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The application of a new classification of food based on degree and purpose of processing:

A quantitative study of Norwegian food sales from a representative sample of retail stores

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In total, Norwegians spent 1.5 billion NOK on ready-to-heat dinners in 2013, almost 400 billion more than we spent in 2010.

"This is amazing! It shows we are going in the right direction!"

Kirsti June Olsen
Director of category, Fjordland to VG 16.2.2014

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List of abbreviations

CPI	Consumer price index
CRE	Central Register of Enterprises and Establishments
DEC	Dietary energy consumption
DES	Dietary energy supply
FAO	Food and Agriculture Organization of the United Nations
FBS	Food balance sheets
FDI	Foreign direct investment
HICs	High-income countries
LMICs	Low- and middle income countries
NCDs	Non-communicable diseases
NSD	Norwegian Social Science Data Services
NOVA	The new classification of food
REK	Research Ethics in Norway
SSB	Statistics Norway
UK	United Kingdom
UN	United Nations
US	United States
WHO	World Health Organization

Abstract

Background and aim: Although generally recognized that increased consumption of processed foods is contributing to the obesity epidemic, industrial processing is generally underestimated or overlooked in frameworks for studying diet and health. To close this gap in research, a new classification of food (NOVA) has recently been proposed, describing foods and dietary patterns in terms of extent and purpose of industrial processing. Research has shown that highly processed foods –"ultra-processed products"- dominate diets in high-income countries, and that these are unhealthy diets. The domination of ultra-processed products in diets has been seen in the context of the food system, characterized by a lightly regulated global food industry with profit interests in increasing sales of these products. The aim of this study is to assess food sales in Norway, applying the new classification of food.

Methods: The new classification was applied to food sales data from a nationally representative sample of retailers. Foods were grouped into NOVA1 minimally processed foods, NOVA2 culinary ingredients, and NOVA3 ready-to-consume products (processed and ultra-processed products). Data from September 2005 and 2013 were analysed in Norway as a whole, in six geographical regions, and in three retail concepts. The analysis included 795 306 sales of food items. Indicators were share of purchases and expenditure for these food groups.

Results: NOVA3, with more than 70% of purchases and 60% of expenditure, dominated food sales. NOVA1 accounted for 12% of purchases and 30% of expenditure. Sweets, snacks and desserts were most frequently purchased food items and accounted for the largest expenditure share both in 2005 and in 2013. Sweet ultra-processed products combined (food and beverages) accounted for every third purchase in 2013, and were purchased two and a half times more often than minimally processed food. Share of purchase and expenditure on NOVA groups changed minimally in favour of NOVA1 and in disfavour of NOVA3 between 2005 and 2013.

Conclusions: The present study indicates that Norwegian diets are dominated by ready-to-consume products to an extent that is likely to be contributing to rising rates of overweight, obesity and related non-communicable diseases. Policy measures should aim at decreasing consumption of ready-to-consume products.

Key words: Food classification, ultra-processed products, obesity, Norway

Sammendrag

Bakgrunn og hensikt: Det er generell enighet om at økt inntak at prosessert mat har bidratt til økningen i overvekt og fedme. Likevel er industriell prosessering av mat ikke inkludert i rammeverk for å studere sammenhengen mellom kosthold og helse. For å bedre forståelsen av disse sammenhengene, er det foreslått en ny klassifisering av mat (NOVA), som beskriver mat og kosthold ut fra grad av og hensikt med industriell prosessering. Studier har vist at de mest prosesserte matvarene, «ultra-prosesserte produkter», dominerer kosthold i høyinntektsland, og at slike kosthold er usunne. Dominansen av ultra-prosesserte produkter har blitt sett i sammenheng med matsystemet, karakterisert ved en lite regulert global matindustri som er avhengig av salg av ultra-prosesserte produkter for fortjeneste. Hensikten med denne studien er å analysere salg av matvarer i Norge i lys av det nye rammeverket.

Metoder: Scannerdata fra salg av matvarer hos et nasjonalt representativt utvalg av matvarebutikker ble klassifisert i henhold til det nye rammeverket. Matvarene ble klassifisert som NOVA1 minimalt prosessert mat, NOVA2 kulinariske ingredienser og NOVA3 spiseklare produkter (inkluderer undergruppene prosesserte produkter og ultra-prosesserte produkter). Data fra september 2005 og 2013 ble analysert for hele Norge, i seks geografiske områder og i tre matbutikkonsepter. Analysen inkluderte 795 306 salg av matvarer. Andel av antall kjøp og andel av omsetning for hver av gruppene ble brukt som indikatorer.

Resultater: Over 70 % av matvarekjøp og 60 % av omsetning var NOVA3, som dermed dominerte salg av matvarer. Søtsaker, snacks, og desserter var de oftest kjøpte matvarene og hadde den høyeste omsetningen. Hvert tredje kjøp var av søte, ultra-prosesserte produkter (mat og drikke), noe som var to og en halv gang så ofte som minimalt prosessert mat ble kjøpt. Andeler av kjøp og omsetning endret seg minimalt fra 2005 til 2013, men i retning av mer NOVA1 og mindre NOVA3.

Konklusjon: Denne studiens resultater tyder på at norsk kosthold er dominert av spiseklare produkter, i et omfang som sannsynligvis bidrar til økende forekomst av overvekt, fedme og livsstilssykdommer. Tiltak for å bedre kostholdet bør fokusere på å redusere inntak av spiseklare produkter, og spesielt søte, ultra-prosesserte produkter.

Nøkkelord: Klassifisering av mat, ultra-prosesserte produkter, overvekt, Norge

1 Background and study objectives

The global obesity epidemic is linked to the nutrition transition, occurring across the globe. An important characteristic of the nutrition transition is the increased consumption of industrially processed foods [1]. Although it is generally recognized that increased consumption of such foods is an important cause of the obesity epidemic [2; 3], industrial processing is generally underestimated or overlooked in frameworks for studying diet and health [4; 5].

To close this gap in research, a new classification of food (NOVA) has recently been proposed, describing foods and dietary patterns in terms of extent and purpose of industrial processing [4; 6]. The evidence base from studies applying NOVA is so far indicating that the most extensively processed foods –"ultra-processed products" are replacing traditional diets [7; 8], dominating global food systems [5], rapidly penetrating markets and market segments across the globe [9; 10], and that diets dominated by ultra-processed products have poor nutrient profiles [11] and are associated with obesity [12], and Metabolic Syndrome [13]. Consumption of ultra-processed products is also inducing unfavourable eating habits, e.g. snacking, as they are ready-to-eat convenience foods [14]. The replacement of traditional diets for ultra-processed products has been seen in the context of the food system, characterized by a lightly regulated global food industry [9].

Overall dietary patterns have been examined in only two countries [7; 15]. Additional studies are needed to increase evidence base supporting the use and relevance of such a classification for public health knowledge and policy action both internationally and in the country in question.

1.1 General objective and research questions

The general objective of this study is to investigate the role and evolution of the participation of industrially processed foods in the Norwegian diet form 2005 to 2013, applying the NOVA classification of food. To assess the general objective the following research questions will be answered:

1. How were purchases of and expenditure on food in Norway distributed between the NOVA groups in 2005 and 2013?
2. How have purchases of and expenditure on NOVA food groups changed in Norway in the period 2005-2013?
3. Which were the top 10 foods sold in 2005 and 2013?

4. Were there differences in purchases and expenditure for NOVA food groups in different geographical regions in 2005 and 2013?
5. Were there differences in purchases and expenditure for NOVA food groups from retail concepts in 2005 and 2013?

Elaboration on theoretical aspects and background, methods and methodological issues follows in the next chapters. The general objective and research questions will be addressed in an article written in accordance with author guidelines for publications in Public Health Nutrition [16].

2 Theoretical aspects

2.1 A global epidemic of overweight and obesity

Some of the largest health challenges globally are related to nutrition [17]. Historically, undernutrition and micronutrient deficiencies have been the main issue regarding nutrition and health; food has been scarce rather than affluent [18]. Even though undernutrition has been reduced globally during the last decades, it is estimated that in 2011-2013 more than 800 million people (about 12% of the world population) are still suffering from chronic hunger [19]. However, during the same period a new issue related to nutrition and health has arisen: the drastic increase in prevalence of overweight (BMI[1] ≥ 25), obesity (BMI ≥ 30) and related non-communicable diseases (NCDs). According to estimations from the World Health Organization (WHO), 35% of adults over the age of 20 were overweight or obese in 2008 globally, of which 14% of women and 10% of men were obese [20; 21]. The situation is recognized as an obesity epidemic [18; 22]. Combined, the two issues present a double burden of malnutrition; the coexistence of undernutrition and overnutrition in populations is seen at global level, within nations, within households, and even within individuals [23; 24; 25; 26].

Global rates of overweight have increased from around 20-25% in 1980 to 35% in 2008, and global obesity rates have doubled in the same period [21]. Both prevalence and growth rates vary substantially across regions. Currently, prevalence is highest in upper-middle and high-income countries (HICs) where 55-60% of the population is overweight [20]. In low- and middle income countries (LMICs) around 20% of the population is overweight. However, the burden of overweight, obesity and NCDs is increasingly affecting the less affluent and lower socioeconomic status populations [18; 20]. Rates of overweight are growing

[1] BMI=bodyweight in kg/(height in m)^2

at a much faster pace in LMICs; prevalence has tripled in these countries in only two decades compared to a doubling over three decades globally[21; 23]. Estimations project that prevalence of overweight and obesity might increase to 58% globally, of which 20 % are obese, if recent trends continue, and that the increase will be much larger proportionally in less developed regions [27]. Within countries, the socioeconomically disadvantaged are disproportionally affected [18; 20]. In HICs, distribution of overweight and obesity is inversely related to socioeconomic status. In LMICs overweight is increasingly a problem for the poor, previously especially for the large groups of urban poor, but later also spreading to the rural poor [18; 28].

Overweight and obesity are established leading risk factors for NCDs, including cardiovascular disease, diabetes type 2, respiratory diseases, and cancer [3; 29]. As with overweight and obesity, there is a worldwide growing epidemic of NCDs [3]. NCDs have been estimated to account for 46% of the global burden of disease and for more than 60% of reported deaths globally [20; 30], and is now the dominant cause of death globally. The total number of deaths from NCDs is expected to increase by 15% globally between 2010 and 2020 and to be the dominant cause of death in most countries by 2030[20; 23].

The epidemic of overweight, obesity and NCDs has serious consequences for individuals and the society. These conditions lead to decreased quality of life, disabilities, loss of income and premature death for the affected individuals. For society, the epidemic translates into substantial costs in terms of decreased productivity and increased public spending on health, which is in turn hindering poverty reduction, and economic and social development [20; 29; 31]. It has been estimated that every 10% increase in NCDs is associated with a 0.5% lower annual rate of economic growth [20].

There has been a strong and increasing international commitment to relieving the double burden of malnutrition. For example, through a United Nations (UN) Political Declaration on NCDs, endorsed by Heads of State and Government in September 2011, commitments were made to establish and strengthen, by 2013, multi-sectorial national policies and plans for the prevention and control of NCDs [32]. In a recent review [33], WHO analysed nutrition policies in 119 member countries. Most of the countries did have policy and programmes addressing nutrition-related health outcomes. However, a range of gaps was identified. For example, it was pointed to incomprehensive policies for reducing overweight and NCDs. Most common was information strategies, such as dietary recommendations and labelling schemes, and only a few countries had taken measures to reduce salt and trans-fatty acids in diets. It was also found that coordination responsibility was seldom placed under the prime minister's or president's office, suggesting nutrition was not given the highest priority.

These and other gaps led the review to conclude there is an increasing need for focus on obesity and NCDs. There is need for strong action to address this global challenge, but country efforts are not yet satisfactory.

2.2 Changing diets in a changing environment

The causes for the obesity epidemic are highly complex, and related to biology and behaviour, as well environmental, cultural and social issues [34]. Ultimately, overweight and obesity is the result of excess consumption of calories compared to expenditure [17; 35]. With industrialization and mechanisation of society, there has been a change towards more sedentary lifestyles at the same time as caloric availability per capita has increased in most countries [3; 18].

Dietary patterns across the globe have changed and are changing in a direction that is causally linked to weight gain; plant-based traditional diets have been replaced by diets high in energy-dense fatty, sugary and salty foods. The changes has led to higher intake of fats, especially saturated fats, and refined carbohydrates, and reduced intake of unrefined carbohydrates [3]. These shifts in dietary patterns have been modelled as "the nutrition transition" [36; 37], and the "new" dietary patters are often referred to as a Westernized diet.

Several mechanisms for how eating behaviour are linked to weight gain have been investigated and indicates the simple explanation of caloric intake versus expenditure is not as straightforward as it may seem; snacking and eating in front of the TV; fewer family meals; binge eating; and eating outside the home, often inside the car, are all associated with overweight and obesity [38; 39].

The effect of the environment on overweight and obesity has received increasing attention; "the obesogenic environment" promotes overweight and obesity by facilitating unfavourable dietary behaviour (such as those mentioned above) or regarding physical activity (e.g. driving instead of walking) [40]. Urban areas are typically obesogenic environments, and urbanization has also been associated with overweight and obesity [37], as have other structural changes in society; e.g. increased trade and free trade agreements [10]. It seems clear that he changes in diets, eating patterns, and physical activity are not occurring to individuals independently of surrounding and society [41].

2.2.1 Processed foods and relation to obesity epidemic

Popkin describes certain global characteristics of the nutrition transition [37]. Technological advances has enabled and availed cheap vegetable oils throughout the world, and intake has increased drastically. Caloric sweetener intake has also increased drastically and provides up

to 20 % of caloric intake in some countries, and is a major concern across the world. A large share of the increase in intake is from beverages. Animal source food intake has seen a major increase. Excess consumption is linked to excess intake of saturated fat and increased mortality [37].

Another characteristic of the dietary changes occurring through the nutrition transition is an increased reliance upon processed foods and beverages in diets [1]. Historically, food processing has been important for conservation of foods throughout seasons, making trade possible and thus increasing food availability and variation, and for preparing safe food with heat. Now, industrial processing methods are necessary for feeding the world population [42]. However, these technological developments in food processing have contributed to cheap, processed foods high in added sugar, salt and fat (including trans-fat) being available and consumed throughout the world [1; 42]. Seventy-five percent of world food sales are now processed foods [43]. High intake of highly processed foods has been causally linked to weight gain [3].

Processed foods are often energy dense as these foods are dry, high in added sugars and fats and low in fibre. Water content is the most important determinant of a foods energy-density, and in processed foods water has often been removed to increase shelf-life and reduce transport costs [42; 44]. In 2003, WHO concluded there were convincing evidence of a causal relationship between high energy-dense foods promoting weight gain, and that energy-dense foods tend to be highly processed [3]. Newer studies supports this: an eight year prospective study found that the foods with highest positive correlations with dietary energy density diets were generally highly processed products low in fibre and rich in saturated fat and trans-faty acids, e.g. cookies, crackers, pancakes, waffles, and processed meats [45], and a systematic review found there is strong evidence for a relationship between energy density in diets and body weight for adults, children and adolescents [46].

Overweight, obesity and NCDs have been linked with intake of specific processed foods and beverages. There is extensive research and evidence for a causative link between intake of sugar sweetened beverages with weight gain, overweight and obesity, and NCDs in adults, and children and adolescents [3; 47; 48; 49; 50; 51]. Satiety mechanisms being badly linked to fluid caloric intake have been proposed as an explanation. Evidence for a causal link between processed meat intake and colorectal cancer has been found to be probable [3].

In addition to the unfavourable nutrient profiles, processed foods have been linked to eating patterns and behaviours that might contribute to overweight, obesity and NCDs. Eating outside the home, and especially fast food consumption, has risen significantly in HICs and in

some lower-income countries [52; 53; 54]. Two of the most well-known fast-food chains, McDonalds and Burger King, are present in 60 and 90 countries, respectively [55]. Fast foods often have poor nutrient profiles in terms of fat content, energy density and added sugars, and research suggests a link to higher energy intake, overweight, obesity and NCDs [56; 57]. Portion sizes from fast food outlets have increased continuously since the 1970s [58], and "supersized" menus are offered and promoted. This is a particular problem since these foods are generally energy-dense. Larger portions of both snacks and fast foods have been found to increase consumption in a meal. As this is not compensated for by reducing intake at next meal it may therefore contribute to an increased overall caloric intake [59].

