

Ultra-processed foods in Canada: consumption, impact on diet quality and policy implications



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Summary

Chronic diseases such as diabetes, stroke, heart disease and metabolic syndrome, as well as obesity, amount to a public health crisis in Canada, other high-income countries, and now globally. They result in loss of well-being and productive life, and cause disability and premature death. The cost of their treatment is now an intolerable burden on Canada's health services.

The diseases mentioned here, and others, are largely preventable by healthy diets. Up to date national dietary guidelines are needed, together with corresponding public policies and actions. So far, guidelines have been based on conventional food groups and nutrients. This made sense in the days when most food was consumed in the form of home-prepared dishes and meals, and rates of chronic diseases and obesity were far lower than they are now.

Such guidelines are now evidently ineffective. Now in Canada most food that is produced and consumed is processed, packaged and made ready to eat or to heat. Guidelines and public policies and actions need to take food processing into account, as recommended by the Canadian Standing Senate Committee on Social Affairs, Science and Technology 2016 report *Obesity in Canada A Whole-of-Society Approach for a Healthier Canada*.

This report assesses the relationship between types of food processing and the quality of diets in Canada, using the 2015 Canadian Community Health Survey-Nutrition. It also uses the well-recognised and attested NOVA system of food classification according to the nature, purpose and extent of food processing. It isolates what the NOVA system identifies as ultra-processed foods, as particularly unhealthy. These food products now amount to virtually half the dietary energy consumed by Canadians. It reinforces many other studies conducted in Canada, the US and other countries consistently showing that healthy diets contain only small amounts of ultra-processed foods, and the less these are consumed, the better.

What this report also shows is that healthy diets as still consumed by a substantial fraction of the Canadian population, are mainly made up of freshly prepared dishes and meals prepared from unprocessed or minimally processed foods, mostly plant-based, together with processed culinary ingredients and some processed foods. They include only small amounts of ultra-processed foods.

These findings should now be incorporated into Canadian dietary guidelines and public policies and actions designed to create and maintain healthy food systems and supplies for all Canadians. Everybody, such as people in government at all levels, in professional and civil society organisations and in industry, and caterers, family members and people personally, need to be sure what healthy diets consist of and what healthy foods are.

Background

Obesity and related diseases are not being prevented

The very high prevalence of chronic diseases and of obesity is jeopardising the Canadian public health system, and the well-being and the economic prosperity of Canadians. This is a global crisis affecting nations in all continents, now and as projected even more in the future (1-2).

As of 2015, a total of 25.1% of Canadians aged 20 years and above have been diagnosed as hypertensive and 8.5% have been diagnosed as having ischaemic heart disease (3). A total of 8.1% of all Canadians over the age of 1 are now diabetic (3). Heart disease and stroke remain leading causes of death in Canada, being the immediate cause of approximately 25% of all deaths (4).

The prevalence of obesity in Canada has increased from 9.7% in 1970-1972 to 14.8% in 1989 and to 23.1% in 2004 (5,6). As of 2015, 12% of children and adolescents aged between 5 and 17 years, and 26.7% of adults, are obese (3). These figures are a reflection of a vast amount of suffering. The economic cost of nutrition-linked diseases in Canada was estimated at \$26 billion in 2008 (7).

Chronic diseases, including diabetes, stroke and heart disease as well as obesity, can be controlled and prevented. Up to 80 per cent of premature deaths from heart disease and stroke can be prevented by eating healthy diets and being physically active (8). Major investments into health research focused on treatment have been made. But prevention remains neglected, and there has been little or no improvement in population diet quality or in well-being and good health in Canada in recent decades.

Neglect of dietary patterns

One reason for this failure is that food and nutrition science, policy and actions continue to overemphasise nutrients and food seen in isolation. For example, the focus on reducing consumption of dietary fats and saturated fats that began in the 1970s has resulted in overuse by food manufacturers of refined carbohydrates, notably sugars, and thus their overconsumption in Canada, the United States and many other countries. As a result, the quality of diets has deteriorated, fuelling the epidemics of obesity, diabetes and other chronic diseases (9).

Food is more than the sum of its constituents. The effect of food is due to all its parts and their synergetic effect, which is to say, their concerted action (10). Furthermore, foods are commonly prepared and consumed not by themselves but in combination, in the form of dishes and meals. This means that analysis of diets needs to be at the level of dietary patterns. Only then will the effect of specific types of nutrients and food on well-being, health and disease become apparent (10-12). Several dietary quality indicators have been developed recently, such as the American and Canadian Healthy Eating Index and the Food Quality Score. These

usually are based on a combination of nutrient and food-based criteria, include only some components of diet rather than the whole diet, and so have limited power to predict the relationship between diets and chronic diseases (13).

Neglect of food processing

Another reason why attempts to prevent and control the epidemics of obesity, diabetes and other chronic diseases have so far failed, is that industrial food processing and its impact on the nature of food and on the state of human health has been overlooked and neglected in epidemiological and nutritional science, as well as in public policies and actions (14-15). Thus, the *Eating Well with Canada's Food Guide* groups all foods as vegetables and fruit, grain products, milk and alternatives and meat and alternatives, but within these groups has nothing to say about added sugar content, and sidelines references to processing.

The preservation of food, other forms of food processing, and cooking, have all been an intrinsic part of the biological and social evolution of humanity (16), and have enabled more secure and diverse food systems and diets (17-18). Some types of traditional methods of preparation and processing, such as fermentation, enhance the nutritional quality of foods (19).

But the extent of food processing has increased rapidly as part of the industrialisation and globalization of food systems, as has its nature, the methods used, and the purposes to which it is now put (15,20). Many of these processes, and the food products they make possible, are problematic (21-23).

The food supplies of high-income countries with less strong uninterrupted culinary traditions, such as Canada, Australia, the United States, and the United Kingdom, have become dominated by packaged, ready-to-consume, 'convenience' food products as from the second half of the twentieth century and particularly since the 1980s (24). Between 1938 and 2001, Canadian food purchases reflected the replacement of home cooking based on unprocessed or minimally processed foods and culinary ingredients by ready-to-consume ultra-processed foods. The energy share of these products as purchased increased in this period from 24% to 54% (25) (The term 'ultra-processed' is explained in the next section). Similar trends have been documented elsewhere (26-27), and are confirmed by global trends (28-31).

The evidence that dietary patterns and quality are now mostly determined by types of food processing is strong and consistent (32-43). But as indicated above, in Canada, food processing has been marginalised in official dietary guidelines. Also, analyses of dietary surveys have been done without classifying foods according to type of food processing. Thus, the current Health Canada's Surveillance Tool Tier System assesses the adherence of dietary intakes with *Eating Well with Canada's Food Guide*. But it is based on a method of nutrient profiling where all foods are classified into four tiers based on total fat, saturated fat, sodium, and sugar (44). This system neglects food processing and is not comprehensive enough to predict the risk of chronic diseases and obesity (45).

