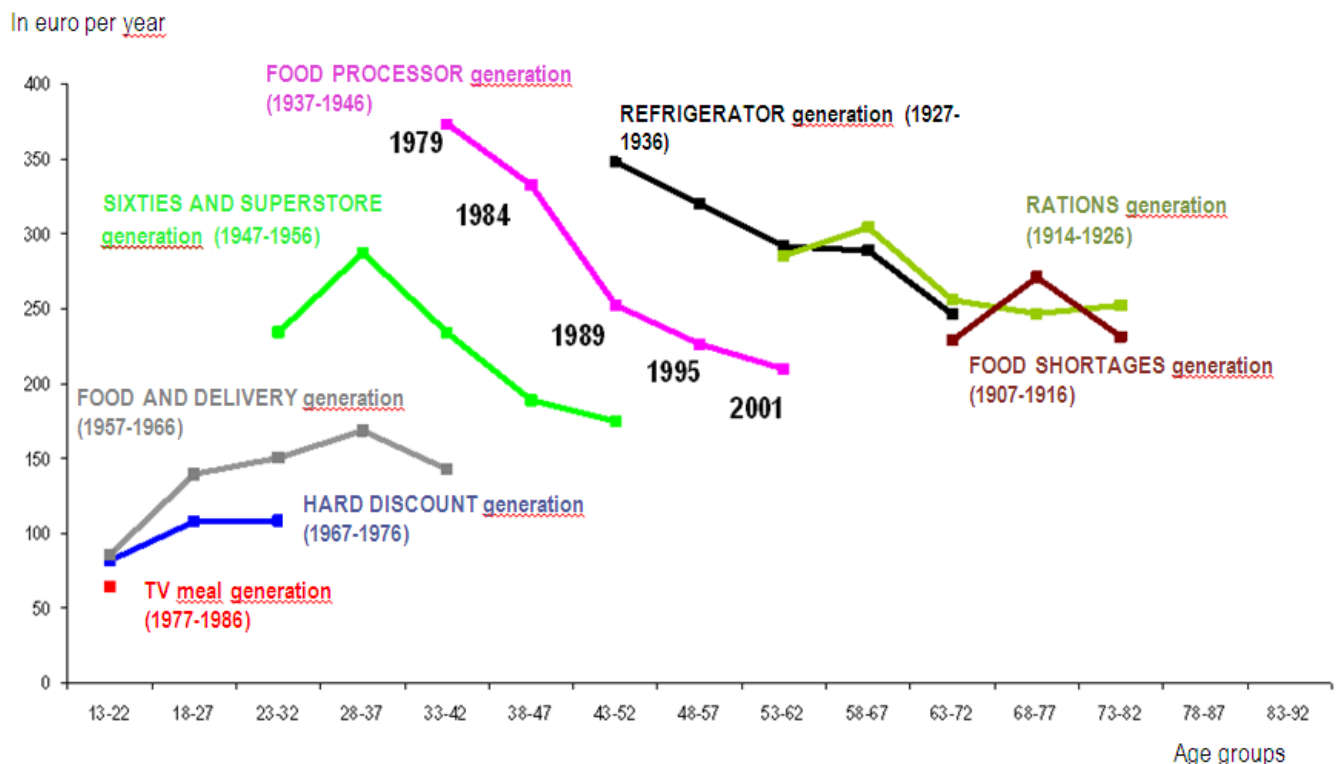
Lastly, dietary behaviours result from force of habit, and are thus connected with age group. The older age groups have a higher intake of bread, fish, fruit, vegetables, sweets and cakes, soups and cheese, while young adults prefer pasta, rice, pastries, milk, chocolate, pizza, sandwiches, convenience foods and meat.

Does this generational effect on dietary habits determine overall dietary changes? The CREDOC studies have examined this issue from many angles. They highlight the preferences of the young for processed foods (chilled dairy products,

convenience foods and preserves, soft drinks and low-calorie products), while the older age groups are drawn to fresh products (fruit, vegetables, meat, fish, potatoes, bread, butter). People born between 1977 and 1986 spend 8 times less on fresh food than their grandparents at the same age. The generational effect can also be observed on budget allocation: the younger age groups spend proportionally much less money on food.

These generational preferences could be symptomatic of dietary changes that could accentuate in the years to come. These trends do however need to be confirmed, since results so far only partially account for temporal events. Specifically, studies have not considered the impact of technological innovations, or the emergence of hard-discount stores, nor do they allow for the effects of quality and price, and do not distinguish between generational effects and societal effects (increase in the number of people living alone, in the average education level...) on changing dietary tastes. Margins of error could significantly reduce the impression given by the graphs below.

Figure 7. Effects of age and generation on fresh fruit expenditure, per household in the lowest revenue level (in 1995 constant euros)



Source : BDF Surveys, 1979, 1984, 1989, 1995, 2000 (INSEE) – CREDOC

Chapter 5. External factors affecting short term dietary behaviours

This chapter presents the main external factors affecting short-term consumer decisions, connected with food product, or shopping environment or eating context.

5.1. Food presentation

The reward circuit in the brain differs according to food product presentation. Attractively presented food triggers a reflex in the brain which prepares for food intake (brain activity in pre-motor areas). This is probably the result of a Pavlov reflex connected with the learned association between aspect, or smell, and the anticipated effects of ingestion which trigger a physiological cascade of events even before the food enters the mouth. The brain plays a key role in initiating this cascade of events and the resulting behaviours.

Brand

Other product characteristics can affect consumer choices according to how exactly the consumer perceives the product, and how fond he or she is of the product. Hence, when hedonistic preferences are ranked for champagne tasted blind, order of preference alters quite a bit when the consumer knows the brands. The very sight of a brand is enough to activate certain brain areas involved in dietary decisions, such as the hippocampus which is associated with memory. Also, brain activity in the areas associated with eating enjoyment is higher when a food is presented and ingested in a context conducive to consumption.

Product name or brand has more impact on consumer expectations and choice than product information, particularly nutritional information.

Food package size

For the consumer, estimation of food volume and energy ration can be affected by the way food is presented.

For the same volume, quantities can seem larger or smaller depending on the form of the container. Quantity appears greater in elongated containers (e.g. bottle) than in even-sided containers. Thus, for a food sold in various sizes, an increase in quantity is underestimated when packaging or portions increase in 3-D. Irrespective of how interested the consumer is in nutrition, of his or her weight or education level (even among nutritionists), the average consumer only perceives an increase of 50-75% when volume does in fact increase by 100%. These underestimations naturally lead the consumer to opt for greater portions.

In addition, choosing between different package sizes or menus depends on how many options are offered to the consumer, since an aversion has been noted to very small or very large sizes, and the consumer thus tends to choose a medium size.

Lastly, the quantity offered to the consumer in shops can be perceived consciously or not as the "normal" quantity to be eaten per meal per person.

Consequently, an increase in size and/or eaten portions incurs an increase in consumption.

5.2. Labelling

Given by labels on packaging, or by facts printed on menus, a wealth of information is available to the shopper or the eater: product composition, human body requirements, effects on health. This information has a varying impact on dietary behaviour, due to how the various types of information are used.

Nutritional labelling

Although quite a few empirical studies have revealed a positive correlation between reading of nutritional labelling and nutritional quality of food choices, the impact of nutritional labelling on public health has yet to be determined. Nutritional labelling can also have a potential impact on manufacturers' strategies, thus indirectly affecting food supply (Box 11).

The fact that nutritional information provided on packaging is considered obscure or perceived negatively, by underprivileged populations, has also been observed. The younger age groups are not particularly sensitive to this information, but the elderly are. These observations raise the question of consumer use and understanding of nutritional labelling. Some evidence can be found below.

Firstly, consumers who are attentive to the connection between diet and health tend to focus on the facts regarding the consequences of their diets, or on the nutritional composition of food products. It is thus not surprising that nutritional knowledge and use of nutritional labelling are both higher when the individual is very aware about nutritional health: educated people, with good incomes, women, and people suffering from an illness.

When faced with a complex nutritional label, consumers tend to focus on one ingredient, e.g. added preservatives or fat content. An experiment has shown that information on fat content determines risk perception by consumers, due to the particularly high impact of this information when foods are classified as "healthy or unhealthy", while information on fibre has no effect (lack of knowledge about fibre and why it is important). This has a "halo effect" which means that product name, brand, or health claim, have more impact on hedonistic and nutritional expectations, than precise nutrient content. The calorie content of foods considered to be "healthy" is thus systematically underestimated, while calorie content for foods considered to be "unhealthy" is overestimated.