As many processed foods are convenient, ready-to-eat and sold in serving sizes, many of these may be consumed as snacks. Nationally representative studies from the United States (US) show that frequency of snacking and share of daily energy intake from snacks have increased between 1989 and 2003-06, to account for 27 % and 24 % of caloric intake for children [60] and adults [61], respectively. Non-processed food items, such as fruits, are also frequently consumed as snacks. In addition, more frequent smaller meals have been proposed as a regulator of appetite and for improved bodyweight management [62]. However, the previously mentioned studies from the US showed that energy-density of snacks had increased over the same time period and salty snacks, candy, sweetened beverages, and desserts were the largest caloric contributors [60; 61]. Further, number of eating and drinking occasions per day has increased between 1997-78 and 2005-10 and was found to be one of the largest contributors to increased daily energy intake in the US [63]. Similarly, in Brazil snacking contributed to 17-22 % of energy-intake, and sweetened coffee and tea, sweets and desserts, fruit, sugar sweetened beverages, fried/baked dough, and breads were among the most commonly consumed snacks [64]. Global official sales data show that worldwide sales of snacks and snack bars (volume) have increased annually by 2 % in HICs and 2.4 % in LMICs between 1997 and 2009 [43].

It has been argued that the industrial use of salt, sugar and fat can contribute to high-palatability of processed foods, which is making people addicted to the tastes of their products [65]. As a response to this claim, Mozaffarian argue it is not the salt, fat and sugar, but rather the industry behaviour, and mainly their marketing and branding which hooks people [66]. According to him, the difference between processed products that have succeeded or failed commercially is not their content of salt, sugar or fat, but rather where marketing and branding efforts have been successful. Marketing efforts of processed branded foods are indeed extensive. Numbers for total global marketing efforts for foods are not available, but

has been estimated to be around $400 billion annually. In 2004, Coca-Cola and PepsiCo had the largest food marketing budgets in the world, at $US 2.2 billion and $US 1.7 billion, respectively, which combined was more that the entire budget for all WHO health matters [55].

A review on the impact of marketing on food-related behaviour, attitudes or beliefs in adults showed there are few relevant studies, of which none were high quality, and results were inconclusive [67]. More evidence and most controversy exist on marketing of unhealthy foods and beverages directed at children. A recent systematic review concludes that evidence from the last 40 years indicate food marketing influences children's food preferences, purchases and diet-related health [68]. The same review study also found that the foods marketed most were low-nutritious and included pre-sugared breakfast cereals, soft drinks, savoury snacks, confectionery and fast foods. Preferences were found to be changing in response to food advertising towards high fat, salty or sugary foods, towards promoted branded foods and towards brand loyalty.

A range of channels and strategies are used for marketing of food to children. TV advertising has been the most popular channel, but internet based marketing, "advergames", magazines, free samples, gifts and tokens, loyalty schemes, licensed characters and programmes, in-school marketing and sponsorships are also employed [68; 69]. Strategies most often used include premium offers, promotional characters, nutrition and health-related claims, the theme of taste, fun and humour [68; 70]. Despite introduction of policy actions and pressure to limit marketing of unhealthy commodities from e.g. WHO [71], marketing practice (type of food and strategies) seem to have altered little in developed countries, and the same strategies are now applied in development countries [68].

2.2.2 The issue is not food nor nutrients, but processing

Research on changes in diets, dietary habits and association to overweight, weight gain and NCDs are often focusing on nutrient profiles of foods, such as fats and sugars or energy-density. However, some studies indicate there is no universal relationship between these commonly used measures on weight gain [39; 45]. Rather, they suggested the difference is between the foods that are processed or not processed and the context of the foods use. For example, nuts, are high fat but were inversely related to weight gain, while sugar-sweetened beverages are low energy-density (due to high water contents) but were positively associated to weight gain. Another study, reviewing evidence on which diet is better for health [72], found that all diets investigated (e.g. low-carb, low-fat/vegetarian, low-glycaemic) had elements in common, such as limiting refined grains, added sugars, and processed foods, and promoting

intake of whole plant foods. Aggregating evidence for all of the diets suggested they all promoted the healthiest dietary pattern; minimally processed foods, close to nature and predominantly plants. Or as Michael Pollan has put it: "eat food, not too much, mostly plants" [73].

It is therefore argued that the big issue is not nutrients nor foods, but processing [6]. The main characteristic of diets and dietary changes over the past decades is processing. As reviewed above, there is evidence on the relationship between some processed food products and health outcomes, but the overall impact of diets based on processed foods has not been sufficiently researched. Therefore a definition of industrially processed foods is needed [4; 74]. "Ultra-processed products" are defined as:

> Ultra-processed products are made from processed substances extracted or refined from whole foods—e.g., oils, hydrogenated oils and fats, flours and starches, variants of sugar, and cheap parts or remnants of animal foods—with little or no whole foods. Products include burgers, frozen pizza and pasta dishes, nuggets and sticks, crisps, biscuits, confectionery, cereal bars, carbonated and other sugared drinks, and various snack products. Most are made, advertised, and sold by large or transnational corporations and are very durable, palatable, and ready to consume, which is an enormous commercial advantage over fresh and perishable whole or minimally processed foods.
>
> Ultra-processed products are typically energy dense; have a high glycaemic load; are low in dietary fibre, micronutrients, and phytochemicals; and are high in unhealthy types of dietary fat, free sugars, and sodium. When consumed in small amounts and with other healthy sources of calories, ultra-processed products are harmless; however, intense palatability (achieved by high content fat, sugar, salt, and cosmetic and other additives), omnipresence, and sophisticated and aggressive marketing strategies (such as reduced price for super-size servings), all make modest consumption of ultra-processed products unlikely and displacement of fresh or minimally processed foods very likely. These factors also make ultra-processed products liable to harm endogenous satiety mechanisms and so promote energy overconsumption and thus obesity [43p2].

According to this definition, ultra-processed products not only have unfavourable nutrient profiles, but also have several other traits inducing eating behaviours linked to overweight and obesity. Further, they are replacing traditional diets and are marketed heavily. Also inherent in the definition of ultra-processed products is an attempt to relate the reliance upon processed foods in diets, and the eating behaviours these foods induce, to food industry behaviour and interests, and the current food system.

2.3 Industrial food processing in light of the food system

The increasing intake of processed foods is on the one hand driven by demand side factors, such as convenience and increased income. On the other hand, these changes are also related to supply-side factors. Technological development increasing the availability of highly

processed foods and the marketing of these has already been discussed. In addition, structures in the food system such as consolidation and globalisation in the food supply chain, trade, and flow of capital are also important dynamics in the availability of processed foods worldwide[1; 75].

Maxwell and Slater have described the modern food system, highlighting the industrialization and commercialization characterized by e.g. larger farms, more processed foods and food packaging, longer supply chains and many food miles, a shift from employment in food production to food manufacturing, and from purchase at local markets and shops, to supermarkets [76].

The transformation from traditional to modern food system has had large consequences for agricultural production. Farm size has increased from a small and moderate size to larger industrial unites, producing fewer crops (often in monocultures), with a more intensive production demanding high inputs [76]. Foods are to a larger degree produced by fewer commercial growers, which has led to farmers becoming contractual farmers [76; 77]. In these relationships, the contractor often controls inputs and outputs, and later adds value through processing and marketing. Farms are increasingly production units of raw material for the food industry, instead of growers of food for direct consumption [78; 79]. The changes in dietary patterns described above are related to industrial monocultures, by the increasing demand for certain products such as soy, corn and animal products [80].

The supply chain is characterized by high concentration of market shares in manufacturing and retailing. In the manufacturing industry, the top 10 actors have been estimated to control 24 % of global sales of packaged foods. Among the largest manufacturers, including Nestlé, Coca-Cola, Cadbury Schweppes, Conagra, Unilever, Kraft and others, most are present in more than 80 countries worldwide. Coca-Cola is present in over 200 countries [55]. Some manufacturers have integrated the food system horizontally, participating in markets for a range of food products, from dairy products to biscuits, baby foods and confectionary. The largest of these are Nestlé, Philip Morris and Unilever [81].

In the retail sector top 10 retailers control 24 % of world market [55]. Within countries concentration rates varies, for example in Norway, four retail groups controls more than 99 % of the market [82]. National and multinational supermarket chains and fast food chains have rapidly increased in scale and reach, at first in HICs and then globally, outcompeting traditional, small grocery stores [5; 81; 83]. Most of these have headquarters in the US or Europe, but with a strong global presence. The effect on nutrition is debated, and it has been suggested that the growth of supermarkets in developing countries, and the processed foods sold

contributes to the nutrition transition [54]. One study on supermarket strategy and implication for nutrition, found that availability of both unhealthy processed foods and healthier unprocessed foods was often high in supermarkets, and the main message promoted was a general "eat more and buy it from us", which regardless of type of food contributed to an obesogenic environment [83].

There is also a large degree of vertical integration in the food chain, as manufacturers and retailers often control several steps in the food chain from retailing and marketing, to processing, and down to agricultural production. Manufacturers have more typically integrated downstream into production, but rarely upstream into retailing [81], although there are examples; in Brazil, Nestlé are using door-to-door sellers in suburbs and floating supermarkets on the Amazon river to reach remote costumers with their packaged food products [9]. Retailers currently seek to extract value from the products supplied, which is what is happening in Europe with own-brand goods, branded manufactured goods and fresh produce [55]. Downstream vertical integration from retailer and manufacturing imply these can set specifications and standards that affects farmers and farm practices [79; 81].

The different sectors in the food supply chain can increase their share of the profit by adding value for the consumer. Turning basic food stuffs into highly processed products or differentiating food stuffs through cleaning, packaging and marketing is a core activity of the global food industry, and has led to growing emergence of value chains for food focused on adding value for the consumer through product innovation and marketing [84]. Already in 1977 (although at that time not related to the obesity epidemic) concern for this development was expressed [85]; it was argued the extensive and increasing food processing is not something that humans need, but rather something the industry needs to add value to basic foods in order to increase profits. Later, Tansey and Worsley described a basic problem of the food market; demand can and will be saturated, while businesses must expand and grow to survive. The solution for business is to turn basic foodstuffs into more expensive foodstuff [86]. It is argued that the global food industry in a position with high market concentration and vertical integration of the food chain, choose to mainly manufacture, market and sell processed products [79].

The food system is also constituted of and dependent upon institutional relations, policies and economics, nationally and globally. Modern-market based economies are shaped by beliefs in the benefits of economic growth, liberalization and less regulations [87].

However, the benefits of this regime is an issue of controversy. Regarding the current topic, foreign direct investment (FDI) by transnational food companies has been found to be

an important driver for the nutrition transition in developing countries through enabling and promoting consumption of highly processed foods [75]. Further, it has been pointed to links between trade liberalization and the diet transition, mediated through for example FDI, "supermarketization" and cultural change, and that public health concerns are not taken (sufficiently) into account in trade and commerce policies [88]. Strong critics claim the focus on economic growth is marginalizing public health and creating a consumption driven economy [55; 87].

Another important issue has been the difficulty of and reluctance to imposing regulations aiming at improving public health under a political paradigm of limiting restrictions. There is a continued tendency for policymakers to view overweight and obesity as a problem of individual choices –"blaming the victim" – and consequently directing policies at individual behaviour instead of at structures in the food system [41; 87]. Political efforts are often limited to targeting individual choices through information campaigns, or to public –private partnerships with industry to limit marketing or contents of salt, sugar and fats in processed foods, through self-regulation. Neither has proven effective [43; 89]. It is argued that what is needed is regulation to limit consumption of ultra-processed food, but that these are not imposed because of a continued belief in the efficiency of the market and reluctance to go against vested interests of the food industry.

The role of the food industry itself in opposing such regulation has been problematized. The concerns raised are related to these businesses' dependency upon processing foods and marketing of these to increase profits, which infers a conflict of interest between public health and food industry profits [5; 89; 90]. In this context, the multinational food and beverage companies with huge and concentrated market power are critically referred to as "Big Food" [89] or "Big Snack" [90] (the latter name chosen to indicate that the ultra-processed products they provide are, unlike traditional foods, not necessary or essential for health). In response to increasing attention to the health implications of the products they sell and market, Big Snack has taken measures to protect their reputation and to avoid regulations. Strategies are compared to those of "Big Tobacco" and include presenting themselves as the solution, for example by self-regulation and reformulation, supporting various health initiatives not related to health, and counteracting regulatory measures by referring to disturbance of the free market and individual choice, lobbying politicians and sometimes lawsuits[29; 43; 89; 90]. It is therefore argued that this conflict of interest must be recognized to a higher extent, that public health policies must be made without regards to the interest of Big

Food and Big Snack, and that regulation, or the threat of such, might be the only measure to reduce the impact of these actors on food systems and diets.

2.4 The NOVA classification of food

The discussion above has pointed to evidence for the unfavourable health impacts of processed food consumed excessively. These health impacts are not just a result of unfavourable nutrient contents of the processed foods, they also induce eating patterns and behaviours, e.g. snacking, which have been linked to overweight and obesity. Marketing of these food products is immense and major actors in the current food system have commercial interests in maintaining and increasing intake of highly processed foods. A call for increased attention and efforts to understanding the "industrial epidemics" is warranted; commodities are creating health harms, and the industry is counteracting public health actions to limit these harms [(43)].

The NOVA framework for classifying food aims at increasing the understanding of the link between high intake of processed foods, the obesity epidemic and the food system issues described above [(6; 74)]. The definition of ultra-processed products is a part of the NOVA framework.

NOVA categorizes food according to the extent and purpose of processing. Processing is defined as "…the methods and techniques used by food manufacturers and associated industries to make unprocessed or 'raw' foods less perishable, easier to prepare, consume or digest, or more palatable and enjoyable, or else to transform them into food products" [(Monteiro, CA et al., unpublished work, p25)]. Farming methods are thus not included, nor is processing performed domestically. It is highlighted that processing per se is not the problem; the problem is the proportion of consumption of such products.

By defining three degrees of extent and purpose of industrial processing, foods are classified in three groups in the NOVA framework[2] [(Monteiro, CA et al., unpublished work)]. Table I in the article gives an overview of the groups, their definitions, characteristics, and examples. Shortly, group 1 is unprocessed and minimally processed food, such as frozen, chilled, fresh, cleaned, portioned food, that is not altered through adding substances. Group 2 is culinary ingredients, which are subtracted or purified parts of a food, such as fats, sugar and flour. Although culinary ingredients are in themselves energy-dense and nutrient deplete, these are not consumed alone, but used to prepare meals from minimally processed foods. Meals

[2] The new framework is still work in progress and the names and sub-divisions of groups have changed over time. However, the main division of the three groups has remained (more or less) the same since the first publications. This presentation is based on the most recent versions

prepared from group minimally processed foods and culinary ingredients are in various combinations the basis of all traditional diets, which are generally related to low prevalence of overweight, obesity and related NCDs [9].

Group 3 is ready-to-consume products. This group is sub-divided in two; processed products and ultra-processed products. Processed products are foods preserved in salt, sugar and brine, for example cured meat, cheese, canned foods. The processed products are usually not eaten alone, but instead as parts of meals. Many of these are also parts of traditional diets, as they are the preserved versions of foods (Monteiro, CA et al., unpublished work). Ultra-processed products have been defined above. These are made mostly from culinary ingredients. As these products are ready-to-consume and often do not require preparation with foods from the other groups, ultra-processing allows for a circumvention of the above described characteristic of culinary ingredients (nutrient deplete, but usually not eaten alone)[11]. Ultra-processing and its additives therefore allow us to make meals and diets consisting of mostly culinary ingredients, which are inherently energy-dense and nutrient-depleted meals and diets. The thesis behind the framework is that ultra-processed products are the principal dietary driver of the obesity epidemic [74].

2.4.1 Extent of processing and dietary patterns: evidence from five countries

It is theorized that analysing diets with the NOVA framework will show that consumption of ultra-processed products are growing, and even replacing traditional meals and diets [74]. In developed countries this seems to be a completed process, indicated by numbers from the United Kingdom (UK) and US , showing that a few ultra-processed products account for all the top selling food items and provide large proportions of total calorie supply [91]. Research from the UK, US and Canada indicate that growth in consumption of ultra-processed products is levelling off at around 60 % of total calorie supply, which seems to be the point of market saturation for these products [9]. In developing countries, ultra-processed products occupy smaller market shares, but sales are growing at rapid rates [8; 9]. It has been suggested that ultra-processed products are dominating global food systems [5]. This situation and it's development is related to the nutrition transition [43].

Results from research using Canadian and Brazilian household expenditure surveys, showed that diets consisting of ultra-processed products were less healthy than those consisting of minimally processed foods and culinary ingredients, in terms of energy density, sodium, added sugar, and saturated fat [8; 11]. In Canada, only the quintile of the population consuming least ultra-processed products could fulfil WHO nutrient recommendations

without decreasing caloric share of ultra-processed products in their diets [11]. Studies from Brazil have found that consumption of ultra-processed products was associated with obesity [12] and Metabolic Syndrome [13].