Time for a complete change

The issues in this report are already being addressed. The Canadian Standing Senate Committee on Social Affairs, Science and Technology 2016 report *Obesity in Canada. A Whole-of-Society Approach for a Healthier Canada* (46) states:

The overwhelming consensus among witnesses with respect to food consumption trends was that the consequence of Health Canada's evolving food guide and the increasing variety and availability of processed and ready-to-eat foods has been a pronounced decrease in consumption of whole foods and alarming increase in the consumption of ultra-processed foods. As a result, Canadians are eating too much calorie-rich and nutrient-poor food.

The Senate committee recommends that:

The Minister of Health immediately undertakes a complete revision of Canada's food guide in order that it better reflect the current state of scientific evidence. The revised food guide must: be evidence-based; apply meal-based rather than nutrient-based principles; effectively and prominently describe the benefits of fresh, whole foods compared to refined grains, ready-to-eat meals and processed foods; and make strong statements about restricting consumption of highly processed foods.

The Heart and Stroke Foundation of Canada (47) also defines healthy eating as being based on freshly prepared dishes and meals, and avoidance of highly processed foods:

A healthy balanced diet includes a variety of vegetables and fruit, whole grains or alternatives and proteins from various sources. These protein sources can include beans, lentils, nuts, lower fat dairy or dairy alternatives (i.e. fortified soy milk, etc.), lean meats, poultry, and fish. A healthy balanced diet does not include highly processed and highly refined foods, confectionaries, sugary drinks, processed meats and snack foods.

Canada's next national food guide and all other relevant public policies and programmes should indeed be designed effectively to enhance well-being and good health and to prevent and control chronic non-communicable diseases and overweight and obesity.

This report is designed to support such work by defining different types of processing, and assessing the relationship between types of food processing and the quality of diets, using the 2015 Canadian community health survey.

The NOVA food classification system

Practically all food is processed in some way. Food is not healthy or unhealthy simply because it is 'processed'. The concept needs to be defined, and a rigorous distinction of foods according to the nature, purpose and extent of processing, and examination of impact on well-being, health and disease, needs to be made (15). This is an essential part of what is now the vital, urgent and necessary task to confront and overcome the public health crisis caused by the prevalence of overweight and obesity and diet-related diseases (30,46,48).

The leading method to classify diets according to food processing is the NOVA system (NOVA is a name, not an acronym). This method was first proposed by a team of investigators at the University of São Paulo led by Prof Carlos Monteiro in 2009 (14), and has been developed and refined after much testing and consultation in a large number of countries, including Canada, the United States, Europe, and many Latin American and other countries (48).

Food processing, as specified by NOVA, involves physical, biological, and chemical processes applied to foods after their separation from nature and before they are prepared for cooking and consumption.

The NOVA system classifies foods according to the nature, purpose and extent of food processing, rather than in terms of foods and nutrients. The system enables the study of food systems and supplies and dietary patterns within and between countries and over time. Within this system, meaningful analysis of food groups, foods and nutrients, can be conducted (49).

NOVA classifies all foods and drinks into four clearly distinct groups as follows:

- Unprocessed or minimally processed foods
 - Processed culinary ingredients
 - Processed foods
 - Ultra-processed foods
-

Unprocessed or minimally processed foods

Unprocessed foods, which can be referred to as ‘fresh’ or ‘whole’, come from plants or animals without any industrial processing. Minimally processed foods are unprocessed foods altered in ways that do not add or introduce any new substance (such as fats, sugars, or salt) but often involve removal of parts of the food. They include fresh, dry, or frozen vegetables, tubers, grains and legumes, fruits and nuts, and meats, fish, seafood, eggs, and milk. Minimal processing techniques typically preserve the food and so extend its duration, aid its use, preparation, and cooking, and improve its palatability.



Unprocessed or minimally processed foods include fresh, dried, or frozen vegetables, grains, legumes, fruits, meats, fish, eggs, and milk. They are the basis of healthy dishes and meals.

Processed culinary ingredients

Processed culinary ingredients are extracted and refined by industry from food constituents (such as fats, oils and sugars) or obtained from nature (such as salt). These substances are not or normally not consumed by themselves. Their main purpose is to be used in the preparation and cooking of foods, so as to make palatable, diverse, nourishing and enjoyable dishes and meals.



Processed ingredients include sugars, fats, oils, and salt. They are used to prepare foods, and to make diverse, nourishing and enjoyable dishes and meals.

Processed foods

Processed foods are made by adding fats, oils, sugars, salt, and other culinary ingredients to minimally processed foods to make them more durable and usually more palatable, and by various methods of preservation. They include simple breads and cheeses; salted, pickled or cured meats, fish and seafood; and vegetables, legumes, fruits and animal foods preserved in oil, brine or syrup. Depending on how they are prepared and used in dishes and meals, these foods can be part of healthy diets.



Processed foods include simple breads and cheeses, and canned plant or animal foods. In moderation these foods can be part of healthy diets.

Fresh dishes and meals

Unprocessed or minimally processed foods prepared with small amounts of processed culinary ingredients and processed foods, make freshly prepared dishes and meals. When made from a variety of foods mostly of plant origin, these promote well-being and good health, and protect against disease (50-52).



Freshly prepared dishes combining unprocessed or minimally processed foods with processed culinary ingredients and modest amounts of processed foods are the basis of healthy meals.

All this is becoming increasingly well understood. The 2015 US dietary guidelines (50) emphasize the value of a variety of vegetables, legumes and fruits, especially whole fruits; and cereals, especially wholegrain. The national official 2014 Brazilian dietary guidelines (which uses the NOVA system), recommend mostly plant-based diets based on freshly prepared dishes and meals (51), and the Australian (53), Swedish (54), Nordic (55) and Mediterranean dietary guidelines (56) all stress the value of unprocessed and minimally processed foods.

Ultra-processed foods

Ultra-processed foods are not modified foods but formulations of industrial ingredients and other substances derived from foods, plus additives. They mostly contain little if any intact food. For these reasons they are often referred to in the literature as 'ultra-processed food products' or simply 'ultra-processed products'. The purpose of ultra-processing is to create products that are convenient (durable, ready-to-eat, -drink or -heat), attractive (hyper-palatable), and profitable (cheap ingredients). Their effect all over the world is to displace all other food groups. They are usually branded assertively, packaged attractively, and marketed intensively.



Ultra-processed foods include fast food, sugary drinks, snacks, chips, candies, cookies, sweetened milk products, sweetened cereals, and sauce and dressings. They are nutritionally poor.

Some substances used to make ultra-processed foods, such as fats, oils, starches, and sugar, are directly derived from foods. Ultra-processed products also include other sources of energy, nutrients and other substances not normally used in culinary preparations. Some of these are directly extracted from foods, such as casein, lactose, whey, and gluten. Many are derived from further processing of food constituents, such as partial hydrogenation of oils (which generates toxic trans fats), or interesterified oils, 'purified' starches, invert sugar, high fructose corn syrup, hydrolysed proteins, and soy protein isolate.

Many sequences of processes are used to combine the ingredients and to create the final product (hence 'ultra-processed'). These processes include several with no domestic equivalents such as hydrogenation, and also hydrolysis, extrusion and moulding.