A review of 58 studies on labelling formats, carried out between 2003 and 2006 in 15 states in the USA, shows that simple signalling systems, such as "traffic lights" (nutritional quality is represented by a green/orange/red colour code), or health claims, are preferred to more exhaustive and precise labelling (absolute and percentage content of daily recommended intake for several nutrients) since they are easier to use. However, signalling systems that are too simple appear to be prescriptive, classifying products – and thus consumer dietary habits - arbitrarily into healthy and unhealthy. The most effective systems combine product range colour codes (green/orange/red) for a few key nutrients (e.g. fats, sugars, calories, salt, fibre), and precise daily recommended intakes for the product. There is as yet no scientific proof as to how effective the various labelling systems are in terms of dietary behaviour modification, but the Food Labelling to Advance Better Education for Life project (FLAVEL), funded by the European Commission, focuses on the impact of nutritional labelling on European consumers, in order to detect the influence of labelling on their dietary choices and purchasing behaviours.

Box 10. Indirect effect of nutritional labelling on food supply

The primary objective of nutritional labelling is to enlighten consumers when they make their food choices. But it is also an important lever for driving food supply. The use of nutritional labelling can lead to nutritional optimization of supply which, even when consumer behaviour remains unchanged, can generate health benefits.

The most apparent effect of nutritional labelling is product reformulation. Since labelling can reveal certain nutritional characteristics which can appear negative to consumers, this incites manufacturers to modify these characteristics. Reformulation sometimes takes place even if certain consumers are not concerned about health matters, since the manufacturer aims to attract other consumers who are sensitive to health, without losing the others. Reformulation depends however on technological feasibility and on whether products are acceptable to consumers from a sensory point of view.

Labelling, since it attracts the attention of consumers to nutritional facts, reinforces competition. However, labelling can also increase fixed costs, lead to economies of scale, and consequently company mergers and acquisitions. Thus, these costs can sometimes raise certain barriers to market entry and contribute to reducing product variety.

Nutritional labelling is currently non-obligatory. It is only mandatory when nutritional or health claims are made (as set down in Regulation (EC) 1924/2006, and European Directive 90/496). Recent research has shown the extent to which nutritional labelling in France has developed. Most products in most sectors now use Type 1 nutritional labelling (simple), and Type 2 labelling (detailed) is usually present on 30-60% of products. Various facts, particularly for recommended intake, are increasingly marked on packaging. Use of labelling however remains uneven, more frequently by national brands and store brands for core or top-quality products, than for cheaper and hard discount products.

Nutritional and health claims

When products are marketed claiming nutritional or health benefits, European directives have an impact on product characteristics by setting minimal differentiation requirements compared to standard products (Regulation (EC) 1924/2006 sets the conditions for making these claims). Public authorities can influence market segmentation, and the respective market shares for products claiming or not claiming nutritional or health benefits.

Research on consumer attitudes to nutritional claims concentrates on the extent to which these claims affect overall perception of product attributes. The claims have a halo effect, focusing attention on certain specific benefits connected with a product, and eluding any risks linked with consumption.

5.3. Food availability

Proximity between shops and meal locations

The development of supply outlets increases consumption of easily accessible foods. However, there has been little research on the effects on this proximity over the long term.

Choice of supply outlet depends on what the consumer finds locally – local markets in large towns, supermarkets elsewhere – but also on age group since elderly people prefer to go to nearby shops.

“Food deserts” are areas where food shops offering products conducive to a healthy diet are few and far between. This term is mainly used in the UK, meaning that poor areas in town centres have been abandoned by food store chains. We have no comparable information for France, but a research field is opening up to respond to the question “should local food stores improve the quality of food they sell?” According to a field experiment undertaken in Glasgow, changes in food offer appear to be insufficient to change dietary behaviours in deprived areas.

Between 1996 and 2005, the number of fast-food outlets more than doubled in France (+120%), while the number of traditional restaurants remained stable. Thus, by 2005, over one restaurant in 4 was a fast-food outlet, even if this figure also included sandwich bars.

Average price of a meal is 7.6 euros in a fast-food outlet compared to 17 euros in a traditional restaurant. Median annual expenditure for people who eat in traditional restaurants is 1040 euros, i.e. three times higher than for fast-food outlets (364 euros). Comparison in terms of number of meals would not be as explicit.

The proximity of a fast-food outlet to a school, and the probability of being obese has been well proven through a study of 500,000 young Californians. Fast-food outlet proximity (but not other restaurants) has been associated with increased BMI in children more frequently than in adults (reducing the distance from school by 0.1 miles increases child obesity by 5.2%). Policies adopted to restrict this proximity help to reduce adolescent obesity, and are particularly relevant in the more deprived districts where high density for obesity matches that of fast-food outlets which offer low nutritional-quality food. But, even though the development of fast-food outlets has often been stigmatized as being partly responsible for obesity, more research is needed to find out whether this is also true in France.

Food choice: optimal product positioning in shops

It is a known fact that product visibility in the home, through purchasing in large quantities (special offers or stocking-up) or by position in the refrigerator or cupboard, increases eating frequency, as well as the quantity consumed each time, especially for ready-made meals.

The food supply chain, from producer to retailer, uses a great many promotional techniques, which aim to create consumer loyalty, to attract non-consumers, and consumers of other brands. These promotional techniques are based mainly on the observation made above and include optimal positioning of products in supermarkets.

No easily-accessible documents exist on these practices, partly because they are considered to be marketing strategy secrets. Having said this, an American study has shown that the nutritional benefits of low-calorie products (e.g. low-fat potato chips) are perceived better when these products are positioned in shelves near to other low-calorie products. On the other hand, these products are more likely to be selected when they are positioned next to traditional products.

5.4. Sensitivity to distraction during meals

How behaviours are adopted and how they persist is the result of a mostly subconscious learning process which integrates environmental factors. It is thus essential to analyse these factors if dietary behaviours are to be changed (see therapeutic education below).

In adults, dietary behaviour is the result of acquired automatic choices, and is often influenced more by environment than by individual will, particularly as regards distraction during eating. Certain types of distraction can lead to overeating.

The effect of distraction on food intake has been studied extensively. The relation between time spent watching television and body corpulence has been proven both in children and in adults. Some authors have suggested that television is partly responsible for obesity especially in children. When the television is on all day, eating is more frequent and, more importantly, consists of high-energy foods. This does not seem directly linked with advertising viewed during the meal because, during the period immediately following the advertising, neither energy absorbed nor quantity absorbed are affected. It is thus more probable that the subconscious of the eater is responsible for ingestion and quality of food ingested. When the television is on during a meal, food intake is higher during the following meal, probably due to poor memorization of how much food was consumed previously, which affects the size of the following meal.

Other distractions linked with meal atmosphere have the same effects on consumption : strong light can stimulate eating, just like low room temperature or loud music. The hypothesis according to which distraction increases the size of both the meal underway and the following meal has been validated in amnesic people. On the other hand, when one is attentive to what one is eating, this leads to smaller meals. This attentiveness means that the quantity eaten is memorised, and that less is eaten during the following meal.

Lastly, research carried out in France and in the Netherlands has shown that social context is much more powerful than initial hunger, and that eating companionship increases food intake. Conversely, solitude diminishes food intake, which is the case for many elderly people. Food intake even increases along with the number of table companions (according to research findings in the USA, in the Netherlands and in France). This phenomenon is particularly true for family and friends, but is the opposite when the table companions do not know each other. Thus, type of table companions affects food intake, which decreases when they are less well-known.

Part three: Strategies for improving dietary practices

Part Three examines the different levers for altering the dietary behaviours of individuals or the population overall.

Responsibility for impact on health of dietary practices is the subject of debate: on one hand, the individual consumer is responsible, and on the other, environmental determinants are to blame. In order to try and modify individual behaviours via public and private initiatives, efforts long focused on individual factors including improved knowledge, intentions, attitudes, motivations and tastes. Over the past decade, the number of studies on the link between consumer lifestyle and behaviours has shot up. Also, strategies have been directed towards the individual and his/her environment, with a view to modifying behaviour.

What is the impact of the initiatives undertaken so far to modify dietary practices? If the strategies already underway are analysed, how can the situation be improved, and what other levers can be introduced? How can the determinants identified in Part Two be used effectively for strategies to modify dietary behaviours over the long term?

Sources and data

The articles used for this analysis focus on the impact of strategies which aim to modify dietary behaviours and/or dietary practices. Also, several international data bases have been used, which were published in reports available over the internet rather than in peer-reviewed journals (e.g. USDA reports or CDC reports – Center of Disease Control and Prevention). The articles were produced mainly in English-speaking countries (USA, UK, Australia, and to a lesser extent northern Europe) but rarely in France.

Econometric and statistical evaluation methods of public policies and identification of causal relations

Ideally, to measure the outcomes of a public policy (nutrition tax, information campaign, advertising ban), the situation of targeted individuals would need to be analysed both before and after implementation of the policy, and this would be compared with what would have happened in the absence of the policy. So, to analyse the effect of a determinant (price, information, nutritional labelling, etc.) on behaviour, changes in the behaviour of a person affected by changes in the determinant would need to be compared with changes in the behaviour of the same person if he/she were not affected by these changes.

The optimum approach: field experimentation

Counterfactual simulations are obtained by randomly drawing "treated" and "control group" individuals from the population, meaning that these two groups usually share the same characteristics. This method is applied in comparing trends between purchases in supermarkets from shelves carrying nutritional labelling, with purchases in shops with no nutritional labelling.