South Korea provides an example of the opposite, where strong policies, social society and practitioners' efforts have led to preservation of traditional aspects of diets and high vegetable consumption. The country has gone through the nutrition transition without reaching the same levels of overweight and obesity compared to other Asian countries [92].

2.5 The Norwegian context

Norway follows the same patterns as described for HICs in this chapter regarding epidemiology and dietary changes. Rates of overweight and obesity has increased during the last half of the 20th century, and data indicate that more than half the population is now overweight, of which almost 20 % are obese [93]. There has been a general increase in weight for the adult population across gender, age, income level, and education [94], but there is a clear correlation between level of education and overweight and other poor health outcomes including NCDs [95]. NCDs accounts for the majority of deaths in Norway [96]. Cardiovascular disease accounts for 35 % of deaths in Norway. Cancer accounts for 25 % of deaths, and prevalence is increasing. Prevalence of diabetes type 2 is increasing, and has tripled in the last 30 years [97]. For all of these three chronic diseases, the socioeconomically lower strata populations are disproportionately affected [96].

According to the Norwegian Directorate of Health, both diet and decreasing physical activity levels have contributed to an increase in overweight and obesity in Norway [95; 97]. Both dietary adherence to nutritional advice and physical activity is lower in lower socioeconomic strata [95].

Although there have been improvements in diet during the last half century, such as increased intake of fish, fruits and vegetables, and favourable changes in types of fat, the Norwegian diet contributes to development of cardiovascular disease, cancer, overweight and diabetes type 2 [97]. Dietary surveillance data show that the average diet contains too much saturated fats, sugar, salt, and alcohol, as well as to low intake of fibre, and some vitamins and minerals. Sugar account for 15 % of energy intake; sales of sugar-sweetened beverages has increased tenfold since 1950, while sales of chocolate and candies has increased from four to 14 kg per person per year between 1960 and 2011. Intake of salt is twice as high as recommended, and around 75 % of salt is consumed through industrially processed foods [97].

The Norwegian food chain share some key characteristics with the global food system, such as concentration in retail and manufacturing, and vertical integration. Large actors in manufacturing are both Norwegian, including Tine SA and Nortura SA, and international, including Orkla, Kraft Foods Inc., PepsiCo, Coca-Cola, Carlsberg and Mars [98].

Structural changes in the retail sector have taken place over the past 20-30 years, and retail chains have replaced local, independent shops [99]. Four retail groups are currently dominating; together they hold more than 99 % of the retail market, each of them between 11 and 40 % [82]. This is the most concentrated retail market in Europe [98]. Three out of the four chains are Norwegian, while the third is based in Sweden. These four groups have large influence on market access, shelf-placement, and prices, negotiated annually between suppliers and retailers, in what is commonly referred to as the "autumn hunt". Further there has been an increasing degree of vertical integration downstream from retailing, through binding contracts with wholesale, manufacturing, (including own brands) and to some extent production [98; 99].

The retail sector is often divided into three concepts: supermarkets, low price stores and convenience stores[3] [98; 99; 100]. Supermarkets focus on a broad variety of products, including fresh foods, and higher level of service. The low price concept aims at every day purchases, with a more limited range of products, focusing on basic foods and lower prices. Convenience stores have the most limited range of products, and might have a certain degree of local adjustment in product range and prices. Convenience stores are often dominating in decentralized areas and in city centres [98]. Low price is the largest concept, and has grown from 1.4 % of market shares in 1980 to 59.7% in 2013 [82; 99]. Convenience stores have the smallest market share of 8.5 %.

When choosing where to purchase foods, Norwegian consumers report proximity to home and quality as most important. Emphasis on price is falling according to consumer responses. However, the high market share for the low price concept might be indicating a mismatch between attitude and action [99]. A preference for familiar brands and actors has been noted, which may be a contributory explanation for Norwegian actors dominating the retail sector[4] [101]. It has been found that Norwegian consumers have a generally high trust in food safety. This trust is however lower for market actors with profit interests, than for

[3] Some also include hypermarket and kiosk.

[4] Although other explanations including import barriers are probably important 101. Pettersen I, Kjuus J (2011) Stor prisforksjell-med naturlige, politiske og strukturelle forklaringer. In *Dagligvarehandel og mat 2011 Perspektiver på verdikjedene for mat* [TS Gabrielsen and I Pettersen, editors]. Oslo: Norsk institutt for landbruksøkonomisk forskning

governmental institutions. To increase feeling of safety, choosing specific foods or choosing large, familiar actors when shopping was used as strategies to increase feeling of trust [102]. Further, trust in Norwegian foods, which are seen as "purer", has also been found among Norwegian consumers [103].

Research on overall diets in terms of extent and purpose of processing of foods have been conducted in three HICs; Canada, UK, and the US, and findings indicate that the NOVA classification of food is a relevant way of investigating increasing overweight and obesity in the current food system. As overweight and obesity is also increasing in Norway, research on food consumption in light of the NOVA classification could contribute to our understanding of the obesity epidemic.

3 Methods and sample

This chapter describes the methods employed for collecting data in the thesis, including the sampling procedure, the research strategy and the study design. It also gives an account of the data processing and how data analysis was performed.

The study examines trends of food sales in Norway, using secondary data on food retail in Norway collected by Statistics Norway (SSB) analysed with the NOVA framework for classifying food based on the degree of processing.

3.1 Study design

Study design in the thesis is ecological and descriptive, with a historical perspective.

First, the study design is ecological, as the unit of analysis is the group and not the individual [104; 105; 106]. Data on food retail at population level will be used as a proxy for population food consumption, through an analysis of the composition of food items sold, as classified in the new framework. Such use of ecological variables is common [104]. There are certain problems related to applying ecological study designs, especially related to inferring causality and the ecological fallacy [104; 105], but these are not as relevant in this study, due to the study design being descriptive. Implications and issues related to using retail sales as proxy for consumption of food will be discussed in section 4.2.1.

This thesis employs a descriptive study design because only levels of exposure will be analysed, and the association between the exposure and outcome (i.e. causality) will not be investigated. Although a study is essentially descriptive, it may contain analytical elements [107]; in this study, investigations of the relationship between sales of food groups and time, retail concept, and geographic location will be performed.

Finally, there is a historical aspect to the study design, as data from 2005 and 2013 will be compared.

3.2 Data source

SSB collects barcode data on food retail for calculation of the food price index, which is a constituent of the Consumer Price Index (CPI) of Norway [108]. The data are collected from food retailers through the head offices of food retail groups in Norway [100]. These barcode data have been collected since August 2005.

3.2.1 Sampling procedure

A representative sample of retailers in Norway, from which the data are reported, is drawn by SSB. The population is defined as food retailers reporting barcode data to the main actors within the retail sector in Norway [100]. Retailers from the following retail groups are thus

included: NorgesGruppen ASA, ICA Norge AS, Coop Norge AS, Rema 1000 Norge AS, and Narvesen Norge AS. The retailers are identified through the Central Register of Enterprises and Establishments (CRE) [100]. Together these cover more than 99 % of the Norwegian grocery market [109]. Food retailers that cannot deliver barcode data, or that do not report to either of these retail groups are excluded from the population (include specialist retailers, independent retailers, gas stations, etc.). As these account for a minimal share of total turnover, the skew in the sample resulting from excluding these is marginal [108].

The sampling procedure applied by SSB is a stratified probability sampling [100; 109]. The stratification criteria applied in this case, for all years, are retail chain and concept [100; 109].

From 2005 to 2010, the sample size was set at approximately 150 food retailers. Regarding stratification, in this period SSB used Neyman Allocation Sampling to allocate the sample size for each stratum (retail chain and concept), based on standard deviation of turnover [108]. Neyman allocation is a specific form of stratified probability sampling, which calculates the sample size for each stratum accounting for the size of the stratum and variance within the stratum [100]. From 2010 onwards a different form of stratified probability sampling was used by SSB: in this period proportional allocation determined the sample size of each stratum based on share of total turnover [109]. In addition, the stratification was refined, and sample size increased to approximately 180 food retailers.

In 2005, the population counted 3078 retailers in total [100]. The sample consisted of 158 retailers [108], i.e. 5.13 % of the population. In 2013 the population counted approximately 4300 retailers, and the sample consisted of 180 retailers (R. Nygaard, personal correspondence, November 13th, 2013), giving a sample of ~4 % of the population. The sample size was chosen to provide a sufficiently large sample for representativeness without resulting in an unmanageable amount of data [100].

3.2.2 Description of data

The retailers in the sample report sales to SSB from the middle week of each month, throughout the year [109], since August 2005. The barcode data are generated electronically at the point and time of sale of one product, i.e. each time a barcode is scanned [100]. Each observation thus represents a single sale of one food item. The barcode data cover sales of close to all types of food products sold in Norway [108].

For this study an anonymized sub-sample of the barcode data was obtained from SSB. The variables reported for each observation are listed in Table I.

Table I Variables obtained from SSB barcode data

Variable	Reported as
COICOP6	Food group code
Quantity	Number of units (unknown unit[5])
Turnover	NOK[6]
Price	NOK (turnover/number of units)
Retail location	County[7]
Time	Month, year
Retail concept	1=Supermarket; 2=low price shops; 3= convenience store

COICOP is a food group consumption classification developed by the UN and used by SSB [(109)]. The two most detailed levels of this classification (COICOP5 and COICOP6) were used in this study to identify the food products in each observation and categorize them according to NOVA. The COICOP5 and COICOP6 food groups are attached in Appendix 1.

The sub-sample consists of data from September 2005 and September 2013. Data from 2005 and 2013 were chosen to get the longest possible time period over which data are comparable, including the most recent data. Due to financial and time constraints in this study, data from one month in the two extremes of the time period were deemed sufficient to get the overall picture.

All observations from the two months were included the sub-sample, except data from a forth retail concept, as they were not possible to anonymize. The excluded data account for less than 1 per cent of the total data, hence the effect of removing them is miniscule (R. Nygaard, personal correspondence, November 13th, 2013).

Data from the country as a whole was chosen due to the sample being representative at country level. The variable county was included in the sub-sample, as analysis of food sales in smaller geographical regions may provide additional insights.

3.3 Data processing and analysis

Excel Version 2010 was used for revision of data, construction of variables, weighing the sample across the two years, and calculations of shares of turnover using pivot tables. IBM

[5] The unit is unknown and could be kilo, litre, or one pre-packed quantity (e.g. one unit could be one package of six apples or one apple), and differs for each observation. This variable was thus not used in analysis, as it would provide very imprecise information. The variable price is derived from turnover/number of units, and is therefore equally imprecise and also not applied in analysis.

[6] NOK=Norwegian Kroner

[7] List of counties in Table 2.6

SPSS version 21 was used performing tests of association. To control for mistakes during the import of data into Excel and initial revision of the data, the process was repeated and an identical calculation performed for the two files, to verify results were the same in the two cases.

3.3.1 Revision of data

The data were checked for invalid or negative variables using the data filter function.

COICOP 011932 Jelly was only included in 2005, while COICOP 011935 Diet products was only included in 2013. Both of these groups were excluded from the analysis, as they could not be compared.

3.3.2 Construction of variables

3.3.2.1 NOVA

A variable for classifying the COICOP6 food groups according to the NOVA classification was constructed. The variable was given three values that represent the groups from the new classification: NOVA1= unprocessed and minimally processed food, NOVA2 = culinary ingredients, NOVA3 = ready-to-consume products. The NOVA classification is accounted for in chapter 2.5 and in Table I in the article. The COICOP6 variable did not allow for separating processed from ultra-processed products, and all ready-to-consume products were thus grouped together as NOVA3. A fourth value was also included; X = unclassifiable, for COICOP6 food groups that aggregated processed with unprocessed foods. The classification of COICOP6 food groups into the NOVA variable is attached in Appendix 1. Table II shows some of the COICOP groups and their NOVA value, for illustrator purposes.

Table II Example of COICOP food groups and their assignment to the NOVA variable

COICOP6, 2005		**COICOP6, 2013**		**COICOP5, 2005 and 2013**	**subNOVA**	**NOVA**
011151	Flat breads and crisp breads	011151	Flat breads and crisp breads	Other baked goods	Breads	3
011152	Pizza	011152	Pizza	Other baked goods	Ready-to-eat/heat meals	3
011153	Cookies	011153	Cookies	Other baked goods	Cakes, pastries, and cookies	3
011313	Salmon, trout	011313	Salmon, trout	Fresh and frozen fish	Fish and seafood	1

The NOVA variable was constructed by assessing each COICOP6 group, deciding its contents, and assigning the appropriate NOVA value. The first step was to consider what each

COICOP6 contained and the extent of processing done. For some of the groups, it was clear from the name (e.g. cake, chocolate, cheese, bread, butter, eggs, grains), while for others it was not (e.g. pork, potatoes, salmon).

To help identify the contents of COICOP6 groups, COICOP5 groups were obtained online [110]. COICOP5 is the level above COICOP6 in the hierarchical food grouping system used by SSB. COICOP5 has 35 groups. As COICOP5 to a large extent separates between processed and unprocessed foods, these were helpful in assigning some of the COICOP6 groups to a NOVA group. For example the name "pork" of one COICOP6 group does not reveal whether it contains only unprocessed pork meat. However, "pork" belongs to the COICOP5 group "fresh or frozen meat", and is separated from the CIOCOP5 group "processed meat", thus "pork" contains only unprocessed, fresh or frozen meat. The same reasoning was applied for other types of meat, as well as fish, vegetables, fruits, and berries.

To assign the appropriate NOVA value the strategy used was based on the guidelines for applying the classification [Monteiro, CA et al., unpublished work], and some assumptions needed to be made. First, the guidelines for grouping food items were assessed (p. 8-13). If the food was not mentioned, a search in the document for the name of the food was made. For many of the COICOP6 groups, it was clear how it would fit into the classification; examples are "flour" to NOVA2 or "cookies" to NOVA3.

As recommended in the guidelines, if a food or category was unclear, the categorization was made based on assumptions of what is most common in Norway. "Yoghurt" is an example; it contains both yoghurts that are not sweetened or flavoured (NOVA1) and yoghurts that are sweetened or flavoured (NOVA3). For this group, an assumption was made that sweetened and flavoured yoghurt are most common in Norway, and the group was assigned to NOVA3. These were informed assumptions based on consultation with e.g. company webpages and product assortments within food groups.
If insufficient information was available to identify the food according to NOVA, the COICOP6 group was given the category unclassifiable. "Nuts and seeds" is an example; it contains both unsalted nuts and seeds (NOVA1) and salted or roasted nuts (NOVA3).

In total there are 143 COICOP6 groups. Some groups are not identical for 2005 and 2013, which has implications for comparison of groups across the two years. Examples are shown in Table III. Corresponding groups across the two years had to be identified. The COICOP5 groups are the same across the two years, and assuming that all foods stayed within the same COICOP5 groups, the task was corresponding COICOP6s within each COICOP5 group. For a comparison between 2005 and 2013 to be possible, the groups corresponding to

each other had to all have the same NOVA value in the two years, as is the case for potato cakes, corn cakes and buns in Table III. If corresponding COICOP6 groups belonged to different NOVA groups, all of these had to be categorized as unclassifiable, as is the case with coffee, tea and cocoa in Table III.

Table III Examples of COICOP6 groups that are not identical in 2005 and 2013

COICOP6, 2005		COICOP6, 2013		COICOP5, 2005 and 2013	subNOVA	NOVA
011154	Potato cakes, corn cakes	011154	Potato cakes, corn cakes	Other baked goods	Breads	3
		011155	Buns for hamburgers and hot dogs	Other baked goods	Breads	3
		011156	Corn cakes	Other baked goods	Breads	3
011159	Other breads			Other baked goods	Breads	3
012101	Coffee	012101	Coffee	Coffee, tea and cocoa		X (1+3)
012102	Tea	012102	Tea	Coffee, tea and cocoa		X (1)
012103	Cocoa	012103	Cocoa	Coffee, tea and cocoa		X (3)
012109	Other coffee, tea, cocoa			Coffee, tea and cocoa		X (3)

Within of the COICOP5 groups there was often one COICOP6 group called "other…", summing up the contents for the COICOP5 group, for example "other fresh and frozen meat" or "other milk, yoghurt and cream". It was often unclear what these groups contained, therefore it was impossible to classify these items unless they explicitly belong to a group, e.g. if the whole COICOP5 belongs to the same NOVA category. for example the group "other fresh and frozen meat" were assigned to NOVA1 while "other of milk, yoghurt and cream" were assigned to NOVAX.

For some COICOP6 groups it was not clear what they contained and a request was sent to SSB for clarification. These groups were potato products and baking accessories. Based on their response, potato products contained mostly potato chips, while baking accessories contained sweet décor, colouring marzipan, etc., thus both were assigned to NOVA3.