Additives in ultra-processed foods include some also used in processed foods, such as preservatives, anti-oxidants and stabilizers. Classes of additives only found in ultra-processed foods include those used to imitate or enhance the sensory qualities of foods or to disguise unpalatable aspects of the final product. These include dyes and other colours, colour stabilizers; flavours; non-sugar sweeteners; and processing aids. They are often bulked with air or water. Synthetic micronutrients may be added to 'fortify' them.

Ultra-processed foods include carbonated and other soft drinks, other packaged sweetened juices and drinks, sugared, fatty or salty packaged snacks, chocolate and candies, industrialised breads, cakes, biscuits, pastries and desserts and ice-cream, sweetened breakfast cereals, sweetened and flavoured yogurts and other milk-based drinks, packaged soups and noodles, margarine, burgers, hot dogs, poultry and fish 'nuggets' or 'sticks', pre-prepared 'ready meals' such as pizza, pasta dishes, French fries, and infant formula, sweetened follow-on milks and various 'baby' products.

Evidence that NOVA works

The NOVA system is now recognized as a valid tool for nutrition and public health research, policy and action, in reports from the World Health Organization (57), the WHO Pan American Health Organization (30), and the Food and Agriculture Organization of the United Nations (58). It is the basis of the official dietary guidelines issued by the Brazilian federal government (51). As indicated above, it also in effect is recommended by the Canadian Senate report on obesity (46).



The NOVA system is recognized and used (left to right) by the Food and Agriculture Organization of the United Nations, the Brazilian national dietary guidelines, and the WHO Pan American Health Organization

NOVA has now been applied worldwide. To date it has been used in more than a hundred studies carried out including in Brazil, Canada, France, the United States, Australia, the United Kingdom and other Latin American and European countries. Uses so far include description of population dietary patterns, assessments of changes over time in the dietary share of ultra-processed foods, and analyses of the association of this share with the nutrient profile of diets and with health outcomes. Based on these applications and on advice and information from users, criteria specifications with comprehensive lists of examples have been developed in successive updated versions of NOVA (32,48,59).

The trouble with ultra-processed foods

After the United States population, Canadians are now the second largest buyers of ultra-processed foods and drinks in the world with an average of at least 230 kilograms per person per year (30). In 2004 in Canada, in all socio-economic groups, practically half of all food consumed measured as dietary energy, was ultra-processed (32). Highest consumers were young people. Manufacture and consumption of ultra-processed foods is also now high in some middle-income countries such as Brazil (37) and Mexico (38), and is growing fast in other middle-income countries in all continents (28-31), displacing home cooking and fresh or minimally processed foods.

Analyses of nationally representative dietary surveys conducted in Canada (32), the United States (33-34), the United Kingdom (60), France (39), Brazil (37), Mexico (38), and Chile (36) invariably show that ultra-processed foods have a low nutritional quality compared with all other foods, and that the more ultra-processed foods are consumed, the more the nutritional quality of diets is degraded. This is also true for the diets of First Nations peoples in the provinces of British Columbia, Alberta, Manitoba and Ontario (35). These products are also less satiating and more hyperglycemic compared with minimally processed foods (41). Such evidence has led the INFORMAS research network (11) to propose the use of the dietary share of ultra-processed foods as a predictor of population diet quality. This use has been endorsed by the WHO Pan American Health Organization (30) and by the UN Food and Agriculture Organization (58).

A substantial number of population studies show that high consumption of ultra-processed foods is associated with obesity and related chronic diseases. A cross-sectional time-series analysis shows a strong correlation between changes in sales of ultra-processed foods and changes in body mass between 2000 and 2013 in 12 Latin American countries (30). Another cross-sectional study based on 19 European countries found a significant positive association between national household availability of ultra-processed foods and national prevalence of obesity among adults (61).

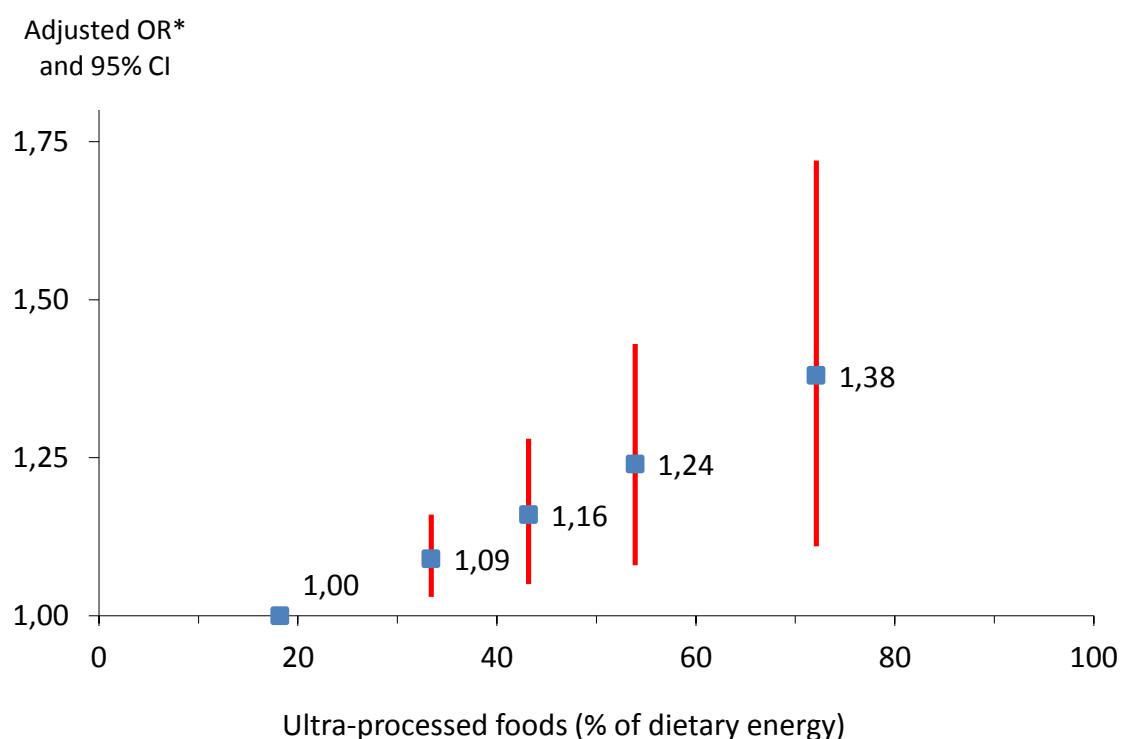
Consumption of ultra-processed foods is associated with higher risk of overweight and obesity in a prospective cohort of Spanish middle-aged adult university graduates (62), as well as higher risk of hypertension in the same cohort (63). Cross-sectional studies undertaken in Brazil also link ultra-processed foods consumption with obesity (64-65), the metabolic syndrome (66), and dyslipidaemias (67). A dietary pattern high in minimally processed foods and low in ultra-processed products is associated with lower odds of metabolic syndrome among Lebanese adults (68).

In the 2004 Canadian diet, after controlling for several confounders, dietary intake of ultra-processed foods was significantly associated with higher rates of overweight and obese (Nardocci et al. in preparation, see figure 1 below). Consumption of ultra-processed foods is the one diet quality index significantly associated with the metabolic syndrome in an Indigenous Cree (Eeyouch) population in northern Québec (69).