Random sampling has also been used recently in France in social experiments (cf. testing prior to general application of the Social Support Benefit). This method can only be used, to evaluate public policies targeting the entire population (e.g. information campaigns) or specific strategies targeting certain people (e.g. therapeutic education), when the choice of "control" and "treated" groups plus strategy implementation take place simultaneously. It would be advisable to use this method more frequently for measuring specific prevention procedures prior to general use.

Econometric methods for correcting selection bias

Econometricians and statisticians have developed several methods for eliminating selection bias, given reasonable hypotheses. These methods aim to re-create the statistical conditions determining the random assignment to a control group or a treated group. The objective is to make sure that the behavioural variations between these two groups can clearly be put down to treatment: this is called high internal validity.

The internal validity of these methods is based on various statistical hypotheses that can often be tested. As a general rule, we have only retained those econometric and economic studies where testing appears convincing.

Econometric models for simulating public policies

The external validity of the methods described above can sometimes be challenged. For example, if social experimentation of a procedure only takes place in a specific region, results are not necessarily valid elsewhere. Ex post and ex ante econometric evaluations of public policies are thus used differently. Ex post evaluations measure the success or failure of a policy after implementation, using data provided by observation of individual behaviours. Internal validity is a crucial factor for method robustness.

Ex ante evaluations also measure success or failure, but usually via hypotheses regarding how individuals choose (or are assigned to) the treatment and how they respond. Internal validity is often weaker since these evaluations involve choices regarding individual rationality, and do not necessarily seek to identify a counterfactual reason (even if, in actual fact, this would make things easier). Thus, hypotheses are often made about how individuals anticipate the costs and benefits of a treatment, before actually choosing it, or about the interactions that can exist between economic agents.

In any case, a reliable evaluation of the impact of public policies must be based on a econometric/statistical analysis carried out on actual data (experimental or not), using where possible large samples and significant variations in the relevant variables (price, tax, information, etc.). This is why most of the simulations offered by articles about public health should be treated with great caution.

Chapter 6. Evaluation of strategies and public policies

At the end of this chapter, a table shows all the strategies implemented in France with a view to modifying dietary behaviour. For each strategy, information is given regarding evaluation effectiveness and scope, plus possible levers for improving impact on dietary behaviour.

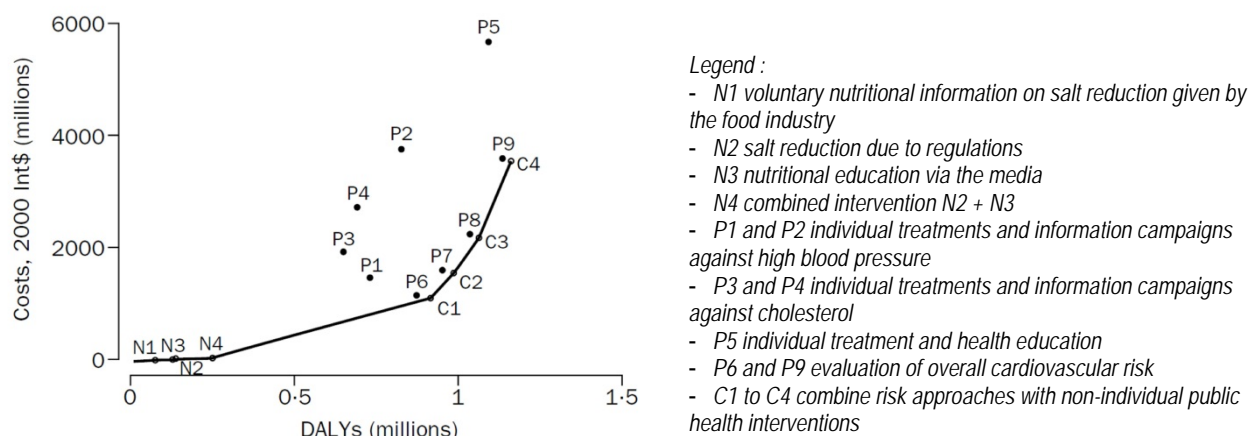
6.1. Generic information campaigns

The impact of campaigns promoting nutritional health remains difficult to evaluate, since many different intermediaries can be mobilized (government agencies, medical specialists, the media, industry), and the campaigns themselves are initiated by progress made in scientific research. Thus, numerous studies reported that, in the 1980s in the USA, there was an improvement in the perceived link between cholesterol and cardiovascular risks, which was correlated with the number of medical articles on this subject. This improved perception of risk is also associated with a real drop in consumption of cholesterol-rich foods in the USA. This drop has also been observed in France, where it is also significantly associated with the number of medical articles on the link between cholesterol and cardiovascular risk. But can the effectiveness of public policies really be proven in this case? No, if one considers that the wealth of medical knowledge published on the role of cholesterol may have had a direct impact on doctors, and thus on their patients. This mounting knowledge has doubtless led to initiatives being taken by insurance companies and the government. The consumer grapevine may also have played an important role. Lastly, it is possible that changing dietary habits within certain social groups (usually the wealthier) have filtered down into other social groups, according to mimetic theory or social norms on diffusion. It is impossible to choose between these different hypotheses (Box 12).

Box 11. Evaluation of strategies using the example of cholesterol

When instituting public policies, it is important to strike a balance between intervention effectiveness and intervention costs according to how high the risk of illness is within the target population. An evaluation was made by the WHO of strategies aiming to reduce the risks related to high blood pressure and cholesterol level (Figure 8). The study compared the impact of: messages broadcast to the general public by the media for modifying diet; legislative measures decreasing the salt content of food products; and personalized medical check-ups and drug monitoring. Results have shown that the best cost-benefit ratios were obtained for strategies combining general public nutritional measures and interventions targeting high-risk individuals.

Figure 8. Costs and DALYs for general public interventions (N), personalized interventions (P) or combined interventions (C) aiming to normalize blood pressure and cholesterol in Europe



The N dots represent an inexpensive strategy which is not very effective in terms of lives saved, the P dots represent expensive personalized and more effective procedures; the best cost-benefit ratio is for a combined approach near to the C1 dot.

Source : Murray CJ, Lauer JA, Hutubessy RC, Niessen L, Tomijima N, Rodgers A, Lawes CM, Evans DB. Effectiveness and costs of interventions to lower systolic blood pressure and cholesterol: a global and regional analysis on reduction of cardiovascular-disease risk. *Lancet*. 2003;361:717-25.

The PNNS is an example of systematic communication, particularly advocating fruit, vegetables and physical exercise, and reduced consumption of fatty, sugary and salty foods. An INPES survey undertaken between 2005 and 2008 analysed the perception of messages communicated since 2002. This shows that the main PNNS indicators have been well assimilated. However, awareness of certain indicators remains poor due to a persistent negative attitude regarding certain foods and due to ignorance regarding their characteristics (as in the case of starchy foods). Men are less receptive to messages, but the gap between socio-professional classes is tending to disappear over time. For all that, even though manual workers are twice as likely to discover new information in PNNS-type health messages, they are also two and a half times as likely to feel guilty because of these messages, and five times as likely to find them stressful. Also, an eye-tracking approach which records the eye movements of people viewing TV advertisements for food products, shows without any doubt that the “Eat well, be fit” information strip at the bottom is hardly ever looked at. The movement in the advertisement attracts the eye, and not the static information strip in black and white. It is thus clear that communicating both qualitative and quantitative guidelines in the same message, even when they are simple, is extremely difficult.

The “5-a-day” campaign for fruit and vegetables has been widely used throughout the world. And it has been evaluated in many countries, including: USA, UK, Denmark, New Zealand, Norway. A concurrent increase in fruit and vegetable consumption (slightly higher in women) has been reported almost everywhere, although limited in scope and over time. Having said this, the 5-a-day guidelines are almost never followed, due to many recurrent factors: family reluctance, product cost, supply disparities, time constraints, and lack of cooking skills.

In the USA, food pyramids represent nutritional guidelines in terms of proportions of food groups required for a daily or weekly balanced diet. It does however appear necessary to create alternative pyramids for cultural groups within populations, in order to include the foods they usually eat.

6.2. Public interventions targeting individuals and socio-cultural class

Nutritional and sensory education

Nutritional education is a common form of intervention used by public health providers, and evaluations have been published. Nutritional education consists of group projects in schools, in local districts, or within specific communities, it supplies information and contributes to inducing changes in behaviour. In most of the projects evaluated in Europe or in the USA, impact is effective for improving target group knowledge and attitudes towards healthy foods, but low for changing long-term behaviour. Nutritional education focuses most of all on children, and less frequently on adults for whom results are less positive. When cultural differences are addressed, there is a significant improvement in nutritional education effectiveness.

Sensory education improves the ability of children to describe what they perceive. It has a modest effect on reducing fussy eating, particularly among the 7-9 year olds. It also increases eating enjoyment and encourages social contact. Whether prolonged sensory education further reduces fussiness remains to be confirmed. But effectiveness is greater if the learning context is formal and theoretical, and continues throughout childhood. Effectiveness also depends on how supportive parents are about this issue in the home.