As describes above, two COICOP groups (jelly and diet products) were excluded from the analysis as the food products they contained were only included in one of the time periods.

Explanation for classification of COICOP6 food groups into NOVA food groups can be found in Appendix 1.

3.3.2.2 subNOVA

To assess composition of food sales within NOVA groups, a variable termed subNOVA was constructed. Such sub-groups have been used in previous publications on the NOVA classification [(see for example: 4; 11)], however not in a consistent way. The sub-groups are not a part of the theoretical framework. subNOVA groups were constructed based on sub-groups used in previous publications and on attempts to group food items that were similar together. These are listed in table IV. A full list of COICOP6 and subNOVA food groups within the NOVA variable can be found in Appendix 2.

Table IV subNOVA groups

NOVA1	NOVA2	NOVA3
Eggs	Animal fats	Baby food products
Fish and seafood	Flours	Breads
Fruits and berries	Oils	Cakes, pastries and cookies
Grains	Salt and spices	Cheese
Meat and poultry	Sugars and sweeteners	Potato chips
Milk		Fish products
Roots and tubers		Margarines
Vegetables		Meat and poultry products
Water		Ready-to-eat/heat meals
		Sauces and dressings
		Soft drinks
		Squash and juice
		Sweet snacks, desserts
		Sweetened breakfast cereals
		Vegetable products

3.3.2.3 Geographic regions

A new variable was calculated to stratify the data according to geographic region. Norway is commonly divided into five geographic regions, listed in Table V [(111)]. These regions are based on geographical, cultural and historic differences, and have no formal political significance. In this study, the capital city of Oslo was separated from the Eastern region and analysed independently.

3.3.3 Data analysis

Data analysis included two indicators for sales of NOVA and subNOVA food groups: share of purchases (counting each barcode scan of a food item as one purchase) and share of expenditure.

Table V List of geographic regions and counties in Norway

Region	Counties
East	Østfold, Akershus, Hedmark, Oppland, Buskerud, Vestfold, Telemark
South	Aust-Agder, Vest-Agder
West	Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal
Middle	Sør-Trøndelag, Nord-Trøndelag
North	Nordland, Troms, Finmark
Oslo (capital city)	Oslo

The indicators were calculated as percentage share of total purchases and percentage share of total turnover, respectively. Separate calculations were made for 2005 and 2013. All data were included, except the two excluded COICOP groups (jelly and diet products).

Relative increases in shares for NOVA and subNOVA groups between 2005 and 2013 were also calculated. The following formula was used for calculating relative change for each NOVA group for both indicators:

$$\frac{\%\text{share}_{2013} - \%\text{share}_{2005}}{\%\text{share}_{2005}} * 100\%$$

Chi-square tests were used to test for statistically significant associations between frequency of purchase for NOVA groups and time, NOVA groups and geographic regions, NOVA groups and retail concepts, and subNOVA groups and time. The unclassifiable group was not included in the chi-square tests. The purpose was to test for a relationship between purchase of NOVA groups and time, region, and retail chain. The unclassifiable group was a mix of foods from all NOVA groups, and including them as one group would thus disturb the test.

The indicators will answer the research questions by answering the following:

RQ 1: How were purchases of and expenditure on food in Norway distributed between the NOVA groups in 2005 and 2013?

a. How large share of purchases were made of NOVA1, 2, and 3?
b. How large share of expenditure was dedicated to NOVA1, 2 and 3?
c. How were subNOVA groups contributing to purchases within each NOVA group?
d. How were subNOVA groups contributing to expenditure shares within each NOVA group in 2005 and 2013?

RQ 2: How have purchases of and expenditure on NOVA food groups changed in Norway in the period 2005-2013?

a. Has share of purchases for NOVA1, 2 or 3 changed between 2005 and 2013?
b. Has expenditure share for NOVA1, 2 or 3 changed between 2005 and 2013?
c. Are there changes within the NOVA groups; which subNOVA groups have a change in share of purchases or expenditure shares?

RQ 3: Which were the top 10 foods sold in 2005 and 2013?

a. Which subNOVA groups were most frequently purchased in 2005 and in 2013?
b. Which subNOVA groups did Norwegians spend the most purchasing in 2005 and in 2013?

RQ 4: Were there differences in purchases and expenditure for NOVA food groups in different geographical regions in 2005 and 2013?

a. How large were share of purchases of NOVA and subNOVA food groups in six geographic regions in Norway in 2005 and 2013?
b. How large are expenditure shares for NOVA and subNOVA food groups in six geographic regions in Norway in 2005 and 2013?

RQ 5: Were there differences in purchases and expenditure for NOVA food groups from retail concepts in 2005 and 2013?

a. How large were share of purchases of NOVA and subNOVA food groups in three retail concepts in Norway in 2005 and 2013?
b. How large were expenditure shares for NOVA and subNOVA food groups in three retail concepts in Norway in 2005 and 2013?

4 Discussion of methodological issues

This chapter discusses strengths and possible limitations of the data and study design, and how these issues might challenge the quality of the study, including generalizability, possible sources of bias and validity. Ethical considerations are included.

4.1 SSB retail sample and representativeness

SSB draws their sample from a population of retailers that cover 99 % of the grocery market in Norway, and sampling strategy is well planned and reasoned [100; 109]. SSB uses these data to calculate CPI, an important official macroeconomic indicator. Thus, the representativeness of the sample is high, and the food sales reported from the sample can probably be generalized to the food retail sector in Norway with high external validity.

However, one issue should be noted; the retail samples are drawn with slightly different strategies in 2005 and 2013, resulting in differing allocation of sample size to the retail concepts[8]. According to a comparison by SSB in 2006, the Neyman Allocation leads to large sample sizes for the strata with large spread in turnover or with large size. Proportional allocation results in a larger sample size for those strata that accounts for a large share of total turnover. The former strategy allocated relatively more retailers to the supermarket strata and relatively fewer to the low price strata [100]. This might result in a skew in results if sales of the NOVA food groups differ between the retail concepts.

To address the impact of this skew between the samples, data were weighted based on a common criteria of share of turnover in the population. Unfortunately, data on the population used by SSB in the sampling procedure are not public, and could not be used. However, data on market shares for the retail concepts based on a very similar population were obtainable [82; 112], and was used for calculating weights. The same procedure of investigating skew between strata in a sample has been used in previous studies, such as the Norwegian dietary survey, Norkost 3 [113].

Market shares for the retail concepts and weights are shown in Appendix 3.Weights were calculated as

$$weight_i = \frac{\%market\ share\ in\ population_i}{\%\ market\ share\ in\ sample_i}$$

i = Supermarket, convenience store, low price

[8] the retail concepts used in the sampling procedure are more refined than the three concepts applied in this study

The weights were applied to the data through multiplying all observations (every one purchase and all turnover values) with the weight from the retail concept in which they were sold. The results showed minimal differences between un-weighed and weighed data for both indicators. Weighing the data did not affect results for comparison between 2005 and 2013 (see Appendix 3).

The sample was drawn without regards to geographic location, and it was not possible to obtain data on geographic distribution of market shares for retailers in Norway. Thus results from geographic analysis must be interpreted with caution, especially the region South, which has only four retailers in 2005 and seven in 2013.

4.2 Internal validity is affected by type of data and sub sample

4.2.1 Retail data as proxy for consumption

There are certain strengths and weaknesses to using retail data as a proxy for food consumption, as for all measures of food consumption. The main issues are the exclusion of certain sources of food consumption and the inability to show individual distribution, while the main strength is not being prone to responder bias, comprehensive data and a consistent collection across time.

The Food and Agriculture Organization of the United Nations (FAO) uses food balance sheets (FBS) to calculate dietary energy supply (DES), which is used as a proxy for dietary energy consumption (DEC) [(114)]. An FBS shows a comprehensive picture of the pattern of a country's food supply, calculating the sources of supply for each food item. Using retail data can be compared to calculating national food supply statistics. Like national food supply statistics food retail data are collected not from individuals, but as an aggregate for the population. Further, they are both measures of food availability, however at different levels; retail is food availability in the sense that it is purchased and brought home. On the other hand, national food supply statistics include all foods available (e.g. for consumption in restaurants), while retail data excludes food not purchased from retailers.

A brief assessment of the probable impact factors that accounts for a difference between food retail and actual food consumption for NOVA food groups follows.

Retail data include foods that will be wasted after brought home. In HICs approximately one third of all foods brought home are estimated to be wasted [(115)]. It has been argued that waste is higher for NOVA1 items as these are more perishable [(11)]. However, a report on food waste from Norway, show that many NOVA3 items (especially fresh baked goods) are also wasted

by many of the respondents [116]. This bias may have led to overestimation of consumption of NOVA1.

Foods eaten outside the homes, i.e. foods eaten at restaurants, cafeterias, fast food restaurant, etc., are not included in the retail data. Pizza restaurants, gas stations and shopping mall cafeterias, are most frequently visited [117], suggesting consumption of NOVA3 is underestimated in this study.

Food purchased in other countries (cross-border shopping) also accounts for a difference between retail data from Norway and Norwegian food consumption. Foods from cross-border shopping to Norway are mostly purchased in Sweden. The foods most commonly purchased are meat and poultry, (NOVA1 and NOVA3) and chocolate and candy (NOVA3) [118]. Studies have shown that eight percent of Norwegian consumption of sweets is purchased abroad [97]. Also for this group, a general underestimation of consumption is the result, and it may be assumed this is more so for NOVA3 than the others.

Harvest (non-commercial) is not included in food retail, and thus accounts for an underestimation of food consumption. All foods harvested will be unprocessed by industry and belong to NOVA1. It therefore represents a skew in the data, underestimating consumption of NOVA1.

There are also some important strengths of using retail data/barcode data as a proxy for food consumption. In contrary to surveys involving respondents, barcode data are generated electronically, and therefore not prone to participation- or information bias, such as recall bias. It has been found that an under-reporting food consumption is common and often skews results [105]. The sample is also not prone to the bias of people generally more interested in health participating in health studies[119]. Further, data on food retail are well suited for application to the new classification of food: data are generated at point of sale and separates what is bought as little processed ingredients and prepared at home and what is purchased as processed foods. Finally, data are comprehensive, covering close to all food items available in food retailers, and are collected consistently over time.

4.2.1.1 Limitations related to indicators

Two indicators for food consumption were used: frequency of purchase and expenditure for food groups. Frequency of purchase tells how often certain food items are purchased, and may provide a picture of the composition of shopping carts. However, frequency of purchase assigns equal value to purchases of very different amount and value. For example one purchase may contain two kilo of meat, the next 200 grams of meat, and a third one pack of

chewing gum, while all are counted as one purchase. Thus, to strengthen analysis, expenditure on food groups was included in the study. This indicator adds more weight to larger and more expensive purchases, and tells how food budgets are prioritized. This indicator is limited in the sense that findings could not be tested for statistical significance with data from only two points in time.

4.2.2 Constructing the NOVA variable from COICOP food groups

COICOP6 food groups were used in the study to assign the observations to food groups in the NOVA classification. This creates a problem in the accuracy in classifying foods; the guidelines for the new classification states that one should avoid using data sources of food consumption that classifies food across NOVA groups (Monteiro, CA et al., unpublished work). The consequence was that some observations could not be classified and that misclassification might have occurred, as some decisions on classification were based on assumptions. This might challenge the internal validity of the study (through inducing measurement bias). However, the CIOCOP6 classification is sufficiently detailed for most COICOP6 groups to allow accurate classification into the NOVA framework. Further, it drastically reduced the time consumption necessary for classification (compared to classifying unique food items). This enables a holistic assessment of the overall food sales, which would not have been possible otherwise.

4.2.3 Limited time series and seasonal variation

Data from two points in time and from one month of the year were analysed. There are two problems related to this. First, possible statistically significant associations between distribution of food sales across NOVA groups and time must be interpreted with caution as we only have two points in time.

Second, there is uncertainty as to whether food sales in one month can be generalized to a longer period of time, e.g. a year. There may be seasonal variation in food retail. By choosing the same month (September) in both years, risk of seasonal differences between the two data sets is eliminated. September was chosen as there are no official vacations or holidays during this month, reducing uncertainty on whether food retail in September provides a representative sample for whole-year retail.

Data from one month may also be affected by offers and sales, as SSB has found Norwegian consumers react strongly to sales prices on food (120). Food items that have recently been on offer may sell less than usual if many consumers stock up during the sale, and reduce demand to a below-normal level for a period after the offer. Effects of such

variations in sale are probably more pronounced in data from one month than they would be if data were representing the full year. These issues are challenging internal validity.

4.3 Other considerations

A possible source of bias in the study is the manual data processing in Excel. However, as described in chapter 2, import of data into Excel and the initial revision were done twice and a calculation made in both versions. Identical results in the two calculations indicate no mistakes were made in this phase of the data processing. The general results have been the same throughout the analysis period, indicating the impact of possible mistakes are not significant.

Some observations had very high turnover, the maximum turnover being above 200 000 NOK (compared to an average of 320NOK and standard deviation of 1045 NOK). Dealing with outliers are most relevant if doing tests which assume normality [121], which is not the case for any analysis made with the turnover variable in this study. Further, there is no evidence of what would be causing this variation, and outliers can be legitimate cases sampled from the correct population, especially if sample size is large [121]. In this study the sample size is very large (almost 800 000 observations). Thus, it was deemed appropriate to include the outliers in the analysis.

4.4 Ethical considerations

Since the data do not contain personal data, applications to the Norwegian Social Science Data Services (NSD) or The Research Ethics in Norway (REK) were not required. The barcode data contain extensive information on turnover and sales for the retailers in the sample. To ensure anonymity of retailers and producers, data have been anonymized prior to being availed for this study. In addition, an agreement of confidentiality has been signed with SSB and data will be deleted when finishing the project.

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Purchase of food in Norway: applying a new classification of food based on the degree and purpose of processing

Abstract

Objective: To assess food sales in Norway, applying a new classification of food based on degree and purpose of processing.

Design: Applying the new classification on food sales data from a nationally representative sample of retailers. Foods were grouped into NOVA1 minimally processed foods, NOVA2 culinary ingredients, and NOVA3 ready-to-consume products (processed and ultra-processed products). Indicators were share of purchases and expenditure for food groups.

Setting: Data from September 2005 and 2013 analysed in Norway as a whole, in six geographical regions, and in three retail concepts.

Subjects: Food item sold (n=795 306)

Results: NOVA3, with more than 70% of purchases and 60% of expenditure, dominated food sales. NOVA1 accounted for 12% of purchases and 30% of expenditure. Sweets, snacks and desserts were most frequently purchased food items and accounted for the largest expenditure share both in 2005 and in 2013. Sweet ultra-processed products combined (food and beverages) accounted for every third purchase in 2013, and were purchased two and a half times more often than minimally processed food. Share of purchase and expenditure on NOVA groups changed minimally in favour of NOVA1 and in disfavour of NOVA3 between 2005 and 2013.

Conclusions: The present study indicates that Norwegian diets are dominated by ready-to-consume products to an extent that is likely to be contributing to rising rates of overweight, obesity, and related non-communicable diseases. Policy measures should aim at decreasing consumption of ready-to-consume products.

Key words: Food classification, diet, ultra-processed products, obesity

Introduction

The global obesity epidemic is linked to the nutrition transition, occurring across the globe [(1)]. An important characteristic of the nutrition transition is the increased consumption of industrially processed foods [(2)]. Although it is generally recognized that increased

consumption of such foods is an important cause of the obesity epidemic [3; 4], industrial processing is generally underestimated or overlooked in frameworks for studying diet and health [5; 6].

To close this gap in research, a new classification of food (NOVA) has recently been proposed, describing foods and dietary patterns in terms of extent and purpose of industrial processing [5; 7] (see Table I[9]). According to NOVA, meals prepared from less processed foods ("minimally processed foods" and "culinary ingredients") are in various combinations the basis of all traditional diets, which are generally related to low prevalence of overweight, obesity and related non-communicable diseases (NCDs). Ultra-processed products are the most extensively processed products and hypothesised as the main dietary driver of the obesity epidemic.

The evidence base from studies applying NOVA is so far indicating that ultra-processed products are replacing traditional diets [8; 9], dominating global food systems [6], rapidly penetrating markets and market segments across the globe [10; 11], and that diets dominated by ultra-processed products have poor nutrient profiles [12] and are associated with Metabolic Syndrome [13]. Consumption of ultra-processed products is also inducing unfavourable eating habits, e.g. snacking, as they are ready-to-eat convenience foods [14]. The replacement of traditional diets for ultra-processed products has been seen in the context of the food system, characterized by a lightly regulated global food industry [10].

Overall dietary patterns based on this classification have been examined in only two countries [8; 15]. Studies from additional countries are needed to increase evidence base supporting the use and relevance of such a classification for public health knowledge and policy action both internationally and in the country in question.