In summary, the evidence presented in this section makes a compelling case to focus on food processing in the analysis of Canadian eating patterns to inform dietary recommendations and public food policies and actions. What now follows is an analysis of the 2015 data on the dietary intake of Canadians using the NOVA system. This includes an account of the association between the dietary share of ultra-processed foods and quality of diets.

Figure 1

Odds ratio for being obese according to quintiles of the dietary share of ultra-processed foods, Canadian population 18 years and older, 2004



Data source: Statistics Canada: CCHS Nutrition 2004- FID file

* Odds ratio for being obese adjusted for age, sex, income, education, physical activity, smoking, immigrant status and residential area.

Mean dietary share of ultra-processed foods per quintile: 1st (18.2%); 2nd (33.4%); 3rd (49.4%); 4th (59.5%); 5th (76.2%).

Material and methods

Data source and collection

This report now examines and analyses new Canadian data. These come from the Canadian Community Health Survey (CCHS, Nutrition focus) conducted by Statistics Canada between January 1st and December 31st 2015 (70). This is a nationally representative survey carried out in all ten provinces. It is based on a multi-level stratified sample where dwellings are the base units within geographic areas. One person per dwelling was randomly selected to enable representation by age, sex, socio-demographic characteristics and residential area. The planned sample size included a total of 24,000 participants.

Of respondents, 19,797 people aged 2 years and above were selected for this study. This excluded breastfeeding or pregnant women, and people who consumed no food or drink on the day of the survey. Data from one 24 hour recall was used. It specified everything that respondents stated that they ate and drank in the previous 24-hour period.

The Food and Ingredient Details (FID) file was used. This contains the quantities and nutrient values for all food items reported by respondents, coded into either a basic food level or an ingredient level. The Nutrition Survey System (NSS) food code given to each food and ingredient was used to classify all consumed items according to the NOVA system.

Free sugars are not listed in the Nutrient Survey System. So the content of free sugars was estimated using a database developed at the University of Toronto in Canada. This provides estimates of free sugars for more than 4,000 food and drink products sold in Canada (71). Free sugars as defined by WHO are 'all monosaccharides and disaccharides added to foods by the manufacturer, cook, or consumer, plus sugars naturally present in honey, syrups, and fruit juices' (72). Each food item of the FID file was matched manually with a corresponding item found in the free sugars database or by using the mean value for the various existing brands of the product. For items not found in the database, free sugars were estimated using the USDA database on added sugars and by following the WHO definition of free sugars.

Classification of foods according to NOVA

Every food or ingredient (n=2784), with its unique NSS food code was classified into one of the four NOVA food groups and into one of the 33 food subgroups within those four groups. (see Table 1).

Pre-prepared dishes like burgers, pizzas and sandwiches were classified as ultra-processed foods unless they were reported as having been prepared at home or consumed at restaurants with tables and service, in which case they were classified as culinary preparations, with each ingredient used in the preparation classified in the appropriate NOVA group.

Data analysis

All estimates presented in this report take into account sampling weights provided by Statistics Canada. All analyses were performed using SAS software. Data access was granted by Statistics Canada, under contract (no. 13-SSH-MTL-3475) and was analyzed at the Québec inter-University Centre for Social Statistics in Montreal and Quebec City.

First, we calculated the dietary share of each of the NOVA food groups and subgroups to total dietary energy intake. (Table 1).

Then we showed how the mean dietary share of ultra-processed foods varied according to sex, age group, education level, household income, residential area, and immigrant status. (Table 2). Additionally, we showed differences in the mean dietary share of ultra-processed foods by province (Table 3).

The mean energy share of each of the NOVA food groups and subgroups was then shown in terms of quintiles of the dietary share of ultra-processed foods, ranging from quintile 1 (lowest consumption) to quintile 5 (highest consumption). (Table 4).

Next, we compared the nutritional quality of two dietary patterns, one made up solely of ultra-processed foods, and the other made up solely of the sum of unprocessed or minimally processed foods, processed culinary ingredients and processed foods (which is to say, non-ultra-processed foods). For this, we specified 21 macronutrients and micronutrients expressed as percentage of total dietary energy or else as g/mg/mcg per 2000 kcal.

Additionally, we estimated the energy density (kcal/g) of the ultra-processed and the non-ultra-processed dietary fractions (after exclusion of drinks). Differences in mean nutrient content between the diet fractions were assessed by comparing confidence intervals. (Table 5).

Finally, we examined how the consumption of ultra-processed foods relates to the nutritional quality of the overall average Canadian diet by showing average nutrient content and energy density across quintiles of dietary share of ultra-processed foods. (Table 6).

Changes in dietary patterns over time were also assessed using the 2004 CCHS data from a previous publication (32).

Results

Consumption of foods according to food processing

In 2015, as reported, Canadians aged 2 years and above consumed on average 1825 kcal per day. Measured in terms of dietary energy, 38.9% was from unprocessed or minimally processed foods, 6.3% from processed culinary ingredients, 6.5% from processed foods, and 48.3% from ultra-processed foods. (Figure 1).

Changes between 2004 and 2015 are all marginal. The dietary share of unprocessed or minimally processed foods decreased by 0.3% and of processed foods by 0.5%. Ultra-processed foods increased by 0.6%.

In the 2015 diet, most dietary energy within unprocessed or minimally processed foods came from meat and poultry (8.0% of total energy intake), followed by grains and flours (7.5%), fruits (6.2%), milk and plain yogurt (4.9%), pasta (2.6%), vegetables (2.2%) and eggs (2.0%). Together, roots and tubers, legumes, nuts, and fish accounted for 5% of energy intake. (Table 1). Compared with 2004, Canadians are now consuming more vegetables, fruits, nuts and fish, and less meat, poultry and milk (32).

Among processed culinary ingredients, most dietary energy came from plant oils (2.6%), table sugars (2.4%) and animal fats (1.2%). (Table 1).