There are no programmes, nor any research work, on sensitivity to hunger and satiety, which could be the subject of educational programmes like those on taste, with a view to teaching children more about these physiological feelings and how to control them.

Therapeutic education of patients

The cognitive-behavioural approach seems to be the most effective to date, but has only been used so far in obese patients or those suffering from dietary behaviour disorders. It is used with individuals but not with populations. It uses the “small steps” strategy, based on a string of small modifications to behaviour and to individual environment.

The main objective is to provide personalised help to patients so that they learn, or carry on using, the proper approach required for coping with a chronic illness in daily life. This approach covers both nutritional quality of food and physical exercise. Both patient and family are included, especially for children. The patient is considered as a major player and must find appropriate solutions for dealing with his or her problems. Self-confidence is thus essential, especially for children and adolescents, and coping with stress is important in adults. For all age-groups, the power of attraction inherent to palatable foods should not be underestimated. Therapeutic education requires on-going and mandatory follow-up, meal regularity during therapy is crucial and must be established prior to implementation of the therapy. Long-term results are convincing, even though success varies according to the individual.

Applying this therapeutic approach to people before onset of illness is currently deemed to be too expensive. New techniques have been tested and could diminish follow-up costs: the internet (personalised programmes and expert systems, the results of which are under evaluation), podcasting (educational programmes which improve learning motivation and which obtain better results), the mandometer (computer tool providing instantaneous feedback about eating kinetics), virtual reality (learning to deal with stress).

Social marketing

This multisite strategy was introduced in the 1970s, for use with specific population groups. Micro-changes are made to the family environment and family circle using daily stimuli, thanks to the collaboration of a local network composed of : health-education providers, people working with town councils and associations, people working on food supply and services, and in agriculture, etc.

The effectiveness of social marketing has been demonstrated in curbing smoking and alcoholism, and in preventing skin cancers, but not yet in modifying diets, because tools for evaluating strategy were not immediately available. An example is the EPODE project initiated in 2004, and although preliminary results are encouraging (child overweight and obesity have diminished), these are not yet published.

6.3. Food supply interventions

The question of whether public interventions regarding food supply are justified is controversial, part a few government initiatives exist worldwide. When they do exist, they are recent (e.g. the PNNS2 in France), which goes to explain why no exact evaluations are available regarding the effectiveness of these measures. Most of the published articles offer conceptual frameworks based on different views of the interaction existing between public authorities and companies. Thus, the logic behind the interventions described in these articles highlights either company self-regulation, or regulatory and coercive action on the part of governments, or joint regulation by public authorities and companies.

On a more concrete note, several studies show that changes in the nutritional quality of food have been introduced by manufacturers in various countries. Some studies have quantified these changes over the past few years, specifically those for salt content, lipids, fibre or sugar. In France, the AFSSA and OQALI studies have started to provide information on this trend and indicate a general shift towards product reformulation, even though this depends on manufacturing sector and individual company.

To understand the different ways of improving the nutritional quality of food, a distinction must be made between "nutrition-oriented" products and "standard products".

When new products offering nutritional benefits are put on the market, consumers are informed about these improvements via nutritional or health claims, which go to justify higher prices. Market share of these products depends upon the amount health-conscious consumers are prepared to pay for them, and upon public regulations regarding these claims. Public regulations demand a sufficiently marked improvement compared to standard products in order for a product to make a nutritional or health claim. Regulations affect market segmentation according to the following principle: either regulations are very strict, which guarantee major nutritional improvements in products put on the market, but which incur higher prices and smaller market shares; or regulations are more lax, which incur lower prices and higher market shares, but also lower nutritional benefits. Research findings have not yet allowed the economic or health consequences of these two options to be established.

As far as standard products are concerned, improvements in nutritional quality often cause changes in taste. Thus, a product could be rejected by the consumer if its nutritional value is not made clear. Some authors suggest that reformulation should be gradual and continuous so that consumers get used to it (e.g. gradual reduction in salt content of a food). The fact remains that market competition in certain sectors can lead to reluctance to take this risk.

In order to address this difficulty, French public authorities have asked manufacturers to sign nutritional improvement charters. The general aim is to encourage manufacturers to make nutritional improvements to their products, particularly for those carrying no claims. These charters can be individual or collective, and in this case can apply to all or part of a manufacturing sector, so that a minimum improvement is made to the nutritional quality of certain products (via a change in how a product is used for example). A total of 17 charters have been signed to date in France by manufacturers and retailers, very often individual companies, and validated by the government (Box 13).

Box 12. Levers for improving the diet of underprivileged populations

Focus on target groups

In fighting against obesity, the “focus group” technique is widely used in English-speaking countries. This allows the expectations and perceptions of a target group to be identified, and the message to be adapted to it. However, few interventions have actually been assessed. Women, particularly obese and overweight women, have emerged as a prime target (22% of poor women are obese according to the OBEPI study, 2009). Group interventions have proved their effectiveness on both weight and quality of life, at a modest cost (between 280€ and 360€ per patient).

Interventions targeting women allow family dietary behaviours to be modified, especially those of children. Mothers do not easily consider their children to be overweight, and perceive food restrictions as a frustration that they are not prepared to impose upon their children. Only one study has shown that an 8-week programme led to weight loss in mothers, together with a reduction in the consumption of fatty foods and soft drinks by children between 1 and 3 years old, and increased physical exercise. Obesity prevention programmes for children increasingly deal with obesity in their parents.

Communicate appropriate messages

A study of 1826 people living in 3 communities showed that energy intake from snacks was more highly correlated with obesity, than fruit and vegetable consumption and amount of physical exercise. The authors concluded that focusing on a reduction in high-energy snack foods, would have a greater impact on obesity than a strategy focusing on greater consumption of fruit and vegetables. This hypothesis has been confirmed by studies on interventions aiming to reduce soft drink consumption in children and adolescents.

The use of video has also been effective, and three times less expensive than individual consultations, but is more suitable for adults than for adolescents. Personalized postal messages have also led to more lasting changes in the food consumption of targeted individuals (the study focused on fruit and vegetables), but the cost of this approach has not been assessed.

Enlist the support of proximity networks and intermediaries

Initiatives focusing on diet are more effective if they are part of a community health approach, integrating community values and attitudes, and if they enlist the support of existing networks (formal and informal) or even strengthen the social ties between individuals. This social dimension improves the rate of adoption in people targeted by the proposed programme. Adopting a behaviour and sticking to it are easier if people are encouraged by their immediate social circle. This can be their family, hence the importance of programmes targeting the entire family, but also local associations or social networks. Participation of doctors improves the effectiveness of intervention, on the condition that these doctors are optimistic about changing the dietary behaviour of underprivileged populations, but this is not always the case.

Make use of food price

When the impact of price and revenue on the food choices of the underprivileged is examined in detail, it is clear that this varies considerably according to product category (cereals, fats, fruit and vegetables, dairy products) and according to social characteristics. Also, nationwide tax policies which aim to make fatty foods more expensive (e.g. fat tax), or to make certain foods qualified as healthy less expensive (e.g. fresh fruit and vegetables), do not target the underprivileged in particular.

In fact, the impact of price intervention (e.g. lowering the price for healthy foods) for improving the nutritional quality of diet, can affect the underprivileged less compared to the rest of the population. A study in experimental economics undertaken in France found that a drop in the price of fruit and vegetables did improve the nutritional quality of dietary choices in the underprivileged, but to a lesser extent than in more wealthy consumers, thus confirming econometric findings. An experiment, combining a drop in the price of healthy products and an increase in the price of products to cut down on, came to the same conclusion.

Strategies providing direct aid to poor families in the USA (like food stamps) lead to increased consumption of familiar foods, but not of healthy foods. Results of a test in France which granted shopping coupons for fruit and vegetables were quite encouraging, but further tests are required before any conclusions can be drawn.

In the USA, some projects have consisted of granting food parcels or shopping coupons on the condition that the target-groups attend the nutritional education programmes. These interventions continued to be effective six months after the end of the programme in terms of increased consumption of fruit and vegetables. However, how this affects other food categories is not known, nor is the impact of prior dietary habits of the beneficiaries (in this case Hispanic).

A European study (TEENAGE) is currently reviewing all the interventions targeting young underprivileged people. The different types of intervention are analysed (health education, environmental action, global policies, price intervention) as well as intervention context (individual, family, school, social circle), and how these compare with equivalent interventions in other European countries.

Box 13. Regulating the nutritional quality of food supply: nutritional improvement charters

Using measures set down in the PNNS1 and PNNS2 programmes, and in addition to information and education campaigns, French public authorities have decided to push for an improvement in the nutritional quality of foods (including generic products and budget products) so that healthy nutritional choices are made by all segments of the population.

To accomplish this, manufacturers are encouraged to sign voluntary charters with the State for improving the nutritional quality of their products. The State thus seeks to spur manufacturers to work towards this collective goal, by improving as many products as possible.