In Norway, overweight, obesity and related NCDs is a public health issue [16]. Evidence suggests that more than half the population is overweight, of which almost 20 % are obese, and rates are increasing [16; 17]. NCDs account for the majority of deaths in Norway [18]. Dietary changes over the past decades have been identified as an important cause, and dietary improvement is a core strategy for promoting public health by the government [19].

This study aims at investigating food sales in Norway with the use of the NOVA framework, assessing i) current food sales and changes between 2005 and 2013 in the country as a whole,

[9] All tables and figures are placed after article manuscript

ii) differences of food sales between six geographic regions, and iii) differences of food sales from three retail concepts.

Methods

Data source and sampling

The data analysed in the present study are derived from monthly routine collection of sales data carried out by Statistics Norway (SSB)[10] from August 2005 onwards. The dataset reports from a nationally representative sample of grocery retailers, and consists of barcode data generated electronically at point of purchase for each individual sale of food and non-alcoholic beverage item. Sales for close to all food products available in Norway are reported [(20)]. Due to extensive amounts of data reported each month, this study focuses on the analysis of data from September 2005 and September 2013.

The retailers were sampled from a population defined as grocery retailers reporting barcode data to one of the four leading retail groups in Norway [(21)]. The population covers more than 99 % of the Norwegian grocery retail market [(22)], and the skew resulting from excluding retailers who cannot deliver barcode data or that do not report to one of the four retail groups is therefore marginal [(20)]. Retailers were stratified according to retail chain and concept, and drawn with respect to share of turnover for the strata. The sample size each month ranges from about 150 to 180 retailers, accounting for about 5 % of the total number of retailers in the population. Detailed description of the sampling strategy is available elsewhere [(20; 21; 22; 23)].

Data collection

The bar code data analysed in the study included 296 121 observations in September 2005, and 501 938 observations in September 2013[11].

The following variables (unit in brackets) were obtained for each observation from SSB: turnover (NOK), amount (unknown unit[12]), price (NOK per unit), county, retail concept and food group (COICOP6 code). The first four variables are reported from the sample, while the

[10] Data are collected during the middle-week of each month throughout the year for the estimation of the food price index, a constituent of the Norwegian Consumer Price Index (CPI).

[11] Each observation is reported independently and without information on the buyer or which purchases are made by the same buyer

[12] The unit is unknown and could be kilo, litre, or one pre-packed quantity (e.g. one unit could be one package of six apples or one apple), and differs for each observation. This variable was thus not used in analysis, as it would provide very imprecise information.

two latter are constructed by SSB based on information on retail chain and food item description, respectively. Retail chains are assigned to four retail concepts: supermarkets, low-price stores, convenience stores, and kiosk. Data from the kiosk retail concept was not available for this study, due to problems of anonymizing[13]. Food and beverage items are assigned to food groups according to a consumption classification called COICOP [(22)], of six hierarchical levels, where COICOP6 is the most detailed level with 139 groups[14].

Classification

For the purposes of this study, the barcode data were systematically analysed using the NOVA system for food stuffs developed at the University of São Paulo. Food items are grouped according to the extent and purpose of the industrial processing they undergo [(5; 24)]. Table I summarizes the definitions of the food groups in NOVA and provides examples of food items belonging to each group.

The first step in the analysis was to assign the 139 COICOP6 food groups in the barcode data to one of the food groups in NOVA. The COICOP6 variable did not allow for separating processed from ultra-processed products, and all ready-to-consume products were thus grouped and analysed together as NOVA3. A fourth group was also included for COICOP6 food groups that aggregated processed with unprocessed foods, and named "unclassifiable".

Assignment to the NOVA groups was done based on a strategy proposed in guidelines for applying the NOVA classification to food consumption surveys, developed by the São Paulo research team [(Monteiro, CA et al., unpublished results)]. As the barcode data do not always distinguish between foods from different NOVA groups, in some cases, assumptions were made. As recommended in the guidelines, if a food or category was unclear, the categorization was made based on assumptions of what is most common in Norway. For example, COICOP6 did not distinguish between yoghurts that are flavoured/ sweetened and those that are not, thus all yoghurts were classified as ultra-processed, assuming this is most common in Norway. If insufficient information was available to identify the food according to NOVA, the COICOP6 group was given the category unclassifiable. For example, "nuts and seeds" contains both unsalted nuts and seeds (NOVA1) and salted or roasted nuts (NOVA3). Two food groups in

[13] These accounted for less than 1 % of turnover in the sample; hence the effect of this exclusion is minimal.

[14] Examples of COICOP6 groups are beef, poultry, salmon and trout, eggs, flours, minced meat and meatballs, cured meat, bacon, canned fish, breads, pizza, ready-to-heat dinners, dinner-bases, sugar, butter, candy, baby foods, and flours.

the barcode data were only included in either 2005 or 2013, and were thus excluded from the analysis (jelly and diet products).

In addition, an analysis of food items within each NOVA group was included. These were classified as 29 subNOVA groups (see Table III).

Data analysis

Frequency of purchase of food items (counting each barcode scan of a food item as one purchase) and expenditure on food items were used as proxies for food consumption. These indicators are not direct measures of consumption, but provide a good indication of consumption trends.

The first analysis involved counting share of total purchases accounted for by each NOVA group in 2005 and in 2013. The relative difference in share between 2005 and 2013 for each NOVA group was calculated and Pearson's chi-square tests for association between time and food purchases were performed[15]. The same was done for subNOVA groups. Frequency of purchase assigns equal value to purchases of very different amount and value. For example one purchase may contain two kilos of meat, the next 200 grams of meat and a third may contain one pack of chewing gum, but all are counted as one purchase. Therefore, to strengthen analysis, expenditure share for the food groups was included as a second indicator. This indicator adds more weight to larger and more expensive purchases. Share of expenditure and relative difference in share between 2005 and 2013 for NOVA and subNOVA groups was calculated. For this indicator, findings could not be tested for statistical significance with data from only two points in time.

To assess food sales in different geographical regions, the counties were divided into six geographical regions in Norway (East, South, West, Middle, North, and Oslo (capital city). Norway is commonly divided into five geographic regions [(25)]. The capital city of Oslo was separated from the Eastern region and analysed independently. Share of purchases and expenditure for NOVA groups were calculated in each region. Chi-square tests for association between regions and frequency of food purchases were performed for 2005 and 2013 separately. The same procedure was followed to assess food sales in three different retail concepts (supermarket, low price store, and convenience store).

[15] The unclassifiable group was not included in chi-square tests

Calculations were carried out in Excel version 2010 using pivot tables. Statistical analyses were performed in IBM SPSS Statistics 21.

Results

Food sales per NOVA group

Figure 1 shows share of food sales for NOVA groups in 2005 and 2013, in purchases and expenditure. Food sales of NOVA3 were at a much higher level than NOVA1 and NOVA2 for both indicators, with more than 70 % of purchases and 60% of expenditure. A little more than 10 % of purchases and around 30 % of expenditure were of NOVA1. The higher share of expenditure than purchases means that purchases of NOVA1 had a relatively higher average price per purchase than purchases of NOVA2 and 3. NOVA2 was purchased least frequently and accounted for the smallest share of expenditure.

Food sales per subNOVA group

Share of purchases and expenditure for subNOVA groups are shown in Figure 2 and Figure 3, respectively. The figures show that subgroups in NOVA3 are larger than subgroups in NOVA1 and NOVA2, and most significantly so in terms of purchases.

Sweets, snacks and desserts are the most frequently purchased food items and the food items with the largest expenditure share both in 2005 and in 2013. These items are purchased more than twice as often than the next group, and more often than all minimally processed foods (NOVA1) items combined.

Table III shows shares for all subNOVA groups. If aggregating all purchases of sweet ultra-processed products[16], these account for every third purchase in 2013. Thus, for each purchase of a minimally processed food, two and a half sweet ultra-processed products are purchased. In expenditure share, sweet ultra-processed products account for around 23 %, compared to 29 % for all minimally processed foods.

Results also show that Norwegians spend less and purchase less frequently minimally processed meat and poultry compared to processed and ultra-processed meat and poultry. The same is found for fish and potatoes (roots and tubers, compared to potato chips).

Table II lists the ten of most sold subNOVA groups, and shows a predominance of food groups from NOVA3 (most of them ultra-processed) in both years and for both purchases and

[16] Sweets, snacks and desserts, cakes, pastries and cookies, soft drinks, squashes and juice, and sweetened breakfast cereals

expenditure. NOVA 3 accounts for the eight most frequently purchased products in 2005 and the seven most frequently purchased products in 2013. Of the ten subNOVA groups on which Norwegians spent the most, seven were NOVA 3 in 2005 and six in 2013.

Six groups are among the top ten lists both for most frequently purchased and for highest expenditure share. All are NOVA3 (four are ultra-processed).

Evolution of food sales between 2005 and 2013

Table III shows that share of purchase and expenditure on NOVA groups changed minimally between 2005 and 2013, but in favour of NOVA1 and in disfavour of NOVA3. Share of food expenditure on NOVA 2 decreased. A Pearson's chi-square test showed time had a small, but significant effect on frequency of purchase of NOVA groups ($\chi 2$ (2) =38,097, $p<0.001$, Cramer's V =0,007, $p<0.001$). Significant standardized residuals are shown in Table III. As indicated by the weak effect size measure, the absolute changes in share of frequency of purchases were small for all NOVA groups (0.1%-0.5 %).

Table III shows relative changes between 2005 and 2013 for subNOVA groups. There is a (highly) statistically significant association between purchases of subNOVA groups and time (χ^2 (28) =6277.631, $p<0.001$). The relationship is weak (Cramer's V=0.093, $p<0.001$). Significant standardized residuals are shown in Table III. Fish and seafood, squashes and juice, eggs, and vegetable products were the only sub NOVA groups that did not have statistically significant standardized residuals in either year.

The changes within NOVA1 show increased sales of fruits, vegetables, roots, and tubers – these foods are both purchased more frequently and a larger share of expenditure is dedicated to them. Most remarkable was the increase for fruits and berries with a doubling of share of purchases and 50% increase in share of expenditure. Fish and seafood is not purchased more frequently, but Norwegians spend more of their food budgets on fish and seafood. Meat and poultry is purchased less frequently and a smaller share of expenditure is dedicated to them.

Within NOVA3 results show increased purchases and expenditure on ready-to-eat/heat meals, breads, and meat and poultry products, which are all “meal-type” products. Purchase and expenditure on chocolate, sweets, snacks, desserts, cakes and pastries, which are all sweet

"snack-type" products have decreased. Soft drinks are purchased less frequently, but a higher share of expenditure is dedicated to them[17].

Comparison of retail concepts

Retail concept had a statistically significant, but weak, effect on frequency of purchase of items in NOVA groups in both 2005 ($\chi 2$ (4) =270,329, $p<0.001$, Cramer's V =0.022, $p<0.001$) and in 2013 ($\chi 2$ (4) =275,301, $p<0.001$, Cramer's V =0.017, $p<0.001$).

Figure 4 show share of purchases and expenditure on NOVA groups in the three retail concepts. In general, food sales in supermarkets are characterized by a higher share of NOVA1 than in other concepts and a lower share of NOVA3. Food sales in convenience stores are characterized by the opposite. In supermarkets around 30 % of expenditure is used on NOVA1 and a little less than 60% on NOVA3, compared to 22 % and 66% in convenience stores. For NOVA2, share of expenditure was almost equal in 2013 across concepts. In 2013, convenience stores had the highest share of purchases of NOVA1.

The subNOVA groups are also sold at different patterns in the three retail concepts. In supermarkets, sales of fish and seafood (purchase and expenditure), meat and poultry (expenditure), vegetables (expenditure), cheese (purchase and expenditure), and sauces and dressings (purchases) are higher than in the two others. Increase in expenditure on fish has taken place in supermarkets only. The higher sale (purchase and expenditure) of NOVA3 in convenience stores is mainly from to cakes, pastries and cookies, sweets, snacks and desserts, and soft drinks. The higher purchase of NOVA1 in convenience stores in 2013 is due to fruits and berries, vegetables, and water.

Comparison of six geographic regions

Region of sale had a weak, but significant effect on sales of NOVA groups in both 2005 ($\chi 2$ (10) =145,055, $p<0.001$, Cramer's V =0.016, $p<0.001$) and in 2013 ($\chi 2$ (10) =68.832, $p<0.001$, Cramer's V =0.009, $p<0.001$). However, no particular patterns were detected, as no regions were consistently higher or lower in sales of any NOVA groups. For expenditure on NOVA groups, all regions seem to convert to similar levels, except in Oslo, where expenditure increased to be higher than in other regions for NOVA1 and expenditure on

[17] More detailed analysis shows that the main increase in ready-to-eat/heat meals is due to increase in sales (purchase and expenditure) of pre-prepared meals, the main increase in breads is accounted for by increasing sales of various tortillas for tacos and buns for hot dogs and hamburgers. In sweets, the largest decrease was accounted for by a fall in gift-wrapped confectionary for both purchases and turnover, while other types of chocolate, yoghurts, and ice cream did not fall or increased their share of purchases and turnover.

NOVA3 decreased correspondingly to be lower than in the other regions. This is shown in Figure 5.

Discussion

This study found that in 2005 and 2013, ready-to-consume, mostly ultra-processed products, dominated food purchase and expenditure in Norway, indicating a high consumption of such items. Sweet ultra-processed products accounted for three out of ten purchased food items and more than a fifth of expenditure on food, but results indicated sales of these had decreased between 2005 and 2013. The study found increased sales for fruits and berries, vegetables, roots and tubers, ready-to-eat/heat meals, breads, and meat and poultry products.

Limitations and strengths

While providing a good estimate, the use of food retail data as proxies for food consumption has limitations. First, there are elements of inaccuracy related to the indicators used, as the contents in each purchase is not standardized and amount of food purchased for a certain expenditure share will vary according to the price of the food item.

In addition, food waste is not accounted for in retail data. Studies show significant amounts of foods are wasted, e.g. 30% in the UK [(26)]. Although fresh baked items are wasted frequently in Norway [(27)] , minimally processed foods are likely to be wasted more often, as these are more perishable. This bias may have led to overestimation of consumption of NOVA1.

Finally, retail data do not include all sources of food consumption, such as foods eaten at restaurants. Pizza restaurants, gas stations and shopping mall cafeterias are most frequently visited [(28)], suggesting consumption of NOVA3 is underestimated in this study.

Data were collected during September in 2005 and 2013, and uncertainty exists on whether retail in September is representative for whole-year retail. Measures have been taken to reduce this uncertainty; September was chosen as there are no official vacations or holidays during this month.

Retail data is measured at population level, and results cannot be extrapolated to individuals or households.

Several strengths are also present. For example, these data are not prone to responder bias, as they are collected electronically. Further, they are suitable for application of the NOVA

classification, as the foods and culinary ingredients purchased for home preparation of meals are identified and separated from the ready-to-consume items.

Comparison

A positive correlation between GDP per capita and consumption rates of ultra-processed products have been found [11]. A comparison of results from other high-income countries is therefore most relevant. EuroMonitor sales data on packaged foods, snacks and soft drinks (proxy for ultra-processed foods) have been analysed in 79 high- and middle-income countries, showing that ultra- processed products dominate the food supplies of high-income countries [11]. Studies from Canada show shares of household food expenditure and dietary energy availability fell for minimally processed foods and culinary ingredients, and rose for ready-to-consume products between 1938 and 2011 [8; 12]. The expenditure share for NOVA1, 2 and 3 in 2011 were 40.8 %, 4.8 % and 54.4 %, respectively. Corresponding shares for caloric intake were 25.6 %, 12.7 %, and 61.7 % [8]. Similarly, in the UK, share of caloric intake were 22.9%, 13.7%, 63.4 % for NOVA1, 2 and 3, respectively [29]. The NOVA3 group consisted mainly of ultra-processed products in all the above mentioned studies. Although results are not directly comparable as different methods and indicators of food consumption have been applied, results indicate food consumption in Norway in terms of the NOVA classification is similar to other high-income countries, and dominated by ready-to-consume products.

It has been suggested that a market saturation point is reached for ultra-processed products when these supply around 60% of calories, and that this point has been reached in high-income countries [10; 11; 30; 31]. This study indicates the same has happened in Norway, as share of purchases and expenditure increased minimally between 2005 and 2013. However, caution must be taken in interpretation of time trends, as this study is based on data from two points in time only.

The findings are in line with other studies of Norwegian dietary development, although comparisons of results is challenging as other studies do not separate foods groups in accordance with NOVA.