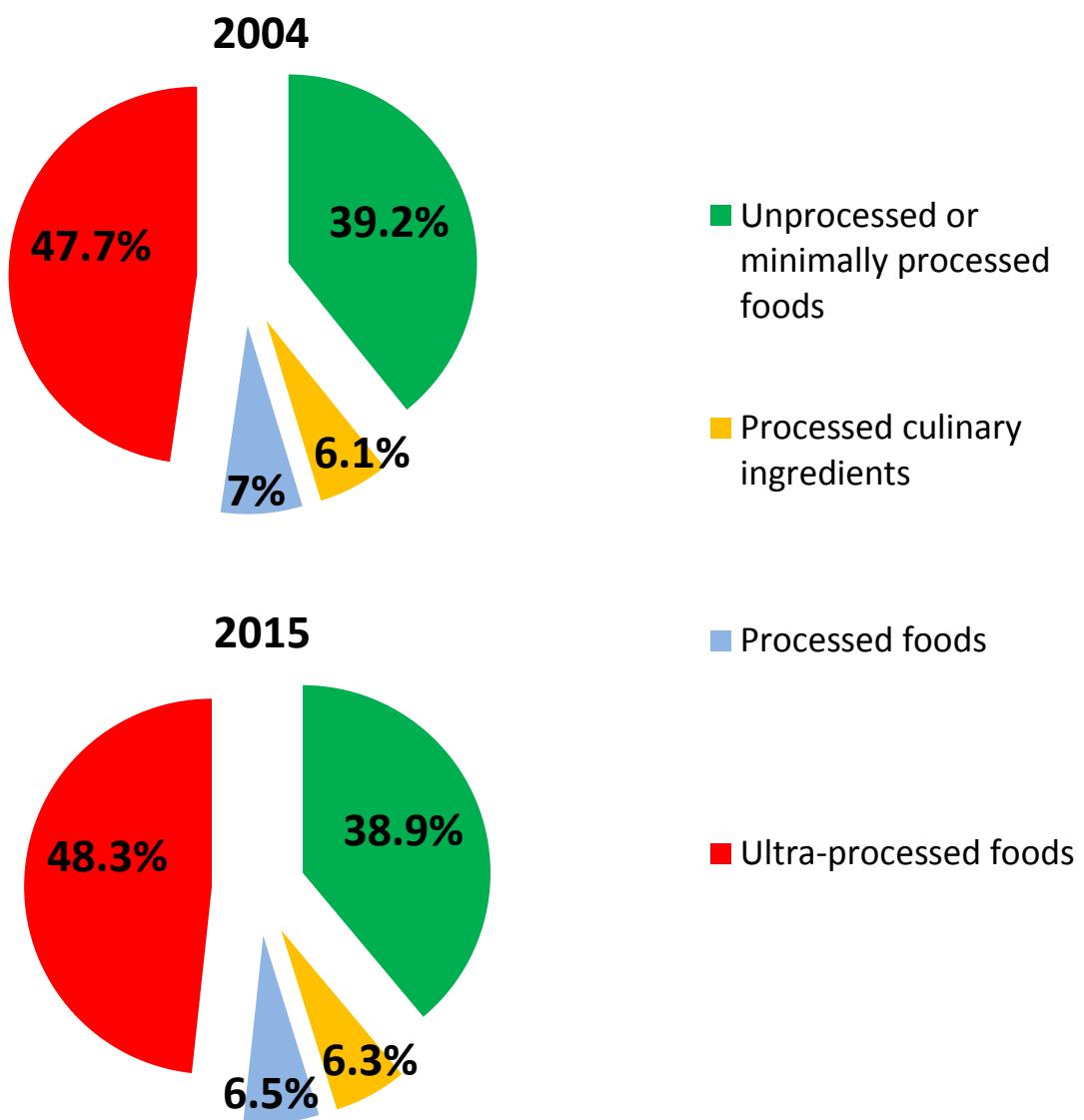
Among processed foods, cheese (3.1%) and preserved plant and animal foods (1.2%) were the main contributors of dietary energy. (Table 1).

Dietary energy from ultra-processed food products came from pre-prepared burgers, pizzas, sandwiches, and frozen dishes (8.7% of total daily intake) and mass-produced packaged breads (8.4%), followed by sweetened milk based products (3.6%), margarine (3.2%), chocolate, candies and desserts (3.0%), cakes, cookies, pies and other sweetened bakeries (3.0%), sauces and spreads (2.9%), chips, crackers and other salty snacks (2.6%), reconstituted meat products (2.5%), and sweetened breakfast cereals (2.0%). Dietary energy from sweetened fruit juices and drinks (3.6%) and carbonated soft drinks (1.5%) decreased, compared with 2004 figures (from respectively 4.7% and 3.1%) (32). (Table 1).

When combined, sweetened ultra-processed drinks (including carbonated drinks, fruit juices and fruit drinks) and sweetened ultra-processed foods (including sweets, cookies, cakes, desserts, milk-based products, and breakfast cereals) accounted for 16.7% of daily dietary energy. (Table 1).

Figure 2

Distribution (%) of total daily energy intake (kcal) by NOVA food groups, Canadian population 2 years and older, 2004 and 2015



Data source: Statistics Canada: CCHS Nutrition 2004 and 2015- FID file

Table 1

Distribution (%) of the total daily energy intake (kcal) according to NOVA food groups, Canadian population 2 years and older, 2015

	<i>Mean</i>	<i>Standard</i>
Unprocessed or minimally processed foods	38.9	0.3
Meat and poultry	8.0	0.1
Cereal grains and flours	7.5	0.1
Fruits	6.2	0.1
Milk and plain yogurt	4.9	0.1
Pasta	2.6	0.1
Vegetables	2.2	0.05
Eggs	2.0	0.1
Roots and tubers	1.8	0.1
Nuts	1.2	0.1
Fish	1.0	0.1
Legumes	0.8	0.05
other ¹	0.7	0.05
Processed culinary ingredients	6.3	0.1
Plant oils	2.6	0.1
Sugars ²	2.4	0.1
Animal fats	1.2	0.05
other ³	0.1	0.0
Processed foods	6.5	0.2
Cheese	3.1	0.1
Canned fruit, vegetables, other plant foods	0.8	0.04
Salted, smoked or canned meat or fish	0.4	0.03
other ⁴	2.2	0.2
Ultra-processed foods	48.3	0.3
Pre-prepared and frozen dishes ⁵	8.7	0.2
Mass-produced packaged breads	8.4	0.1
Sweetened fruit juices and drinks	3.6	0.1
Sweetened milk-based products ⁶	3.6	0.1
Margarine	3.2	0.1
Chocolate, candies, sweet desserts	3.0	0.1
Cakes, cookies, pies, other sweet bakeries	3.0	0.1
Sauces and spreads	2.9	0.1
Chips, crackers, other salty snacks	2.6	0.1
Reconstituted meat products ⁷	2.5	0.1
Sweetened breakfast cereals	2.0	0.1
Carbonated drinks	1.5	0.1
other ⁸	3.3	0.1
Total	100	

Data source: Statistics Canada: CCHS Nutrition (2015)- FID file

¹ Coffee, tea, sea foods, un-disaggregated home-made dishes. ² White and brown sugar, iced sugar, molasses, honey, maple syrup. ³ Vinegar, coconut milk, corn starch. ⁴ Salted, sweetened or oil roasted nuts or seeds, prepared tofu, simple breads, baby food dinner. ⁵ Frozen dishes, burgers, pizzas, sandwiches and other pre-prepared products bought in fast-food outlets. ⁶ Ice cream, chocolate milk, flavoured yogurt, milkshakes.

⁷ Sausages, deli-meats, meat spreads, bacon, fish sticks. ⁸ Canned soups, baby cereals and snacks, canned mixed dishes, cheese products, frozen French fries and onion rings, fish or seafood imitations, meal replacements, sweeteners, protein shake powder, egg substitutes, coffee whitener, meatless burgers and sausages.