These charters, echoing the priorities defined by the PNNS, can focus on nutritional composition and volume of food consumed, i.e. consumption of salt and simple carbohydrates, total lipids, saturated fatty acids, complex carbohydrates and fibre, fruit and vegetables.

Manufacturers having voluntarily signed the nutritional charters, are allowed to inform consumers about the improvements to which they have committed in these charters. The phrase "company committed to nutritional progress as recommended by the government (PNNS)" can be used on packaging as long as nutritional information is also on the labelling. These charters carry no legal obligation.

Between February 2007 and February 2010, 15 charters were voluntarily signed, mainly by individual companies, both manufacturers and retailers, but seldom by collective sectors of the food industry. The Observatory for Food Quality (OQALI: www.oquali.fr), set up following a PNNS proposal, monitors the status of these commitments and measures their overall impact. Estimated impact on food supply and consumption is not yet complete.

As far as food supply is concerned, the commitments made by the companies having signed the charters cover on average between 5% and 15% of market share depending on the product. If these charters were fully applied, this would entail considerable modifications in the intake of certain nutrients. As an example, roughly 10,000 tons of sugar would be taken off the market.

A preliminary study was undertaken using OQALI data to estimate more precisely individual consumption and impact of the charters.

Given the hypothesis that a consumer chooses, for food groups where companies had signed the charters, only those products marketed by these companies, a significant variation of total intake would be observed, thus:

- a drop in sugars of 4.2%, i.e. 16 kcal/day;
- an increase in fibre of 2.3%, i.e. 0.8 kcal/day;
- a drop in lipids of 2.5%, i.e. 20 kcal/day;
- a drop in sodium of 7.8%
- an increase in vitamin D of 8.3%, i.e. 0.2 µg/day (4% of daily recommended intake).

These charters have only been signed so far by a modest number of companies, but their commitments could have a significant effect. Having said this, modifications in food consumption will only take place if the commitments of these companies filter down to cover a large proportion of the food supply. In addition to increasing the number of individual charters signed by manufacturers or retailers, another course of action would be to encourage food sectors to make collective commitments, so that nutritional quality of the less popular products within each sector would improve.

Dealing with perception bias when fixing portion size

In France, there is no precise data regarding changes in food portion sizes, even if an increase in portion size and in packaging volume is a common trend in most developed countries.

In the USA, on the other hand, increase in portion size and packaging volume have often been quantified and reported in the literature, since this trend is evident. Both portion size and packaging have often doubled over the past 20 years, whether for food consumed at home, in a restaurant, or sold in supermarkets. The development of a market for large portions has allowed manufacturers to diminish unit production costs. But this has also led to an increase in purchased quantities, due to the aversion shown by consumers towards very large or very small sizes. Given this aversion bias, an experimental study on fast-food menus offered to a representative sample of Americans, found that a policy for regulating menus aiming to reduce the quantities bought by individual consumers, could prove effective. Thus, if the offer of small-size portions is extended and large-size portions are scrapped, then consumers would choose as usual the medium-size portion, but which would have diminished in size. Fast-food restaurants would maintain profits and consumption level would automatically diminish.

It should be noted however that very small-sized packaging can induce an increase in consumption, particularly for treats and for people exercising cognitive restraint (deliberate effort to limit food intake with a view to controlling weight). Small-sized packaging does give the impression that consumption is under control and this can encourage self-indulgence.

Role of advertising

A recent study has measured the outcome on food consumption of a ban, implemented in the province of Quebec in 1980, on advertising which targeted children under 13. For fast-food restaurants, the main outcome of the ban was reduced purchasing probability, but the ban did not affect family expenditure once in the restaurant. When fast-food expenditure of families with children in Quebec was compared with that of equivalent families in Ontario, the authors of this study estimated that the ban had entailed a decrease in fast-food expenditure in Quebec of between \$13.73 million and \$31.27 million (i.e. between 3.5 and 8.1 million meals) per year in the 1980s and early 1990s.

A recent American study using econometric analysis holds that, if television advertising for fast foods were scrapped, there would be a drop of 10% in the number of overweight children and adolescents. Given the methodology used, this figure represents the maximum outcome that could be expected from such a measure.

As for the situation in France... In 2002, French children watched television for 13 hours per week (compared to 22 hours in the USA), 70% of advertising was for food (56% in the USA) and 49% was for fatty or sweet products. In 2007, according to a UFC-Que Choisir study, 85% of food advertising targeting children is for foods that are far too rich in fats, salt, or added sugars. This advertising is often screened between mealtimes. The food industry seems to have voluntarily reduced its advertising during children's viewing periods, by 51% between 2006 and 2008 according to the Advertisers' Association. Given the controversy on this subject between consumer associations and the food industry, an independent study seems to be called for which would inform about trends for advertising directed at children.

Improving availability of products conducive to good health: the example of fruit and vegetables

Interventions that aim to encourage higher consumption of fruit and vegetables have been put in place, and often consist of increasing product visibility. In France and elsewhere, action to promote fruit and vegetables to children in schools has been successful, particularly in increasing fresh fruit consumption.

In the USA, in residential homes for children, increased supply of fruit and vegetables clearly encouraged adolescents to consume more of these products.

In France, the installation of fruit vending machines in schools was considered to be a real success, but these were banned from secondary schools on 1st September 2005. The current campaign called "a fruit break" has revealed that, while fruit consumption has dropped due to the economic crisis, this is less pronounced in children having benefited from the campaign.

Also, while fruit and vegetable distribution in schools has had a positive effect on fruit consumption, this has seldom affected vegetables. This has been observed in various countries. Thus, in Norway and Denmark, programmes in primary schools offered children who agreed to participate, one fruit twice a week and one vegetable twice a week on other days. Consumption of fruit rose for all children (+0.3 to 0.4 item/school day) but there was no change for vegetables. Free distribution of fruit and vegetables in the USA also had no effect on vegetable consumption.

It should be noted however that a large disparity exists between expressed intention and real life in the school context: in New Zealand, while 91% of schools claim to have a dietary policy, only 16.5% have a satisfactory policy. There is no equivalent data for France.

Generally speaking, interventions providing availability and access to fruit and vegetables are more effective when undertaken in enclosed sites, such as the workplace or schools. Interventions in shops are less effective, and while many initiatives encouraging access to fruit and vegetables have been implemented for eating outside the home, no data is available since these measures have not been evaluated.

Development of price policies

Subsidies

Policies providing direct aid to poor families in the USA (food stamp programmes) have led to an increase in the consumption of popular products, but not of healthy foods. On the other hand, if specific coupons for fruit and vegetables are distributed, overall results are encouraging and the coupons fully used.

Generally speaking, the outcome of subsidies is more convincing in a closed context, when food substitutes are limited in number, and when subsidies are only given for products targeted for increased consumption. When the cost of a food increases, consumption drops, and vice versa. This simple mechanism goes to explain why the price drop for the fresh fruit (low-fat products) sold in school vending machines, significantly increased sales, as shown in an American field test.

This mechanism also explains why special offers significantly boost both purchases and consumption. This can be a problem when the special offers are for fatty or sweet products because consumers tend to stock up. And the larger the stock, the higher the eating frequency of the product is and the quantity eaten each time.

In a wider context, interventions in school or university cafeterias in the USA show that when choice is greater and price drops by about 50%, purchases of fruit and salads are multiplied by three or even four, without changing total sums spent in cafeterias. But these behavioural changes are driven by economic concerns only, and consumption levels return more or less to normal afterwards, indicating that sporadic interventions do not lastingly modify consumer preferences a great deal: the outcome observed could be explained by the replacement of home consumption of fruit and vegetables, by cafeteria consumption. Also, a threshold has been detected regarding the extent to which subsidy rate modifies purchasing behaviour.

A study on the relative effects of price and nutritional information on consumption of low-fat products in a city restaurant (for a price drop between 20% and 30%) shows that, when these two factors are separate, a price intervention has a greater effect than nutritional information. When the two factors are combined, these interventions have mixed effects: sometimes the nutritional message can even be interpreted negatively as regards taste, and thus counterbalances price drop.

Tax policies

Simulations indicate that modulating VAT or excise duties according to the nutritional profile of foods would be a simple and inexpensive tool for altering behaviour. Research based on price policy simulation has deduced that taxation of dairy products, animal fats, convenience foods, and savoury and sweet snacks, should be a priority, if the nutritional objective is to reduce calorie, cholesterol and fat intake. This type of intervention has its limits.

First and foremost, this research shows that nutrient intake does not react much to price variations: a price increase of 10% on the above products would lead to a 3.4% reduction in energy intake, and 4.3% in saturated fats. Hence, to reach one sole nutritional guideline would require great changes in price. Also, the secondary effects of such a measure on food quality are not known: a decrease in calcium intake (-2.8%) could ensue, or in phosphorous (-3.2%). Lastly, these policies would tax products that are very popular with the lower social classes, and would thus be regressive. These mixed reactions to price variations remain to be investigated, since existing simulations focus on the average individual and not on more vulnerable people.