A previous publication from Norway reports that expenditure share for sugary foods and beverages account for almost one fifth of all expenses for food and non-alcoholic beverages [32], which is similar but a little lower than the share found in this study (23%). High intake of free sugars, sweets, and soft drinks is a well-known issue in Norway and is previously

documented in several surveys [32; 33]. The way sugar is consumed has changed, through decreasing use of table sugars, syrups, etc. for home use, and increasing consumption of sugars through candy and soft drinks. Sweet ultra-processed products, especially candy, chocolate and sweetened beverages, contribute most to intake of added sugars for children, adolescents and adults [32; 34]. The findings in the current study highlight sweet ultra-processed products as the vehicle for sugar intake.

Annual reports on dietary development show increasing consumption of vegetables and fruits between 1999 and 2011 [32; 33]. In the present study, an increase in sales of fruit, berries and vegetable consumption was found between 2005 and 2013. Consumption of potato, a staple food in Norwegian diet, has more than halved since the 1970s, while consumption of potato products have multiplied many times. Half of potato crops are now used for processed potato products [33]. In line with this the present study found minimally processed potatoes account for less than 0.5% of purchases and about 1.5% of food expenditures, while potato chips accounts for 2% of purchases and 1.5%-2% of food expenditures.

Meat consumption is reported to be increasing in Norway [33]. As noted by Monteiro et al. [9], it is often assumed that consumption of all meat is increasing, while in Brazil the only meat whose consumption is increasing is processed meat. The present study indicates the same might be true in Norway.

Implications for health

The present study did not address nutrient contents of food consumption nor health outcomes, and health implication of findings are thus difficult to assess. However, results from Canada may provide preliminary indications for Norway. One study showed that only the quintile of the population with lowest consumption of ultra-processed products was anywhere near fulfilling nutrient recommendations from the World Health Organization (WHO) [12]. The other 80% of the population consumed more than half of energy intake through ultra-processed products, and would need to reduce caloric share of these in diet to fulfil nutrient goals of WHO. Norwegian consumption of NOVA3 was even higher than in Canada in terms of expenditure share [8]. If nutrient profile of such diets in Norway is similar to that in Canada, a reduction of purchases and consumption of NOVA3 is necessary for the prevention of obesity and NCDs.

The high consumption of sweet ultra-processed products is a particular problem for health. Energy share from sugar exceeds the recommended ten percent, and children and adolescents

consume an even higher energy share from sweets than adults [32; 34]. There is evidence of the link between excessive intake of free sugars, especially through sugar-sweetened beverages, and overweight and NCDs [4; 35; 36]. The frequency of purchase for these products indicates sweet ultra-processed products are very regularly consumed. Although the high sugar intake is well-known and problematized, the present study indicates even more effort is needed on reducing intake of the sweet ultra-processed products that are the main vehicles for sugar intake.

The present study found increasing purchase of and expenditure share for fruits, berries, vegetables, roots and tubers, and fish and seafood within NOVA1 and a decrease in purchase and expenditure of sweet ultra-processed products. These are dietary shifts line with Norwegian dietary recommendations [37]. Some of these changes were more present in Oslo and in supermarkets, both higher socio-economic status indicators. Market saturation for ultra-processed foods have been explained by increasing awareness of health outcomes in the population [31]. Although weak, the present findings may be indications of dietary patterns going into the fifth stage in the nutrition transition, characterized by a higher awareness of health outcomes related to lifestyle [38]. Other studies also indicate this. An emerging health trend and focus on healthy diets has been found over the past years [39] and consumers are to a higher degree sceptic of the food selection in fast food outlets due to health concerns, and prefer improved selection of fruits, vegetables, and foods with less fat and more fibre [40]. There is also attention to the health benefits of traditional foods and diets through the New Nordic Diet [41].

However, the overall level of food purchases and expenditure on NOVA3 did not decrease, and for some, especially ready-to-eat/heat meals and processed meat and poultry, both purchases and expenditure increased. Individual and group variations in diets are not identified in this study, thus caution must be taken in interpretations.

Policy implications

Norwegian diets are dominated by ready-to-consume products to an extent that is likely to be contributing to the rising rates of overweight, obesity, and related NCDs. The present and previous studies indicate consumption of ready-to-consume products need to decrease and that increased consumption of meals prepared from minimally processed foods and culinary ingredients should be promoted through strong policy measures involving all sectors.

Norwegian public efforts to improve diet is outlined in a recent white paper on public health[16], which calls for concerted action across sectors. Strategies to improve diets include dietary recommendations, encouraging consumption of fruits and vegetables, fish, whole grain products, and limiting consumption of sugar, red and processed meats, and products high in saturated fats and salt. A labelling scheme, "the keyhole" indicates healthier choices within a food group, based on criteria for contents of added sugar, salt and saturated fats. Further, the food industry is strongly encouraged to create healthier products, especially reducing contents of salt, trans-fatty acids and palm oil. A self-regulation plan for eliminating marketing of unhealthy commodities to children has been developed by the food industry. The plan will run from 2013 to 2015, and evaluated by the government authorities and the industry, before a ban will be considered.

The current study provides preliminary evidence for the need for increased focus on ready-to-consume products as vehicles for intake of added sugar, salt and fat. Although reformulations and labelling to help choosing the healthier option might contribute to improving nutrient profile of diets, the current study recommends the main aim to be reducing overall intake of such products. This is particularly important regarding sweet ultra-processed products.

This and previous publications [30; 42; 43] propose a conflict of interest between public health (reducing intake of ready-to-consume products) and food industry profits (increasing sales of ready-to-consume products). When engaging with food industry it is important that policy authorities recognize this conflict of interest, and that public health improvement is always the main priority. No evidence has been found for efficiency of food-industry self-regulation, unless there is a clear threat of regulation [30]. Thus, the present study supports stronger regulatory policies, or at least threats of such, for the desired effect of industry self-regulation. This should be combined with continued informational and educational campaigns with emphasis on how to prepare meals and dishes from foods and culinary ingredients.

Research gaps and potentials for future research

To further assess and confirm the findings from Norway, studies on caloric contribution of NOVA groups to the Norwegian diet are needed, as well as studies linking the consumption of specific NOVA groups and subgroups to health outcomes. Studies on individual and household level should be conducted to assess individual variations. Importantly, there are clear socioeconomic differences in food consumption [34] and health [16], which should also be further investigated with the use of the NOVA framework. Longer time series and data covering the whole year would provide a better understanding of time trends.

Conclusion

The present study indicates that Norwegian diets are dominated by ready-to-consume products, which account for 70% of purchases and 60% of food expenditure. Sweet ultra-processed products alone accounted for every third purchase and a fifth of food expenditure. Drawing on findings from Canada, such diets are likely to be contributing to the rising rates of overweight, obesity, and related NCDs. The present and previous studies indicate consumption of ready-to-consume products need to decrease and that increased consumption of meals prepared from minimally processed foods and culinary ingredients should be promoted through strong policy measures involving all sectors.

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Tables

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Table I NOVA classification of food: definitions and examples

NOVA	Extent of processing	Characteristics	Examples
1 Unprocessed or minimally processed foods	No or minimal processing, does not add or introduce any substances, but may involve subtracting parts of the food in ways that do not significantly affect its use. Processes include cleaning, peeling, portioning, skinning, boning, drying, fat reduction, pasteurization, sterilizing, chilling, freezing, sealing, bottling (as such), simple wrapping, vacuum and gas packing	Foods of very different nutrient profiles, but will in appropriate combinations provide all the essential nutrients and make out the basis of healthy diets. A common feature of foods in this category is the short durability and many of these foods need cooking in order to be safe and edible	Fresh, chilled or frozen meats, fish, vegetables, and fruits, unflavoured milk and milk products, eggs, whole grains, nuts, seeds, water
2 Culinary ingredients	Processing to extract or purify specific parts of foods. Specific processes include pressing, milling, crushing, grinding, pulverizing	Nutritional properties and uses entirely different from their original foods. Most are energy-dense and nutrient deplete, but they are typically inedible by themselves, and are mostly used to enhance flavour of meals when cooking with unprocessed and minimally processed foods	Animal fats, oils, sugar, flour, salt
3 Ready-to-consume products	Processing that mixes unprocessed or minimally processed foods and culinary ingredients to create food products that are ready-to-consume and more durable. The resulting products are of sub-divided in two **Processed products**: Foods preserved in salt, sugar, brine, or by smoking **Ultra-processed products**: Made from processed substances extracted or refined from whole foods—e.g., oils, hydrogenated oils and fats, flours and starches, variants of sugar, and cheap parts or remnants of animal foods—with little or no whole foods. In addition to so-called industrial ingredients are often used: ingredients that are not available in supermarkets and not used in food preparation at home or in restaurants. These are of several types; further processed versions of culinary ingredients, such as modified starch, hydrogenated oils, high fructose corn syrup, or preservatives, stabilizers, colours, and sweeteners.	**Processed products:** Processing has typically deranged the nutrient properties of the food. Although these products are ready-to-consume, they are often not consumed alone, but rather as part of meals **Ultra-processed products:** Typically energy dense, have a high glycaemic load, are low in dietary fibre, micronutrients, and phytochemicals, and are high in unhealthy types of dietary fat, free sugars, and sodium. Intense palatability omnipresence and sophisticated and aggressive marketing strategies make modest consumption of ultra-processed products unlikely and displacement of fresh or minimally processed foods very likely. These factors also make ultra-processed products liable to harm endogenous satiety mechanisms and so promote energy overconsumption and thus obesity	**Processed products:** Canned, bottled, smoked meats, fish, vegetables, and fruits, cheese **Ultra-processed products:** Ready-to-eat/heat meals, dinner helpers, dressings, breads, reconstituted meat, fish, vegetable products, sweets, chocolates, cakes, sweetened drinks, cheese products

Source: Adapted from Monteiro et al., unpublished results

Table II Ten most sold subNOVA groups in 2005 and 2013, frequency share and expenditure share

	a) Frequency of purchase					
	2005	**Share (%)**	**NOVA**	**2013**	**Share (%)**	**NOVA**
1	**Sweets, snacks, desserts***	**18.7**	**3u****	**Sweets, snacks, desserts**	**16.2**	**3u**
2	**Meat and poultry products**	**6.8**	**3**	**Meat and poultry products**	**8.0**	**3**
3	Cakes, pastries, and cookies	6.4	3u	**Breads**	**6.0**	**3u**
4	Sauces and dressings	6.3	3u	Cakes, pastries, and cookies	5.9	3u
5	**Cheese**	**5.3**	**3**	**Ready-to-eat/heat meals**	**5.9**	**3u**
6	**Breads**	**4.8**	**3u**	Sauces and dressings	5.8	3u
7	**Ready-to-eat/heat meals**	**4.6**	**3u**	**Cheese**	**5.0**	**3**
8	**Soft drinks**	**4.1**	**3u**	Salt and spices	4.0	2
9	Meat and poultry	3.9	1	Vegetable products	3.6	3
10	Salt and spices	3.6	2	**Soft drinks**	**3.5**	**3u**
	b) Expenditure					
1	**Sweets, snacks, desserts**	**12.2**	**3u**	**Sweets, snacks, desserts**	**11.2**	**3u**
2	**Meat and poultry products**	**9.5**	**3**	**Meat and poultry products**	**10.8**	**3**
3	Meat and poultry	8.7	1	**Breads**	**7.2**	**3u**
4	**Cheese**	**6.7**	**3**	Meat and poultry	6.8	1
5	**Breads**	**6.0**	**3u**	Fruits and berries	5.8	1
6	Milk	5.4	1	**Cheese**	**5.8**	**3**
7	**Soft drinks**	**4.8**	**3u**	**Soft drinks**	**5.4**	**3u**
8	**Ready-to-eat/heat meals**	**3.9**	**3u**	Vegetables	5.2	1
9	Vegetables	3.8	1	**Ready-to-eat/heat meals**	**4.7**	**3u**
10	Fruits and berries	3.9	1	Milk	4.5	1

*Items in bold are in all four top ten listings

**3u = ultra-processed products

Table III Share of purchases (%) and share of expenditure (%) for NOVA groups in 2005, 2013 and relative change

	Share of purchases (%)			Share of turnover (%)		
NOVA groups	2005	2013	Relative.Δ	2005	2013	Relative Δ
NOVA 1 Minimally processed foods	**12.5†††**	**13.0****	**3.4**	**28.2**	**30.0**	**6.5**
Meat and poultry	3.9***	2.3†††	-39.9	8.7	6.8	-21.9
Vegetables	2.2†††	2.6***	19.7	3.9	5.2	35.3
Fish and seafood	1.5	1.5	0.0	2.0	3.1	56.8
Milk	1.3†††	1.6***	22.8	5.4	4.5	-17.8
Water	1.1†††	1.2**	9.4	1.0	0.9	-15.3
Grains	0.9†††	1.0**	12.5	0.4	0.5	18.7
Fruits and berries	0.9†††	1.8***	100.8	3.9	5.8	50.2
Roots and tubers	0.4†††	0.6***	33.9	1.4	1.9	31.8
Eggs	0.2	0.2	0.0	1.5	1.4	-5.2
NOVA 2 Culinary ingredients	**6.6**	**6.7**	**2.1**	**4.5**	**3.4**	**-24.9**
Salt and spices	3.6†††	4.0***	10.3	0.9	1.0	8.9
Animal fats	1.1***	0.6†††	-43.7	2.2	1.2	-48.2
Flours	0.7†††	0.8***	16.4	0.4	0.4	0.0
Oils	0.6††	0.7**	12.5	0.3	0.3	0.0
Sugars and sweeteners	0.5†††	0.6**	14.0	0.6	0.5	-8.0
NOVA 3 Ready-to-consume products	**72.5***	**72.0**	**-0.7**	**61.0**	**60.8**	**-0.5**
Sweets, snacks, desserts[a]	18.7***	16.2†††	-13.4	12.2	11.2	-8.1
Meat and poultry products[b]	6.8†††	8.0***	17.9	9.5	10.7	12.9
Cakes, pastries, and cookies[a]	6.4***	5.9†††	-7.9	3.4	3.0	-11.4
Sauces and dressings[a]	6.3***	5.8†††	-8.8	3.0	2.1	-30.5
Cheese[b]	5.3***	5.0†††	-6.4	6.7	5.8	-13.5
Breads[a]	4.8†††	6.0***	26.5	6.0	7.2	19.2
Ready-to-eat/heat meals[a]	4.6†††	5.9***	28.8	3.9	4.7	19.6
Soft drinks[a]	4.1***	3.5†††	-13.4	4.8	5.4	11.2
Vegetable products[b]	3.5	3.6	2.0	1.7	1.4	-15.9
Fish products[b]	3.3***	3.1††	-5.7	2.7	2.5	-5.7
Squashes and juice[a]	2.9	2.9	0.0	2.8	2.4	-15.0
Potato chips[a]	1.9†††	2.1**	7.4	1.6	1.9	19.0
Baby food products[a]	1.8††	1.9*	6.9	0.5	0.5	0.0
Sweetened breakfast cereals[a]	1.2†††	1.3*	9.3	0.6	0.5	-12.0
Margarines[a]	0.9***	0.8††	-12.3	1.7	1.5	-10.7
Unclassifiable	**8.4**	**8.4**	**0.0**	**6.3**	**5.9**	**-7.0**
Total	**100**	**100**		**100**	**100**	

[a] Only ultra-processed products

[b] Processed and ultra-processed products

*/**/***Count significantly higher than expected at p<0.05/0.01/0.001 in chi-square test

†/††/††† Count significantly lower than expected at p<0.05/0.01/0.001 in chi-square test

Figures

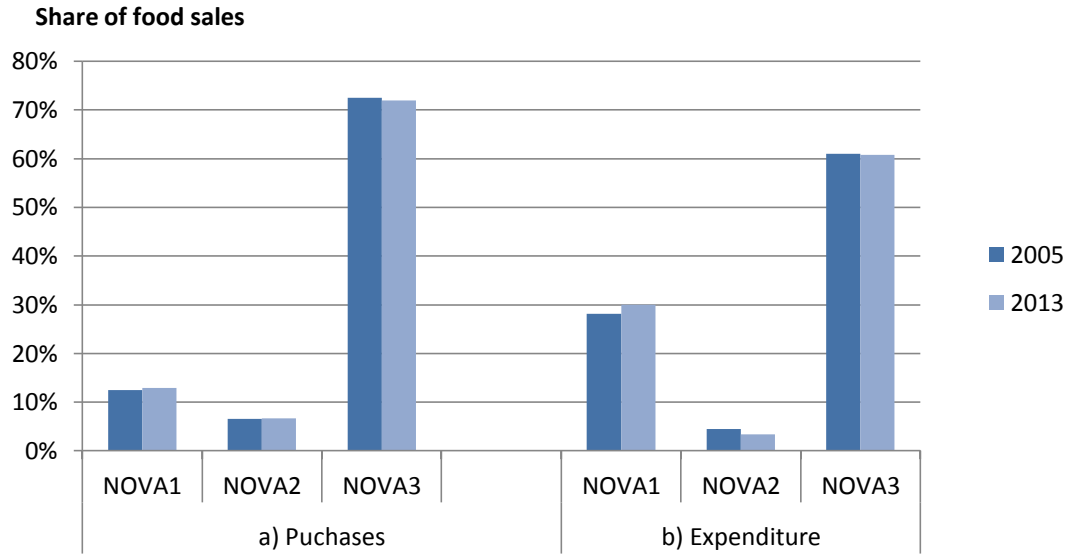

Figure 1 Share of food sales for NOVA groups in 2005 and 2013 in a) purchases and in b) expenditure