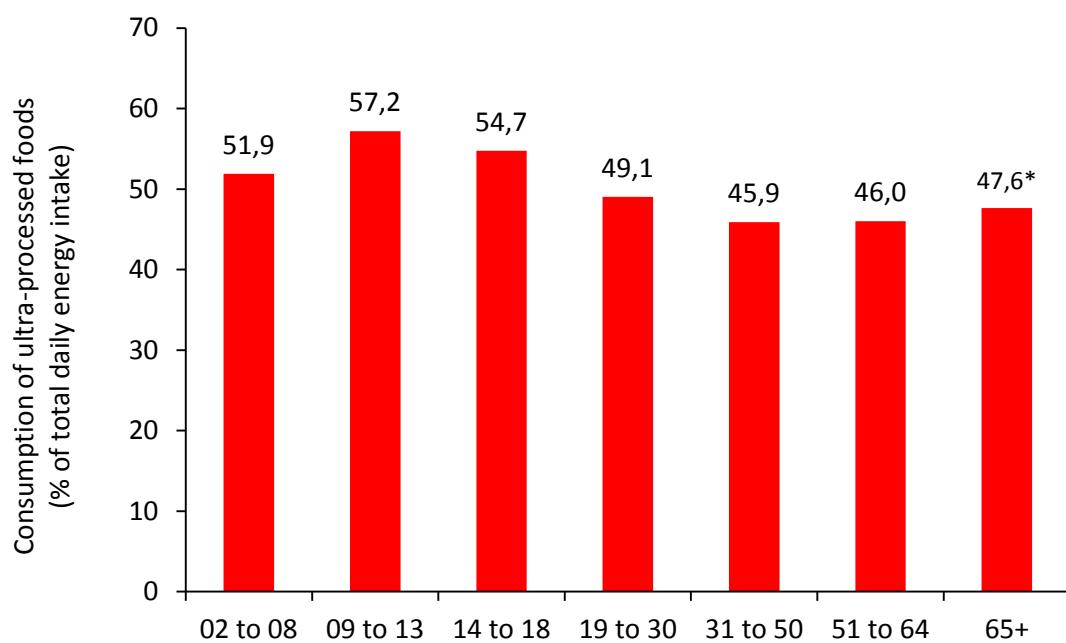
Social, economic and cultural factors

Consumption of ultra-processed foods was slightly higher among men compared with women. It was significantly and consistently higher among younger people, those with less education, people living in rural areas, and among people born in Canada. It did not vary significantly according to household income (Table 2).

Overall, the dietary share of ultra-processed foods was above 42% of total dietary energy in all socioeconomic groups studied, with one exception. It was highest among children aged 9 to 13, at 57.2% of total dietary energy, and adolescents aged 14 to 18, at 54.7%. (Figure 3). An impressive difference, and the exception, is between people who are Canadian born (51.6% of total dietary energy) and people who have migrated to Canada (37.8% of total dietary energy). (Table 2).

Figure 3

Mean consumption of ultra-processed foods (% of total daily energy intake) according to age groups, Canadian population 2 years and older, 2015



Data source: Statistics Canada: CCHS Nutrition (2015)- FID file

* Significant linear trend across all age groups ($p<0.0001$) using general linear models

Table 2

Mean consumption of ultra-processed foods (% of total daily energy intake) by socio-demographic variables, Canadian population 2 years and older, 2015

	<i>Number</i>	<i>Ultra-processed (% kcal)</i>	<i>P value*</i>
Sex			
Women	10243	46.7	Ref
Men	9556	49.8	<.0001
Age group (years)			
2-8	2184	51.9	Ref
9-13	2016	57.2	<.0001
14-18	1991	54.7	0.9576
19-30	1779	49.1	<.0001
31-50	4364	45.9	<.0001
51-64	3375	46.0	<.0001
65+	4090	47.6	<.0001
<i>P trend</i>			<.0001
Education level			
Less than high school diploma	3819	52.9	Ref
High school diploma	3919	49.1	<.0001
College diploma or equivalent	3958	47.4	<.0001
University diploma	3793	42.7	<.0001
<i>P trend</i>			<.0001
Household income¹			
Lowest	1278	48.1	Ref
Lower middle	3416	48.0	0.2966
Upper middle	4855	48.0	0.0049
Highest	10250	48.4	0.0096
<i>P trend</i>			0.0042
Residential area			
Rural	4681	52.4	Ref
Urban	15118	47.3	<.0001
Immigrant status			
Born in Canada	16470	51.6	Ref
Migrant	3296	37.8	<.0001

Data source: Statistics Canada: CCHS Nutrition (2015) - FID file

* Based on general linear models

¹Lowest: < \$15,000 if 1 or 2 people; < \$20,000 if 3 or 4 people; < \$30,000 if 5+ people.

Lower middle: \$15,000 to \$29,999 if 1 or 2; \$20,000 to \$39,999 if 3 or 4; \$30,000 to \$59,999 if 5+;

Upper middle: \$30,000 to \$59,999 if 1 or 2; \$40,000 to \$79,999 if 3 or 4; \$60,000 to \$79,999 if 5+;

Highest: > \$60,000 if 1 or 2; > \$80,000 if 3+.

There was an interesting variation in the dietary share of ultra-processed foods across provinces (Table 3), ranging from a lowest 44.3% of total dietary energy in British Columbia to a highest 55.4% in Nova Scotia. Overall, consumption of ultra-processed foods was higher in the Maritimes provinces and in the Prairies, compared to Quebec, Ontario and British Columbia.

Table 3

Mean consumption of ultra-processed foods (% of total daily energy intake) by province, Canadian population 2 years and older, 2015

Province	<i>Number</i>	<i>Ultra-processed (% kcal)</i>
Newfoundland	1265	53.8
Prince Edward Island	1136	53.5
Nova Scotia	1447	55.4
New Brunswick	1286	54.7
Quebec	3095	48.9
Ontario	4099	47.1
Manitoba	1348	52.9
Saskatchewan	1427	52.8
Alberta	2168	48.9
British Columbia	2528	44.3

Data source: Statistics Canada: CCHS Nutrition (2015) - FID file

Quintiles of intake of ultra-processed foods

The contribution of all NOVA food groups and subgroups to total energy intake across quintiles of the dietary share of ultra-processed foods in the Canadian diet was examined. The quintiles were based on the dietary share of ultra-processed foods. The mean share of ultra-processed foods ranged from 20.7% of dietary energy (1st quintile) through 38.5% (2nd) to 51.1% (3rd) to 63.2% (4th) to a colossal 81.2% of total dietary energy (5th quintile). (Table 4).

Of ultra-processed foods, here are some examples. Pre-prepared and frozen dishes increased across quintiles from 0.8% to a massive 23.7% of dietary energy. Mass produced packaged breads increased from 4.9% to 9.8%. Chocolates, candies and sweet desserts increased from 1.3% to 4.9%. Carbonated drinks and sweetened juices and drinks increased respectively from 0.4% to 3.5% and from 2.1% to 4.9%. Chips, crackers, and other salty snacks increased from 0.8% to 5.5%. (Table 4).

As the dietary share of ultra-processed foods increased across quintiles, the dietary share of almost all subgroups of unprocessed or minimally processed foods, uniformly and significantly decreased. Examples are meat and poultry (from 12.7% to 2.5%), fruits (from 9.5% to 2.4%), vegetables (from 3.4% to 0.8%), fish (from 1.6% to 0.2%), and legumes (from 1.6% to an almost non-existent 0.1%). The same trend was shown for culinary ingredients and for processed foods. (Table 4).