On the other hand, behavioural reactions to price variations are fairly well understood, even if they are sometimes surprising: a tax on fatty and sweet foods would have more effect on fruit and vegetable consumption among the higher classes than among the poorer classes. Raising food tax is inequitable since it would heavily affect consumers who have no choice but to buy inexpensive and high-energy products.

Concretely, soft drinks are suspected to contribute to child obesity and have been the subject of time- and place-limited taxation in the USA. No significant effect has been observed on adolescent BMI. However, partisans of this type of tax feel that there may be a threshold effect above which both price and hence behaviour would be affected, as in the case of smoking.

Likewise, a recent meta-analysis on taxation of energy-dense foods and on subsidies for health-promoting foods, shows that effects are usually very slight on individual weight. However, significant price variations greatly affect low-income groups, children and adolescents, and populations at risk for overweight and obesity. These preliminary findings will need to be backed up by more research.

Hence, current results published in the literature do not make a case so far for nutritional tax policies, since there is no direct proof that they are effective in rapidly modifying individual behaviour and the population's state of health. Their long-term outcomes are also unknown and remain to be investigated. Also, theoretical studies point to the possible existence of secondary effects that price policies could inflict on food supply. In particular, manufacturers could decide not to add the tax, and thus increase sales price, in order to maintain demand. But this decision could lead them to reduce production costs, the outcome of which could be lower quality, which in turn could cancel out the potential benefits of the tax. However, this risk has only been identified in theory and remains to be confirmed empirically.

A comparison between taxes, subsidies, and restricted access to food products, shows that subsidies modify food purchases, but not necessarily consumption or body weight. Increasing access can affect purchasing, and sometimes food intake and body weight as well. Data on restricted access are too limited to be considered as representative.

Table 7. Interventions for modifying dietary behaviour

How each intervention is evaluated, and how possible levers can be used for improving impact on dietary behaviours.

Strategies targeting individuals	Evaluation - Effectiveness	Scope of strategy	Levers
Generic nutritional information campaigns, PNNS type	Effective for improving knowledge and attitudes, but not behaviour	Nationwide	Probably insufficient when used alone, but could be combined with strategies targeting individuals or supply/context
Food pyramids	Poor effectiveness when used alone (1%-3% of Americans follow guidelines) but useful learning tool Only realistic guidelines are followed Assimilated with normalisation	Nationwide	Related messages that are clearer, stable, oriented to eating enjoyment A tool for evaluating food quality in the workplace and school
"5-a-day" guideline	Average increased consumption of 1 portion (80g) after campaign lasting 4 to 12 months Satisfactory knowledge of programme and message content, low impact on consumption	Nationwide, local authority, workplace, schools	More concrete suggestions : fruit juice at breakfast, fruit as a snack, vegetables with main dish, fruit as a dessert Encourage supply in cafeterias and restaurants, and in life settings
Group education in nutrition	Effective for improving knowledge and attitudes, but not behaviour	Local authorities : county, town, workplace, school	Participation of individuals in games Differentiate nutritional education according to culture
Individual therapeutic education	Effective if family or friends are involved in the programme; cognitive-behavioural therapies perform better than behavioural therapies targeting diet and physical exercise.	Hospital, health-care providers (for patients and social circle).	Group workshops to bolster individual care Maintain a non-rigid attitude towards food (no cutting-out), no snacking, no distraction during meals, increased physical exercise

Combined strategies	Evaluation – Effectiveness	Scope of strategy	Levers
Promotion of community health (e.g. EPODE in France)		Towns, associations, counties	Participation of target populations in elaborating strategies (involvement) Requires support of food industry, media
Social marketing	Few evaluations available. Has the advantage of encouraging a change in standards and practices, both collective and individual More effective in specific locations	Towns, associations, counties, education systems.	All stakeholders need to be mobilized so that priorities and strategies are adopted collectively

Strategies targeting personal environment of consumer	Evaluation – Effectiveness	Scope of strategy	Levers
Family environment	Confirmed link with consumption of fats, soft drinks, fruit and vegetables	Town, local authority, health-care providers	Educational programmes for parents in teaching and assisting their children
Encourage access to healthy products outside the home	Significant changes over time. Risk of consumer completing diet with special offers, without stopping consumption of less healthy products	Local authorities, workplace, manufacturers	Educational programmes for children (gardening, cooking...). Distribution of fruit and vegetables in schools
Limit access to certain products	Strong link between BMI and reward foods Exposure to soft drinks is a significant predictor of consumption Confirmed link between obesity and fast-food proximity to schools	Schools, families Manufacturers, schools Towns	Parental education on this issue. Vending machines for healthy products in public places Appropriate town planning
Action on price using taxes and subsidies	Contradictory impacts : Modest results for high taxes A tax of +10% on sweet foods = -25% in child obesity, -28% in overweight children, -14% in female obesity. Underprivileged populations: subsidies for fruit and vegetables are more effective than taxes on fatty and sweet foods. Significant results for low-income households, children and young people, populations at risk of obesity Subsidies modify purchasing, but not always consumption or body weight (confirmed)	Nationwide	Significant effect above a certain threshold together with massive information campaigns. Strategy combining taxes on certain products, and subsidies on others.
Nutritional labelling regulations	Impact of nutritional labelling on BMI is difficult to evaluate : selective use by overweight people Relatively successful for fats and iron Risk of associating healthy with lower organoleptic quality	Nationwide	Continue to inform the 21% of the French population who read labelling. Clearer scientific data, easier and more motivating labelling procedures. Extend labelling to restaurants (including canteens) and convenience foods.
Direct aid to consumers (food coupons)	Few evaluations Reduces inequalities for fruit and vegetables	Nationwide, local authorities, workplace	Accessible food supply (e.g. markets) together with personal advice
Regulate advertising	Experiments have proven the link between repeated exposure to advertising and eating frequency Estimations based on econometric analyses : if advertising is scrapped = -10% overweight children	Nationwide	Advertising regulated for fatty and/or sweet foods during TV programmes for children. Use of TV as learning tool
Action on food supply by improving product quality	Few studies measuring exact impact have been published -Self-regulation by manufacturers: limited effect -Government regulations :great effect -Public/private joint regulations rarely evaluated	Manufacturers Nationwide	-Small modifications affecting numerous aspects -Ban on trans fats within EU for example -Public/private partnerships for pooling expertise
Action on food portions and packaging	Container and portion size affect consumption levels in and out of the home. Demand focalises on medium size.	Manufacturers	Reduced range of portions and container size Development of small portions for restaurants and cafeterias

Conclusions

Great changes in dietary practices have occurred.

An overall approach to diet is required for understanding impact on health.

- Changes in dietary practices over the past few decades, particularly the increase in the proportion of lipids in diet, are linked with modifications in food supply and more generally with changes in lifestyle.
- Research on the links between diet and health focused primarily on the role of nutrient intake (lipids, vitamins...) or individual foodstuff intake (fruit, vegetables, meat...). This research, often experimental, has confirmed certain hypotheses linking food consumption to effects on metabolism which can be good or bad for health. Extrapolation of these findings, obtained in controlled trials, to real life requires the integration of other aspects (living conditions, income...).
- Certain epidemiological studies, after examining different types of diet, have established a number of typologies which are more representative for studying real dietary behaviour.
- Although correlations between diet typologies and health have been clearly proven, it is difficult to establish causalities between changing dietary practices and certain chronic illnesses (cancer, cardiovascular disease). Links are more clearly established for obesity.
- These investigations require a critical mass of data, in order to draw meaningful statistics, and also require more customised data collection methods. The variables describing dietary practices (snacking, junk food eating...), and health practices (physical exercise, use of health care) need to be more precisely defined. Data collection procedures should be standardised, so allowing the data for individual countries to be compared and their specificities more clearly defined.

The physiological mechanisms regulating food intake are affected by environment

- Physiological regulation of food intake is extremely precise and is based on the alternate cycle of two physiological states: hunger and satiety. A network of internal signals, coming from the digestive tract and from the central nervous system, modulates the sensations of appetite and fullness. This mechanism allows self-regulation of energy intake, and is particularly effective in young children. This regulatory system seems to have altered in obese people.
- Energy compensation can take place between one meal and the next, in the case of temporary deficiency or excess. This regulation is disproportionate: dietary deficiencies are compensated far more easily than dietary excess managed. In a society with plenty of choice, temporary over-eating is thus more likely to be poorly managed during the following meals, resulting in weight gain.
- Intake is adjusted more effectively by eaters aware of the physiological signals of hunger and fullness, and more attentive to what they are eating. Distractions in the immediate vicinity (eating in front of the TV, in a noisy place...) increase the quantity ingested during the meal and upset the energy compensation process from one meal to the next.
- Nutritional composition and food consistency determine the satiation capacity of food. This information can lead to levers being designed for limiting the consumption of foods not affected by physiological regulation (e.g. soft drinks).
- Eating triggers a sensation of enjoyment by activating a physiological system in the brain called the reward circuit. This eating enjoyment is accentuated by palatable foods (nice taste) which are more often than not fatty or sweet high energy-dense foods. Enjoyment of sweet foods has been observed from birth. In obese animals and humans, recent findings have shown that addictive-type mechanisms can be created for sweet foods: thus ever greater quantities need to be eaten in order to achieve the same level of enjoyment.