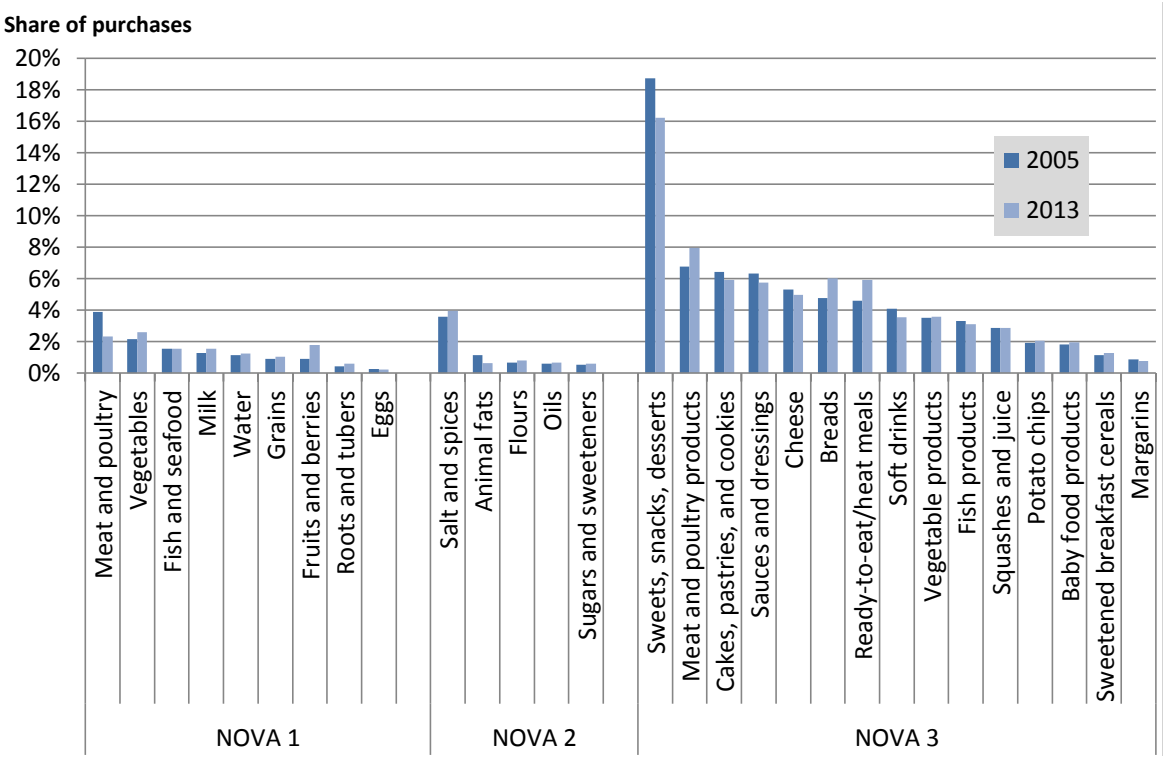

Figure 2 Share of purchase for subNOVA groups, 2005 and 2013

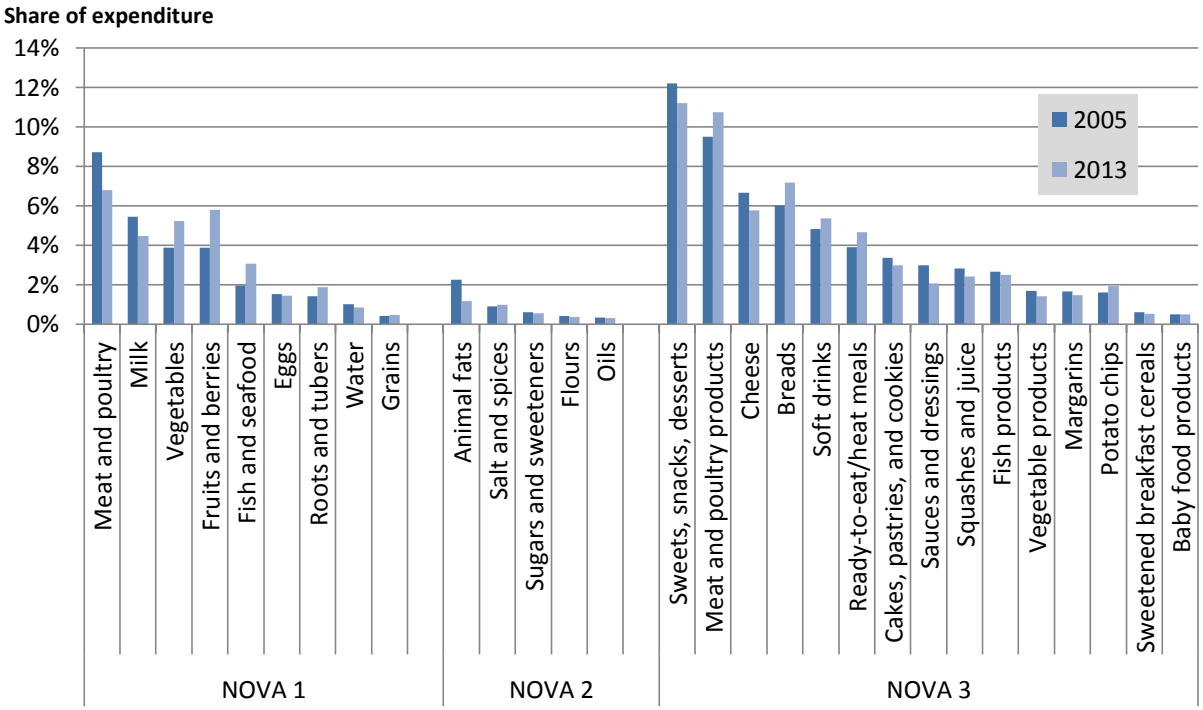

Figure 3 Expenditure shares for food groups, 2005 and 2013

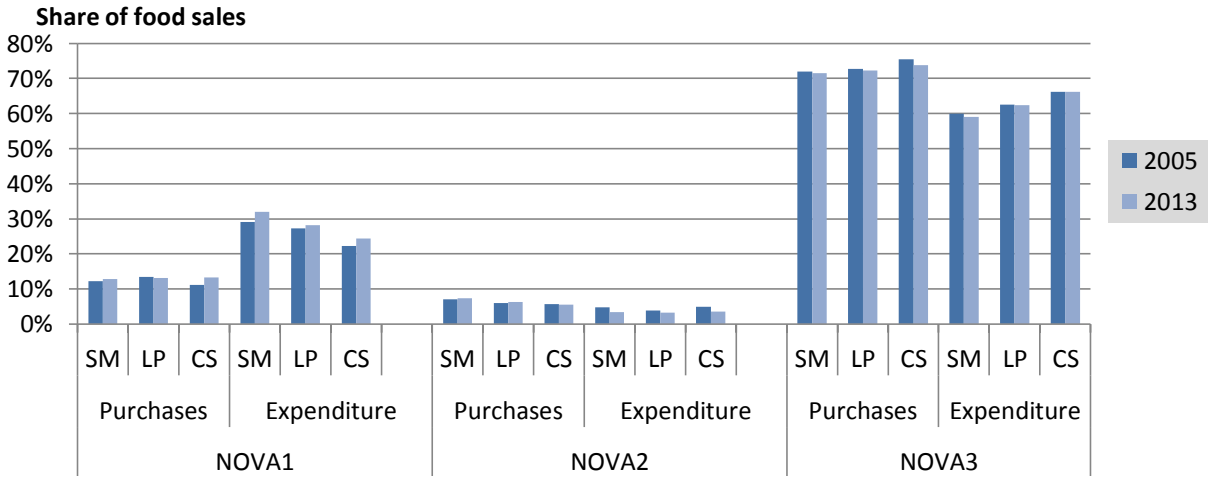

Figure 4 Share of food sales in three retail concepts, SM=Supermarket, LP=Low price store, CS= Convenience store

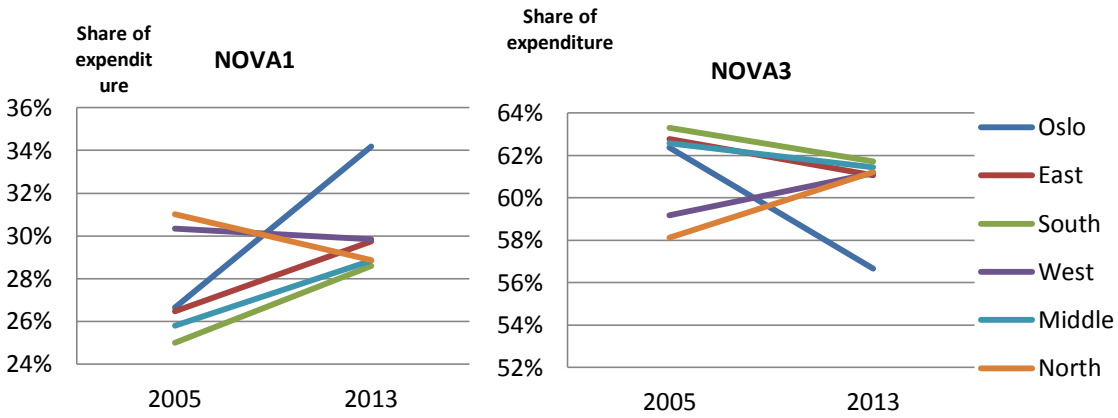

Figure 5 Share of expenditure for NOVA1 and NOVA3 in geographic regions

Appendix 1: COICOP groups and classification into subNOVA and NOVA

COICOP food groups and classification into NOVA and sub NOVA variables. Pink fill indicates groups that correspond across 2005 and 2013 with equal NOVA values (i.e. they could be included in analysis). Grey fill indicates groups that were unclassifiable (NOVA X) either alone or due to groups corresponding across 2005 and 2013 with unequal NOVA values. Yellow fill indicates groups that were excluded from analysis.

COICOP6, 2005		COICOP6, 2013		COICOP5, 2005 and 2013	subNOVA	NOVA	Explanation
011111	Flour	011111	Flour	Flour, cereals and grains	Flours	2	
011112	Rice and other grains	011112	Rice and other grains	Flour, cereals and grains	Grains	1	
011113	Breakfast cereals	011113	Breakfast cereals	Flour, cereals and grains	Sweetened breakfast cereals	3	Assuming most are sweetened
011119	Other flours, cereals and grains			Flours, cereals and grains	Cereals, flours and grains	X (1+2+3)[18]	According to SSB a marginal group in 2005. Products are either not included in data in 2013 or sorted under the above three
011120	Breads			Breads	Breads	3	
		011121	Breads	Breads	Breads	3	
		011122	Baguettes and bread rolls	Breads	Breads	3	
011130	Pasta			Pasta	Pasta and noodles	X (2+3)	Unclassifiable due corresponding groups not belonging to same NOVA
		011131	Pasta	Pasta	Pasta and noodles	X (2)	
		011132	Noodles	Pasta	Pasta and noodles	X (3)	
011141	Buns	011141	Buns	Cakes	Cakes, pastries and cookies	3	
011142	Pastry	011142	Pastry	Cakes	Cakes, pastries and cookies	3	
011143	Tarts, pies	011143	Tarts, pies	Cakes	Cakes, pastries and cookies	3	
011144	Muffins, brownies	011144	Muffins, brownies	Cakes	Cakes, pastries and cookies	3	
011145	Creamy cakes	011145	Creamy cakes	Cakes	Cakes, pastries and cookies	3	
		011146	Dry cakes	Cakes	Cakes, pastries and cookies	3	
		011147	Waffles, pancakes	Cakes	Cakes, pastries and cookies	3	
		011148	Ready-to-bake cake mix	Cakes	Cakes, pastries and cookies	3	

[18] Show NOVA value of food items within unclassifiable and excluded groups

COICOP6, 2005		COICOP6, 2013		COICOP5, 2005 and 2013	subNOVA	NOVA	NOVA if not X/excl.
011149	Other cakes			Cakes	Cakes, pastries and cookies	3	Explicitly clear that whole COICOP5 group is NOVA 3
011151	Flat breads and crisp breads	011151	Flat breads and crisp breads	Other baked goods	Breads	3	
011152	Pizza	011152	Pizza	Other baked goods	Ready-to-eat/heat meals	3	
011153	Cookies	011153	Cookies	Other baked goods	Cakes, pastries and cookies	3	
011154	Potato cakes, corn cakes	011154	Potato cakes, corn cakes	Other baked goods	Breads	3	
		011155	Buns for hamburgers and hot dogs	Other baked goods	Breads	3	
		011156	Corn cakes	Other baked goods	Breads	3	
011159	Other breads			Other baked goods	Breads	3	Explicitly clear that whole COICOP5 group is NOVA 3
011211	Beef	011211	Beef	Fresh and frozen meat	Meat and poultry	1	
011212	Pork	011212	Pork	Fresh and frozen meat	Meat and poultry	1	
011213	Mutton, lamb, goat	011213	Mutton, lamb, goat	Fresh and frozen meat	Meat and poultry	1	
011214	Game	011214	Game	Fresh and frozen meat	Meat and poultry	1	
011215	Poultry	011215	Poultry	Fresh and frozen meat	Meat and poultry	1	
011219	Other fresh and frozen meat and poultry	011219	Other fresh and frozen meat and poultry	Fresh and frozen meat	Meat and poultry	1	Explicitly clear that whole COICOP5 group is NOVA 1
011221	Cured ham and sausages	011221	Cured ham and sausages	Processed meats	Meat and poultry products	3	
011224	Bacon	011224	Bacon	Processed meats	Meat and poultry products	3	
011225	Canned meat	011225	Canned meat	Processed meats	Meat and poultry products	3	
011226	Hot dogs	011226	Hot dogs	Processed meats	Meat and poultry products	3	
011227	Minced meat, meatballs	011227	Minced meat, meatballs	Processed meats	Meat and poultry products	3	
011228	Ultra-processed meat spreads	011228	Ultra-processed meat spreads	Processed meats	Meat and poultry products	3	
		011220	Pâtés	Processed meats	Meat and poultry products	3	
011222	Side meat			Processed meats	Meat and poultry products	3	Assuming these are most commonly salted
011223	Knuckles			Processed meats	Meat and poultry products	3	Assuming these are most commonly salted
011229	Other processed meats	011229	Other processed meats	Processed meats	Meat and poultry products	3	Explicitly clear that whole COICOP5 group is NOVA 3
011311	Cod	011311	Cod	Fresh and frozen fish	Fish and seafood	1	
011312	Pollock	011312	Pollock	Fresh and frozen fish	Fish and seafood	1	
011313	Salmon, trout	011313	Salmon, trout	Fresh and frozen fish	Fish and seafood	1	

COICOP6, 2005		COICOP6, 2013		COICOP5, 2005 and 2013	subNOVA	NOVA	NOVA if not X/excl.
011314	Catfish, herring, flounder	011314	Catfish, herring, flounder	Fresh and frozen fish	Fish and seafood	1	
011315	Shellfish	011315	Shellfish	Fresh and frozen fish	Fish and seafood	1	
011319	Other fresh and frozen fish	011319	Other fresh and frozen fish	Fresh and frozen fish	Fish and seafood	1	Explicitly clear that whole COICOP5 group is NOVA 1
011321	Salted, dried, smoked fish	011321	Salted, dried, smoked fish	Processed fish	Fish products	3	
011322	Canned fish	011322	Canned fish	Processed fish	Fish products	3	
011323	Reconstituted fish products	011323	Reconstituted fish products	Processed fish	Fish products	3	
		011324	Fried, patinated fish	Processed fish	Fish products	3	
011329	Other processed seafood	011329	Other processed seafood	Processed fish	Fish products	3	Explicitly clear that whole COICOP5 group is NOVA 3
011411	Milk	011411	Milk	Milk, yoghurt and cream	Milk	1	Assuming milk is most commonly consumed unsweetened and unflavoured
011412	Yoghurt	011412	Yoghurt	Milk, yoghurt and cream	Sweet snacks, desserts	3	Assuming yoghurts are most commonly consumed sweetened and/or flavoured
011413	Cream	011413	Cream	Milk, yoghurt and cream	Animal fats	2	
		011414	Sour cream, kesam	Milk, yoghurt and cream	Milk products	X (2+3)	Unclassifiable due corresponding groups not belonging to same NOVA
011419	Assorted milk products			Milk, yoghurt and cream	Milk products	X (3)	
011440	Cheese	011440	Cheese	Cheese	Cheese	3	
011450	Desserts and other milk products	011450	Desserts and other milk products	Desserts and other milk products	Sweet snacks, desserts	3	
011460	Eggs	011460	Eggs	Eggs	Eggs	1	
011510	Butter	011510	Butter	Butter	Animal fats	2	
011521	Margarines	011521	Margarines	Margarines and oils	Margarines	3	
011522	Oils	011522	Oils	Margarines and oils	Oils	2	
011631	Citrus fruits	011631	Citrus fruits	Fresh fruits	Fruits and berries	1	
011632	Bananas	011632	Bananas	Fresh fruits	Fruits and berries	1	
011633	Apples	011633	Apples	Fresh fruits	Fruits and berries	1	
011634	Pears	011634	Pears	Fresh fruits	Fruits and berries	1	
011635	Stone fruits	011635	Stone fruits	Fresh fruits	Fruits and berries	1	