Altogether, this information shows that Canadian dietary patterns change across quintiles, from diets largely based on cooked dishes and meals made with unprocessed or minimally processed foods, culinary ingredients and some processed foods (quintile 1), to diets increasingly dominated by ultra-processed food products (quintiles 3 and 4 and especially 5).

The impact of the displacement of fresh or minimally processed foods and freshly prepared dishes and meals by ultra-processed foods on dietary quality is described in the next sections.

Table 4

Distribution (%) of the total daily energy intake (kcal) according to NOVA food groups by quintiles of the dietary share of ultra-processed foods, Canadian population 2 years and older, 2015

	Quintiles of the dietary share of ultra-processed foods				
	Q1	Q2	Q3	Q4	Q5
Unprocessed or minimally processed foods*	60.2	46.2	36.9	27.1	13.6
Meat and poultry*	12.7	9.6	7.8	5.0	2.5
Cereal grains and flours*	12.9	9.4	6.7	4.4	1.7
Fruits*	9.5	7.1	5.7	4.6	2.4
Milk and plain yogurt*	6.0	5.6	5.3	4.3	3.0
Pasta*	3.6	3.3	2.7	2.1	0.8
Vegetables*	3.4	2.6	2.0	1.5	0.8
Eggs*	2.7	2.2	1.9	1.7	1.0
Roots and tubers*	2.6	2.2	2.0	1.4	0.6
Nuts*	2.6	1.1	0.8	0.6	0.2
Fish*	1.6	1.3	0.8	0.6	0.2
Legumes*	1.6	1.0	0.5	0.4	0.1
other * ¹	1.0	0.8	0.7	0.5	0.3
Processed culinary ingredients*	8.9	7.5	6.2	4.8	2.9
Plant oils*	4.3	3.0	2.1	1.7	1.1
Sugars* ²	2.9	3.0	2.6	2.0	1.2
Animal fats*	1.6	1.4	1.4	1.1	0.6
other* ³	0.1	0.1	0.1	0.0	0.0
Processed foods*	10.2	7.8	5.8	4.9	2.3
Cheese*	3.6	3.9	3.4	2.9	1.5
Canned fruit, vegetables, other plant foods*	1.1	1.0	0.8	0.7	0.3
Salted, smoked or canned meat or fish*	0.6	0.4	0.4	0.4	0.1
other* ⁴	4.9	2.5	1.2	0.9	0.4
Ultra-processed foods*	20.7	38.5	51.1	63.2	81.2
Pre-prepared and frozen dishes* ⁵	0.8	3.6	7.5	12.4	23.7
Mass-produced packaged breads*	4.9	7.9	9.5	10.9	9.8
Sweetened fruit juices and drinks*	2.1	3.3	4.1	4.3	4.9
Sweetened milk-based products* ⁶	1.7	3.3	4.1	4.8	5.2
Margarine	3.1	3.5	3.7	3.2	2.4
Chocolate, candies, sweet desserts*	1.3	2.3	3.4	3.9	4.9
Cakes, cookies, pies, other sweet bakeries*	1.1	2.7	3.3	4.1	4.8
Sauces and spreads*	1.7	2.9	3.3	3.7	3.3
Chips, crackers, other salty snacks*	0.8	1.8	2.6	3.4	5.5
Reconstituted meat products* ⁷	0.8	2.0	2.5	3.2	4.7
Sweetened breakfast cereals*	1.0	2.0	2.3	2.5	2.4
Carbonated drinks*	0.4	0.8	1.5	2.3	3.5
other* ⁸	1.0	2.4	3.3	4.5	6.1
Total	100	100	100	100	100

Data source: Statistics Canada: CCHS Nutrition (2015) - FID file

¹⁻⁹ See table 1 footnote

*Significant linear trend across all quintiles ($p<0.0001$) using general linear models

Nutritional quality of two types of dietary patterns

Here the nutritional quality of two dietary patterns is compared. One is made up solely of ultra-processed foods, and the other is made up solely of the sum of unprocessed or minimally processed foods, processed culinary ingredients and processed foods (which is to say, non-ultra-processed foods).

There were significant differences in terms of all macronutrients between the two diet fractions. Ultra-processed foods had almost half the amount of protein (11.6% compared with 21.3%), considerably more carbohydrates (52.3% compared with 46.6%) and more total fat (35.8% compared with 31.8%). (Table 5).

Big differences were evident for some factors and nutrients critical for maintenance and promotion of good health and well-being and for the prevention of chronic diseases and overweight and obesity.

The energy density of ultra-processed foods was practically twice as high (2.9 compared with 1.5 kcal/g). Free sugars were three times higher in ultra-processed foods (18.2% compared with 5.7% of dietary energy). Sodium density was almost twice as high (4486.2 compared with 2433.4 mg/1000 kcal). Dietary fiber was lower (17.1 compared with 21.4 g/2000 kcal). Saturated fats were slightly but significantly higher in the non-ultra-processed diet fraction (10.8% compared with 11.3% of dietary energy) because of substantial consumption of animal-based minimally processed foods. Making these diets more plant-based can reduce saturated fat to recommended levels. (Table 5).

There were highly significant differences in intake of most micronutrients, which also promote good health and well-being and protect against various diseases. For minerals, ultra-processed foods contained a lot less potassium, calcium, magnesium, phosphorus and zinc. Iron on the other hand was higher in ultra-processed foods. For vitamins, ultra-processed foods contained half or less than half of vitamins A, B12, and riboflavin, and less vitamin C, D, B6, and niacin. Thiamine was much the same. (Table 5).

Table 5

Nutrient content of two types of dietary patterns, Canadian population 2 years and older, 2015

	<i>Only ultra-processed foods</i>	<i>All foods other than ultra-processed foods¹</i>
Energy density (kcal/g) ^{2*}	2.9	1.5
Protein (% total energy)*	11.6	21.3
Carbohydrates (% total energy)*	52.3	46.6
Free sugars (% total energy)*	18.2	5.7
Total fats (% total energy)*	35.8	31.8
Saturated fats (% total energy)*	10.8	11.3
Dietary fiber (g/2000 kcal)*	17.1	21.4
Sodium (mg/2000 kcal)*	4486.2	2433.4
Potassium (mg/2000 kcal)*	2120.9	4267.5
Calcium (mg/2000 kcal)*	674.5	1255.7
Zinc (mg/2000 kcal)*	8.2	13.8
Iron (mg/2000 kcal)*	14.9	12.3
Magnesium (mg/2000 kcal)*	266.5	448.8
Phosphorus (mg/2000 kcal)*	1080.2	1690.2
Vitamin A (mcg/2000 kcal)*	451.2	1117.1
Vitamin B6 (mg/2000 kcal)*	1.2	2.3
Vitamin B12 (mcg/2000 kcal)*	2.3	6.5
Vitamin C (mg/2000 kcal)*	104.5	134.1
Vitamin D (mcg/2000 kcal)*	5.0	7.4
Thiamin (mg/2000 kcal)	1.8	1.8
Riboflavin (mg/2000 kcal)*	1.5	3.3
Niacin (mg/2000 kcal)*	32.1	49.8

Data source: Statistics Canada: CCHS Nutrition (2015)- FID file

¹ Unprocessed or minimally processed foods, culinary ingredients and processed foods

² Energy density only calculated for the solid fraction of the diet, referring to the sum of dietary energy provided by solid foods divided by the amount of these foods in grams.