- Social norms and attitudes, which vary according to age group, personal experience, and social and cultural backgrounds, shape and set dietary behaviour for time schedules, family meals, and table manners. These social conventions can help or hinder physiological regulation.
- An integrated approach needs to be found for addressing all the factors involved in food intake regulation and for assessing their relative importance.

Generic nutritional information and prevention campaigns have little short-term impact on behaviour when used alone.

- Nationwide information campaigns reach first and foremost the social groups already aware of the link between nutrition and health. The less privileged classes are all the more impervious to nutritional messages, since these messages are on a completely different wavelength to the attitudes the less privileged have about diet, health or body norms. They also need to cope with other worries which appear more urgent or more important to them. These messages could thus increase behavioural disparities in the short-term.
- For the same reasons, the impact of nutritional labelling is low, and targeted towards educated or nutrition-conscious social groups. Also, the technical information that is marked on labels is rarely used by consumers, who are not always able to take advantage of it and whose attitudes concerning food fall into simple categories: good or bad, healthy or unhealthy.
- Awareness of nutritional messages and their application do not generally lead immediately to the desired changes in behaviour. Over a longer time scale, changes in the behaviour of the wealthy, induced by preventive campaigns, may filter down into other strata of society through adoption of the culturally dominant model.

Dietary behaviour can be affected by information strategies combining different tools and targeting individuals or specific groups.

- How information is communicated is as important as the information itself. Nutritional information is more effective in the short-term when it is part of a specific campaign targeting an individual (therapeutic education) or a cohesive group (social marketing).
- Therapeutic education – the cognitive-behavioural approach used with obese patients or people suffering from dietary behaviour disorders – and social marketing – a concept created in the 1970s which aims to make micro-changes in the social environment by mobilizing a local network of intermediaries – have shown that the “small steps” strategy can induce minor modifications to behaviour that accumulate and last longer. The success of these initiatives depends on how supportive the family, local contacts and social groups are.
- Precisely-targeted strategies are costly, hence the advantage of combining them with more general and less costly prevention initiatives. Costs can also be lowered by using the diverse and widespread means of communication currently available, some of which allow information to be accessed by the individual.

The consumer is subjected to different environmental stimuli which can bias opinion. Food availability and composition are more effective levers on action than prices.

- According to economic theory, the consumer reigns over a market which must cope with his or her nutritional needs, hedonistic preferences and health concerns. Nutritional prevention policies are thus focused on the consumer (even risking guilty feelings about food choices). However, recent findings that call on both economics and marketing have shown that consumer opinions can be distorted by errors of perception and by the impact of environmental stimuli. Thus, policies have greater impact when they also affect food supply, and purchasing and eating contexts: availability, food composition....
- Altering the nutritional and energy quality of foods (through regulations, or incentives such as nutritional improvement charters and public/private agreements) entails adjustments to certain food components that are detrimental or beneficial (salt, saturated fatty acids or trans acids, omega 3...) and improves the satiation properties of food (added fibre, lower energy density).
- Playing on food availability has a short-term impact: the presence of fruit baskets instead of snack machines has proved effective in school experiments.

- In the USA, proximity of fast-food restaurants (particularly near schools) is known to lead to overeating.
- Food packaging size (visual bias) and clearly marked nutritional claims (detracting attention from other product characteristics) can lead to quantity and/or energy content of foods or dishes being underestimated.
- Economic simulations tend to show that taxes or subsidies are not always effective levers in the short term. For a significant drop in the consumption of foods reputed to be bad for health (usually high-energy products), the tax needs to be high (threshold effect), which would penalize the consumers who have no choice but to buy these inexpensive products. These interventions on supply can also lead manufacturers to reformulate products (lower nutritional quality of basic ingredients used), and consumers to substitute products (move towards budget products); the indirect effects of these adjustments can compromise the improvement in nutritional intake that was sought initially.

Certain periods of life are more favourable to modifications in dietary behaviour

Childhood

- Although dietary behaviour alters with age, sensory preferences are set during early childhood and are difficult to change thereafter. Sensory learning forms taste and food spectrum, and this starts before birth in the seventh month of pregnancy.
- Repeatedly offering a variety of foods without forcing the child seems to be the best way of widening food acceptance. School not only provides tasting opportunities, but could also improve awareness of hunger, fullness and satiety.
- Preventive action has proved effective for mothers whose children risk being overweight, particularly by changing the mothers' attitudes regarding their traditional responsibility for nourishment. Child obesity-control programmes increasingly call for parental learning.
- New research themes are currently investigating the impact of perinatal nutrition which, according to animal experiments, incurs lasting metabolic imprinting and which can sometimes be passed down (epigenesis).
- Dietary habits change during adolescence, and meals can be taken both with the family and outside the home. When outside the home, adolescents experience a certain freedom (meal times, meal composition...). These practices do however appear to be temporary, and a return to a family type of diet is observed when they start a couple relationship, when children are born, or when they start working. So, dietary disorders apart (anorexia, bulimia, not dealt with here) and risky practices (binge drinking), the diet of adolescents is not a public health problem. If difficulties with dietary behaviour are experienced during childhood, this phenomenon can be accentuated upon adolescence and have negative consequences on personality and health.

Old age

- During old age, dietary behaviour can become more unstable. Retirement, death of spouse, solitude, deteriorating health and less autonomy, are all events that modify the lives of elderly people, and often have negative repercussions on dietary practices and food intake.
- A considerable proportion of elderly people suffer from malnutrition, which is recognized as a public health risk factor.
- Elderly people are attentive to preventive messages concerning health.
- Carers and the immediate social circle of old people are crucial for maintaining good dietary practices and/or implementing nutritional preventive strategies.
- It should be noted that dietary behaviour is probably linked to one's generation. This hypothesis, suggested by CREDOC findings using the Budgets survey, needs to be scientifically supported. To what extent will the behaviours observed today in the young last during life? What will be consequences for public health?

Preventive messages reach underprivileged populations to a lesser degree

- Dietary inequalities have continued into recent years. Food can absorb up to 50% of the budget of the more underprivileged households in France, while this figure stands at 17% on average.

- Underprivileged populations, poor and/or undereducated, suffer more from obesity.
- The diet of underprivileged populations corresponds less to nutritional guidelines than that of wealthier populations. A greater number of risk factors are associated with their dietary practices: sedentary lifestyle, distraction linked to TV viewing, low self-esteem... The preventive messages for nutrition and health are less well understood and can even make them feel guilty.
- The desire to buy foods that are promoted by intense advertising (high energy-dense foods) undermines their efforts to conform to guidelines.
- Intervention for overweight and obese mothers is a stimulus to changing family diet.

Shift in number and nature of dietary behaviour determinants.

- This expertise has focused on the relationship between dietary behaviour, types of diet, food composition, health and preventive nutrition policies. Each determinant identified in this expertise is being researched in more detail. But it is not easy to integrate these determinants given the vast number of scientific issues involved, the multiple levels and scales of observation, and the wide range of methods used.
- These determinants come into social, agricultural, environmental, cultural, and marketing policies, which are also undergoing major change. The connection between them and dietary practices has been explored very little in the scientific literature, particularly in France. Changes in food supply and dietary behaviours will be driven by the necessity to produce nutritional food, in sufficient quantities to meet the needs of a growing world population, while preserving natural resources.

Research needs

If detailed typologies of French consumer behaviours are to be established, large pooled longitudinal cohorts need to be recruited and which are representative of the entire population. Tools need to be validated for collecting and using reliable data. If these methods were extended to other countries, the specificities of the French dietary model would stand out.

The causalities between diet and health can be determined in two ways: firstly by using the systems approach to integrate all the fragmentary knowledge available about how nutrients affect physiological systems; and secondly, by combining epidemiological studies with systematic phenotyping and genotyping of individuals in the cohorts (requiring a biological sample bank). This second approach would need to include detailed analysis of gut flora, since its role appears to be increasingly important.

Changes in food supply (product quality, price, availability...) can have major unintentional effects on dietary behaviour, necessitating further research (effects on market segmentation, market competition, consumer preferences...).

Consumer behaviour models need to account for the relative weight of each determinant, particularly the effects of environmental and spatial factors on individual diet. One priority consists of combining economic mechanism models, with models of the biological systems responsible for the connections between diet and health.

Another priority will be to explain through brain imaging techniques how the different signals leading to purchasing choices function. Also, how signals of fullness and satiety are related with food and meal characteristics (such as the role of sugar on the activation of reward pathways) and meal context (particularly talking about food and distraction).

Research into the evaluation of public policies needs to be organized and extended. The ambivalent outcomes of these policies (mostly positive but potentially a source of growing inequalities, such as for price policies) should be specifically addressed using cost-benefit analyses, up to and including estimation of the social costs of saved lives. The reasons for the difference in impact between product marketing tactics and information campaigns remain to be explored.