COICOP6, 2005		COICOP6, 2013		COICOP5, 2005 and 2013	subNOVA	NOVA	NOVA if not X/excl.
011636	Melons	011636	Melons	Fresh fruits	Fruits and berries	1	
011639	Other fresh fruits	011639	Other fresh fruits	Fresh fruits	Fruits and berries	1	Explicitly clear that whole COICOP5 group is NOVA 1
011651	Dried fruit	011651	Dried fruit	Processed fruits	Dried and processed fruits	X (1+3)	Unclassifiable due corresponding groups not belonging to same NOVA
011652	Canned fruits	011652	Canned fruits	Processed fruits	Dried and processed fruits	X (3)	
011659	Other processed fruits			Processed fruits	Dried and processed fruits	X (1+3)	
011660	Fresh berries			Fresh and frozen berries	Fruits and berries	1	
		011661	Fresh and frozen berries	Fresh and frozen berries	Fruits and berries	1	
011670	Nuts, seeds	011670	Nuts, seeds	Nuts and seeds	Nuts and seeds	X (1+3)	Unclassifiable due to aggregation of unsalted/unroasted (NOVA1) and salted/roasted (NOVA 3) nuts
011711	Potatoes	011711	Potatoes	Fresh vegetables	Roots and tubers	1	
011712	Cabbage	011712	Cabbage	Fresh vegetables	Vegetables	1	
011713	Root vegetables	011713	Root vegetables	Fresh vegetables	Roots and tubers	1	
011714	Tomatoes	011714	Tomatoes	Fresh vegetables	Vegetables	1	
011715	Cucumber	011715	Cucumber	Fresh vegetables	Vegetables	1	
011716	Lettuce	011716	Lettuce	Fresh vegetables	Vegetables	1	
011717	Mushrooms			Fresh vegetables	Vegetables	1	
011719	Other fresh vegetables	011719	Other fresh vegetables	Fresh vegetables	Vegetables	1	Explicitly clear that whole COICOP5 group is NOVA 1
011771	Canned legumes	011771	Canned legumes	Conserved vegetables	Vegetable products	3	
011772	Potato products	011772	Potato products	Conserved vegetables	Crisps	3	According to SSB, this group consists mainly of potato crisps
011773	Conserved corn-products	011773	Conserved corn-products	Conserved vegetables	Vegetable products	3	
011774	Conserved tomatoes	011774	Conserved tomatoes	Conserved vegetables	Vegetable products	3	
011775	Conserved mushrooms			Conserved vegetables	Vegetable products	3	
011779	Other processed vegetables	011779	Other processed vegetables	Conserved vegetables	Vegetable products	3	
011811	Sugar, sugar cubes			Sugar and sweeteners	Sugars and sweeteners	2	

COICOP6, 2005		COICOP6, 2013		COICOP5, 2005 and 2013	subNOVA	NOVA	NOVA if not X/excl.
011812	Sugar, sugar cubes	011812	Sugar, sugar cubes	Sugar and sweeteners	Sugars and sweeteners	2	
011813	Powdered sugar, sugar candy	011813	Powdered sugar, sugar candy	Sugar and sweeteners	Sugars and sweeteners	2	
011814	Artificial sweeteners	011814	Artificial sweeteners	Sugar and sweeteners	Sugars and sweeteners	2	Assuming they are extractions of one unit
011819	Other sugars and sweeteners			Sugar and sweeteners	Sugars and sweeteners	2	Assuming they are extractions of one unit
011821	Jam, marmalades	011821	Jam, marmalades	Preserves	Sweet snacks, desserts	3	
011822	Fruit stews			Preserves	Sweet snacks, desserts	3	
011829	Other preserves			Preserves	Sweet snacks, desserts	3	
011831	Honey	011831	Honey	Other sweet spreads	Sugars and sweeteners	2	
011833	Chocolate spread	011833	Chocolate spread	Other sweet spreads	Sweet snacks, desserts	3	
011832	Syrup			Other sweet spreads	Sweet spreads and preserves	X (2)	Unclassifiable due corresponding groups not belonging to same NOVA
011839	Other sweet spreads	011839	Other sweet spreads	Other sweet spreads	Sweet spreads and preserves	X (2+3)	
011840	Ice cream	011840	Ice cream	Ice cream	Sweet snacks, desserts	3	
011851	Dark chocolate	011851	Dark chocolate	Chocolate, confectionary, lozenges, etc.	Sweet snacks, desserts	3	
011852	Milk chocolate	011852	Milk chocolate	Chocolate, confectionary, lozenges, etc.	Sweet snacks, desserts	3	
011853	Confectionary	011853	Confectionary	Chocolate, confectionary, lozenges, etc.	Sweet snacks, desserts	3	
011854	Drops, lozenges	011854	Drops, lozenges	Chocolate, confectionary, lozenges, etc.	Sweet snacks, desserts	3	
011855	Chewing gum	011855	Chewing gum	Chocolate, confectionary, lozenges, etc.	Sweet snacks, desserts	3	
		011856	Assorted chocolate	Chocolate, confectionary, lozenges, etc.	Sweet snacks, desserts	3	
		011857	Wine gums	Chocolate, confectionary, lozenges, etc.	Sweet snacks, desserts	3	
011859	Other candy and chocolate			Chocolate, confectionary, lozenges, etc.	Sweet snacks, desserts	3	Explicitly clear that whole COICOP5 group is NOVA 3
011911	Sauces	011911	Sauces	Sauces, spices and garnish	Sauces and dressings	3	
011912	Salt, spices, herbs	011912	Salt, spices, herbs	Sauces, spices and garnish	Salt and spices	2	
011913	Balsamic oils, vinegar			Sauces, spices and garnish	Sauces and dressings	3	
		011914	Dressings and dips	Sauces, spices and garnish	Sauces and dressings	3	
		011915	Ketchup, mustard	Sauces, spices and garnish	Sauces and dressings	3	
		011916	Mayonnaise, remoulade	Sauces, spices and garnish	Sauces and dressings	3	

COICOP6, 2005		COICOP6, 2013		COICOP5, 2005 and 2013	subNOVA	NOVA	NOVA if not X/excl.
011919	Other sauces, spices and garnish			Sauces, spices and garnish	Sauces and dressings	3	Explicitly clear that whole COICOP5 group is NOVA 3
011922	Pre-prepared salads	011922	Pre-prepared salads	Pre-prepared salads and dinners	Pre-prepared salads	X (1+3)	Freshly prepared dishes need to be broken down into ingredients. Some pre-prepared salads will be only fresh vegetables; others have more ingredients like dressings or cheeses. Unclear what the predominant ingredient is, so this was termed unclassifiable
		011923	Pre-prepared dinners	Pre-prepared salads and dinners	Ready-to-eat/heat meals	3	
		011924	Pre-prepared sandwiches	Pre-prepared salads and dinners	Ready-to-eat/heat meals	3	
011929	Other pre-prepared meals			Pre-prepared salads and dinners	Ready-to-eat/heat meals	3	Explicitly clear that whole COICOP5 group is NOVA 3
011931	Soups	011931	Soups	Soups and dinner bases	Ready-to-eat/heat meals	3	
011932	Jelly			Soups and dinner bases		Excluded (3)	Only included in data in 2005
011933	Stews			Soups and dinner bases	Ready-to-eat/heat meals	3	
		011934	Dinner bases	Soups and dinner bases	Ready-to-eat/heat meals	3	
011939	Other pre-prepared meal helpers			Soups and dinner bases	Ready-to-eat/heat meals	3	Explicitly clear that whole COICOP5 group is NOVA 3
011940	Assorted snacks	011940	Assorted snacks	Assorted snacks	Sweet snacks, desserts	3	
011950	Baby food products			Baby food, diet products	Baby food products	3	
		011951	Baby food products	Baby food, diet products	Baby food products	3	
		011953	Diet products	Baby food, diet products		Excluded (3)	Only included in data in 2013
011960	Baking accessories	011960	Baking accessories	Baking accessories	Cakes, pastries and cookies	3	According to SSB this group consists mainly of decor for cakes, colouring, marzipan, etc. (NOVA 3)
012101	Coffee	012101	Coffee	Coffee, tea and cocoa	Coffee, tea and cocoa	X (1+3)	Unclassifiable due corresponding groups not belonging to same NOVA
012102	Tea	012102	Tea	Coffee, tea and cocoa	Coffee, tea and cocoa	X (1)	
012103	Cocoa	012103	Cocoa	Coffee, tea and cocoa	Coffee, tea and cocoa	X (3)	

COICOP6, 2005		COICOP6, 2013		COICOP5, 2005 and 2013	subNOVA	NOVA	NOVA if not X/excl.
012109	Other coffee, tea, cocoa			Coffee, tea and cocoa	Coffee, tea and cocoa	X (3)	
012211	Mineral water	012211	Mineral water	Mineral water and soft drinks	Water	1	Assuming this includes mostly unsweetened water and carbonated water, and that sugary drinks are placed with soft drinks
012212	Carbonated and non-carbonated soft drinks	012212	Carbonated and non-carbonated soft drinks	Mineral water and soft drinks	Soft drinks	3	
012219	Other soft drinks			Mineral water and soft drinks	Soft drinks	3	
012221	Squash	012221	Squash	Squash and juice	Squash and juice	3	
012222	Juice	012222	Juice	Squash and juice	Squash and juice	3	
012229	Other squashes and juice			Squash and juice	Squash and juice	3	

Appendix 2: Overview of COICOP6 and subNOVA

NOVA	subNOVA	COICOP6, 2005 and 2013
1	Eggs	Eggs
	Fish and seafood	Cod
		Pollock
		Salmon, trout
		Catfish, herring, flounder
		Shellfish
		Other fresh and frozen fish
	Fruits and berries	Citrus fruits
		Bananas
		Apples
		Pears
		Stone fruits
		Melons
		Other fresh fruits
		Fresh berries
		Fresh and frozen berries
	Grains	Rice and other grains
	Meat and poultry	Beef
		Pork
		Mutton, lamb, goat
		Game
		Poultry
		Other fresh and frozen meat and poultry
	Milk	Milk
	Roots and tubers	Potatoes
		Root vegetables
	Vegetables	Cabbage
		Tomatoes
		Cucumber
		Lettuce
		Mushrooms
		Other fresh vegetables
	Water	Mineral water
2	Animal fats	Cream
		Butter
	Flours	Flour
	Oils	Oils
	Salt and spices	Salt, spices, herbs
	Sugars and sweeteners	Sugar, sugar cubes
		Powdered sugar, sugar candy
		Artificial sweeteners
		Other sugars and sweeteners
		Honey
3	Baby food products	Baby food products
	Breads	Breads
		Baguettes and bread rolls
		Flat breads and crisp breads
		Potato cakes, corn cakes

		Buns for hamburgers and hot dogs
		Corn cakes
		Other breads
NOVA	**subNOVA**	**COICOP6, 2005 and 2013**
3	Cakes, pastries and cookies	Buns
		Pastry
		Tarts, pies
		Muffins, brownies
		Creamy cakes
		Dry cakes
		Waffles, pancakes
		Ready-to-bake cake mix
		Other cakes
		Cookies
		Baking accessories
	Cheese	Cheese
	Potato chips	Potato products
	Fish products	Salted, dried, smoked fish
		Canned fish
		Reconstituted fish products
		Fried, patinated fish
		Other processed seafood
	Margarines	Margarines
	Meat and poultry products	Cured ham and sausages
		Bacon
		Canned meat
		Hot dogs
		Minced meat, meatballs
		Ultra-processed meat spreads
		Pâtés
		Side meat
		Knuckles
		Other processed meats
	Ready-to-eat/heat meals	Pizza
		Pre-prepared dinners
		Pre-prepared sandwiches
		Other pre-prepared meals
		Soups
		Stews
		Dinner bases
		Other pre-prepared meal helpers
	Sauces and dressings	Sauces
		Balsamic oils, vinegar
		Dressings and dips
		Ketchup, mustard
		Mayonnaise, remoulade
		Other sauces, spices and garnish
	Soft drinks	Carbonated and non-carbonated soft drinks
		Other soft drinks
	Squash and juice	Squash
		Juice
		Other squashes and juice
	Sweet snacks, desserts	Yoghurt
		Desserts and other milk products

		Jam, marmalades
		Fruit stews
		Other preserves
NOVA	**subNOVA**	**COICOP6, 2005 and 2013**
3		Chocolate spread
		Ice cream
		Dark chocolate
		Milk chocolate
		Confectionary
		Drops, lozenges
		Chewing gum
		Assorted chocolate
		Wine gums
		Other candy and chocolate
		Assorted snacks
	Sweetened breakfast cereals	Breakfast cereals
	Vegetable products	Canned legumes
		Conserved corn-products
		Conserved tomatoes
		Conserved mushrooms
		Other processed vegetables
X	Cereals, flours and grains	Other flours, cereals and grains (NOVA 1+2+3)
	Coffee, tea and cocoa	Tea (NOVA 1)
		Coffee (NOVA 1+3)
		Cocoa (NOVA 3)
		Other coffee, tea, cocoa (NOVA3)
	Dried and processed fruits	Dried fruit (NOVA 1+3)
		Other processed fruits (NOVA 1+3)
		Canned fruits (NOVA 3)
	Milk products	Sour cream, kesam (NOVA 2+3)
		Assorted milk products (NOVA 3)
	Nuts and seeds	Nuts, seeds (NOVA 1+3)
	Pasta and noodles	Pasta (NOVA2)
		Noodles (NOVA 3)
	Pre-prepared salads	Pre-prepared salads (NOVA 1+3)
	Sweet spreads and preserves	Syrup (NOVA2)
		Other sweet spreads (NOVA 2+3)
Excluded		Jelly (NOVA 3)
		Diet products (NOVA 3)

Appendix 3: Comparing weighted and unweighed sample

Share of total turnover for retail concepts in population and sample, and post-stratification weight (% population/%sample)

	2005			2013		
	% of total turnover, population	% of total turnover, sample	Weight (pop/sample)	% of total turnover, population	% of total turnover, sample	Weight (pop/sample)
Supermarket	39.2[19]	63.1	0.621	31.7	49.8	0.637
Low price	46.9	32.3	1.452	59.7	48.9	1.220
Convenience store	13.9	4.59	3.028	8.5	1.3	6.489

Comparison of results with weighed and unweighed sample

	2005			2013		
Purchases	Unweighed	Weight	Difference*	Unweighed	Weight	Difference
NOVA1	12,5 %	12,5 %	0,1 %	13,0 %	13,1 %	-0,1 %
NOVA2	6,6 %	6,3 %	0,3 %	6,7 %	6,4 %	0,3 %
NOVA3	72,5 %	73,1 %	-0,6 %	72,0 %	72,4 %	-0,4 %
Unclassifiable	8,4 %	8,2 %	0,2 %	8,4 %	8,2 %	0,2 %
Total	100 %	100 %		100 %	100 %	
Expenditure						
NOVA1	28,2 %	27,3 %	0,9 %	30,0 %	29,1 %	0,9 %
NOVA2	4,5 %	4,4 %	0,1 %	3,4 %	3,4 %	0,0 %
NOVA3	61,0 %	62,0 %	-1,0 %	60,8 %	61,6 %	-0,9 %
Unclassifiable	6,3 %	6,3 %	0,0 %	5,9 %	5,9 %	-0,1 %
Total	100 %	100 %		100 %	100 %	

*Difference =unweighed-weighed. Positive sign thus indicates this study's results overestimates consumption

[19] Calculated from supermarket + hypermarket in AC Nielsen, which is how SSB define supermarket