Abbreviations

ABENA: Survey on the diet and nutritional status of food aid beneficiaries
AFSSA: French agency for health security of food
BMI: Body Mass Index
CIHEAM: International Centre for Advanced Mediterranean Agronomic Studies
CNIEL: French federation for dairy product economics
CNRS: French National Centre for Scientific Research
CREDOC: Research centre for studies on standards of living
DALY: Disability Adjusted Life-Years
DQI: Diet Quality Index
ENNS: National nutrition health survey
EPIC: European Prospective Investigation into Cancer and nutrition
ESCo: Collective scientific expertise
GI: glycemic index
HDI: Healthful Diet Indicator
HEI: Healthy Eating Index
IFN: French Institute for Nutrition
INCA: National study of individual dietary habits
INPES: French Institute for Health Promotion and Health Education
INRA: French National Institute for Agricultural Research
INSEE: National institute of statistics and economic studies
INSERM: National institute of health and medical research
InVS: Institute for Public Health Surveillance
MAAP: Ministry of Food, Agriculture and Fisheries
MDS: Mediterranean Diet Score
MUFA: Mono-unsaturated fatty acid
NBER: American National Bureau of Economic Research
NCD: Non-communicable diseases
OCHA: CNIEL Observatory of dietary habits
OBEPI: National epidemiological survey on overweight and obesity
OECD: Organisation for Economic Co-operation and Development
OQALI: Observatory for food quality
PNA: National food supply programme
PNNS: National nutrition-health programme
PUFA: Polyunsaturated fatty acid
SU.VI.MAX: Vitamins and antioxidant supplements study
UNIOPSS: National federation of private non-profit organisations for social and health issues
WHO: World Health Organisation

Annex. Documentation and choice of articles

Throughout the expertise process, the group of experts analysed a great number of scientific articles and international reports, and almost 1600 were used in building the final expertise report.

Two INRA documentation researchers assisted the group of experts in seeking sources of information, in building up the bibliography, in finding articles and in editing references in the final expertise report.

Methodology

Since the field covered by this expertise is vast, an initial large-scope search was made in international data bases, the outcome of which was a decision about the reach of the expertise and on the main topics to be included.

An initial corpus of over 5000 articles was established. Thereafter, bibliography data bases were examined using complex equations, combining several levels of key words which had been validated by the experts. A great deal of teamwork was necessary between the documentation researchers, the scientific steering committee, and the experts, in order to define these key words and fine-tune the search for material.

Throughout the expertise process, original research articles and more technical articles on the different topics were passed on to the experts. Networking was made possible by the creation and maintenance of a shared website (SilverPeas®).

Main sources of information

The following scientific citation indexes were used:

Web of Science. Created by Thomson Scientific (ex-ISI), this is “the” citation index consulted by the scientific community the world over. All scientific and social science disciplines are covered, meaning that citation searches can be extended to cross-disciplinary research and research at the interface between disciplines.

CAB Abstracts. This base was set up by CABI Publishing (Commonwealth Agricultural Bureaux), and specialises in agricultural topics in the widest sense (including health, human diet and economics, and rural sociology).

Econlit. This base which specialises in economics was set up by the American Economic Association,

FSTA. (Food Science and Technology Abstract) Set up by IFIS (international Food Information Service), this database covers food science and technology, and human nutrition.

Medline / Pubmed. Set up by the National Library of Medicine (NLM-USA), Pubmed is a citation database covering all biomedical disciplines biochemistry, biology, clinical medicine, economics, ethics, odontology, pharmacology, psychiatry, public health, toxicology, veterinary medicine.

ProdInra. Institutional database for INRA publications.

Other scientific and technical databases were used: BDSP (French public health database, in use since 1993), Emerald (database specialised in marketing and supply chains), Business Source (EBSCO; marketing journals), SocIndex (sociology database), CAIRNS (gateway for French-speaking journals in human and social sciences).

The group of experts also referred to grey literature: scientific or technical reports published by French institutions such as INSEE, AFSSA, CREDOC, IFN, OCHA, OQALI; international documents such as NBER reports ; papers presented in international symposia organized by ACE (American College of Epidemiology) or the European Chemoreception Research Organization...

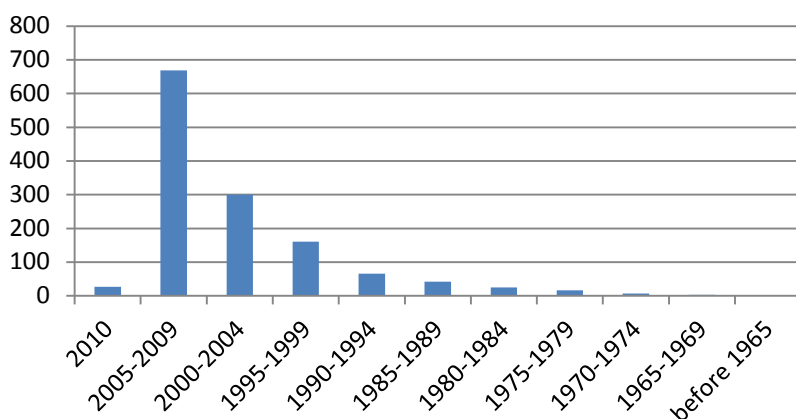
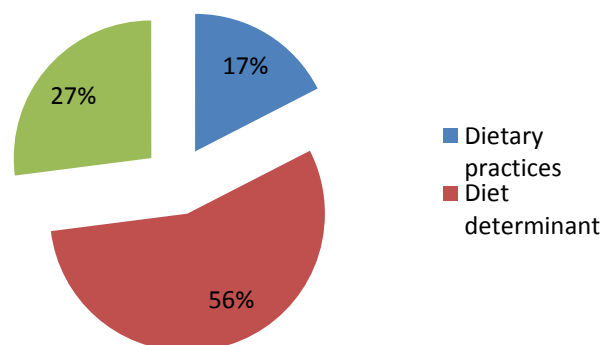
Information on the citations in the report

Almost 1600 citations were selected by the experts and are referred to in the report.

Some of the experts had not finalised their contributions when the Keywatch (a flexible open source monitoring system) analysis was carried out, so that this only covers 1314 citations.

Number of citations by major topic

The citations are not evenly spread between the three parts of the expertise, and the part devoted to diet determinants represents more than half the total number of citations.

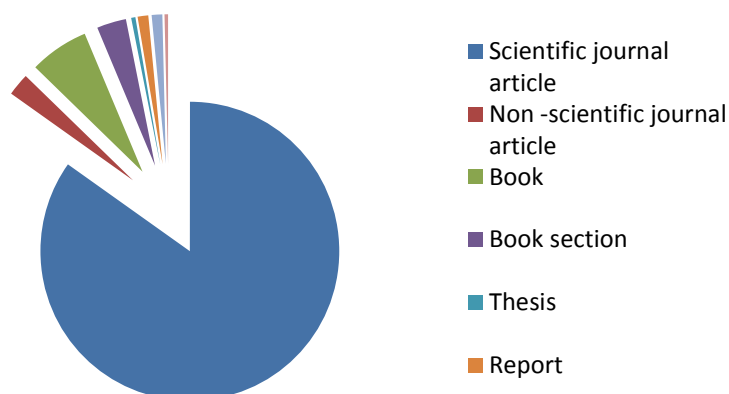


Number of citations by year of publication

The experts referred mainly to recent findings, and 54% of citations are dated within the past ten years.

Number of citations per type of document

In 86% of cases, the experts quoted articles published in national and international peer-reviewed scientific journals, which corresponds to the definition required by scientific expertise.



The top 17 journals to be quoted: the scientific journals in which the greatest number of quoted articles were published.

<i>Appetite</i>	93
<i>Physiology and Behavior</i>	68
<i>American Journal of Clinical Nutrition</i>	65
<i>Journal of the American Dietetic Association</i>	46
<i>Public Health Nutrition</i>	26
<i>International Journal of Obesity</i>	23
<i>British Journal of Nutrition</i>	20
<i>European Journal of Clinical Nutrition</i>	20
<i>Food Quality and Preference</i>	18
<i>Jama-Journal of the American Medical Association</i>	15
<i>American Journal of Agricultural Economics</i>	14
<i>Cahiers de Nutrition et de Diététique</i>	13
<i>Journal of Nutrition</i>	13
<i>Journal of Marketing Research</i>	11
<i>Food Policy</i>	9
<i>Journal of Agricultural and Food Chemistry</i>	9
<i>Nutrition</i>	9

Word cloud for frequent words in the French titles quoted in the ESCo Dietary Behaviour report

Titles in English and titles in French were analysed separately, the latter more often pertaining to the social sciences (about 10% of the total bibliography is in French).

Word cloud for frequent words in the French titles quoted in the ESCo Dietary Behaviour report



Word cloud for frequent words in the English titles quoted in the ESCo Dietary Behaviour report



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** In bold : experts who coordinated parts of the report.



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