*Differences in nutrient content between the two dietary patterns are significant based on comparing confidence interval

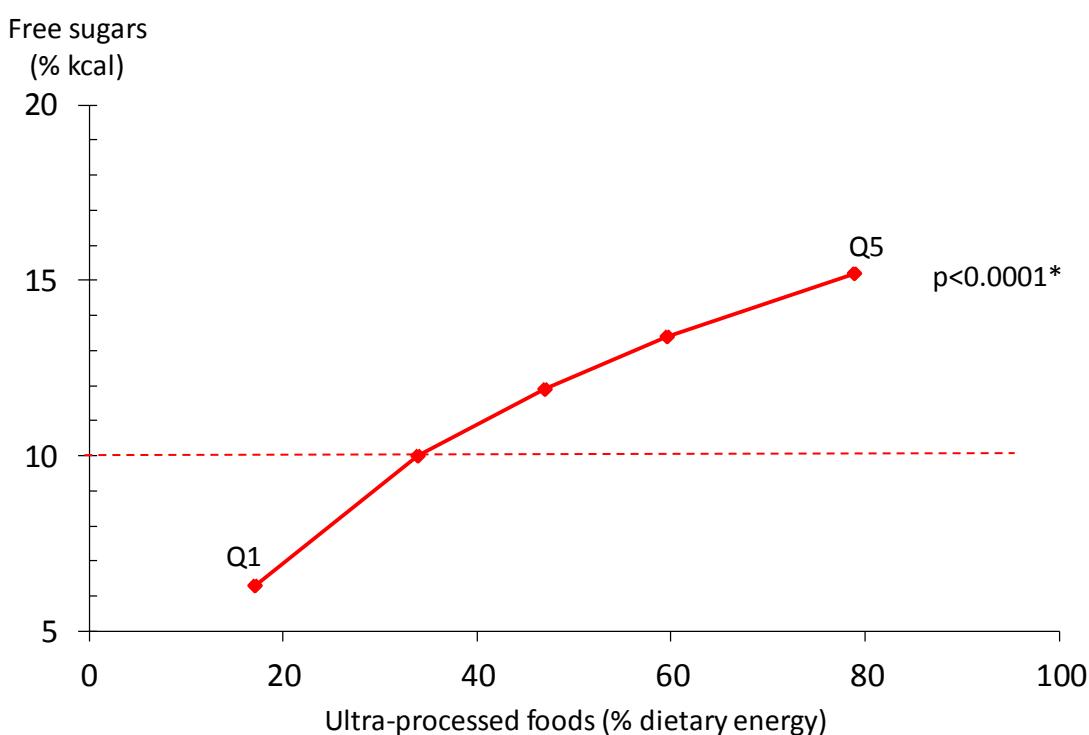
Ultra-processed foods damage diet quality

Finally, the mean energy density and mean nutrient content were compared across quintiles of the dietary share of ultra-processed foods. (Table 6). General nutritional quality was highest in diets containing least ultra-processed foods (quintile 1) and lowest in diets containing most ultra-processed foods (quintile 5). This trend was almost invariably consistent across all quintiles, even after adjusting for sex, age, residential location, income and education. Which is to say, healthy diets are low in ultra-processed foods, and the more ultra-processed foods are contained in diets the less healthy they become.

Specifically, as the dietary share of ultra-processed foods increased across all quintiles, energy density increased, protein and dietary fibre decreased, and free sugars, sodium and saturated fats increased. Most minerals and vitamins decreased substantially across quintiles. Intake of fats across quintiles was much the same. (Table 6).

Figure 4

Free sugars consumption according to quintiles of the dietary share of ultra-processed foods, Canadian population 2 years and older, 2015



Data source: Statistics Canada: CCHS Nutrition (2015)- FID file

*Significant linear trend across all quintiles ($p<0.0001$) using general linear models, both in unadjusted and models adjusted for sex, age, residential location, income and education

The red dotted line represents the WHO recommended upper limit for free sugars intake (10% of dietary energy)

Table 6

Nutrient content of diets according to quintiles of the dietary share of ultra-processed foods, Canadian population 2 years and older, 2015

	Quintiles of the dietary share of ultra-processed foods (% kcal) ¹				
	Q1	Q2	Q3	Q4	Q5
Energy density (kcal/g) ^{2*}	1.5	1.7	1.8	1.9	2.3
Protein (% total energy)*	19.7	17.8	17.0	15.7	14.7
Carbohydrates (% total energy)*	47.1	49.0	50.3	50.9	50.9
Free sugars (% total energy)*	6.3	10.0	11.9	13.4	15.2
Total fats (% total energy)*	33.2	33.2	32.7	33.3	34.4
Saturated fats (% total energy)*	10.2	10.8	11.0	11.3	11.4
Dietary fiber (g/2000kcal)*	22.9	20.5	19.6	18.3	16.0
Sodium (mg/2000 kcal)*	2767.4	2936.7	2995.2	3122.1	3321.1
Potassium (mg/2000 kcal)*	3498.7	3157.7	2983.5	2808.0	2522.6
Calcium (mg/2000 kcal)	898.9	939.6	939.8	909.6	881.1
Zinc (mg/2000 kcal)*	12.9	12.1	10.9	10.2	10.1
Iron (mg/2000 kcal)	13.4	13.7	13.7	13.6	13.5
Magnesium (mg/2000 kcal)*	392.2	357.4	333.4	314.1	280.5
Phosphorus (mg/2000 kcal)*	1525.4	1453.3	1403.1	1325.8	1250.4
Vitamin A (mcg/2000 kcal)*	924.2	851.4	749.5	710.3	546.2
Vitamin B6 (mg/2000 kcal)*	2.2	1.9	1.8	1.6	1.4
Vitamin B12 (mcg/2000 kcal)*	5.3	5.0	4.3	4.1	3.8
Vitamin C (mg/2000 kcal)*	129.9	125.4	124.5	112.3	99.1
Vitamin D (mcg/2000 kcal)*	6.7	6.0	6.0	5.4	4.2
Thiamin (mg/2000 kcal)*	1.7	1.7	1.8	1.8	1.8
Riboflavin (mg/2000 kcal)*	2.3	2.2	2.2	2.1	2.0
Niacin (mg/2000 kcal)*	47.5	43.1	41.6	39.0	36.2
Total dietary energy (kcal)*	1568.7	1745.6	1788.4	1791.7	1875.3

Data source: Statistics Canada: CCHS Nutrition (2015)- FID file

¹Mean dietary share of ultra-processed foods per quintile: 1st (17.1%); 2nd (33.9%); 3rd (47.0%); 4th (59.6%); 5th (78.9%).

²Energy density only calculated for the solid fraction of the diet, referring to the sum of calories provided by solid foods divided by the amount of these foods in grams

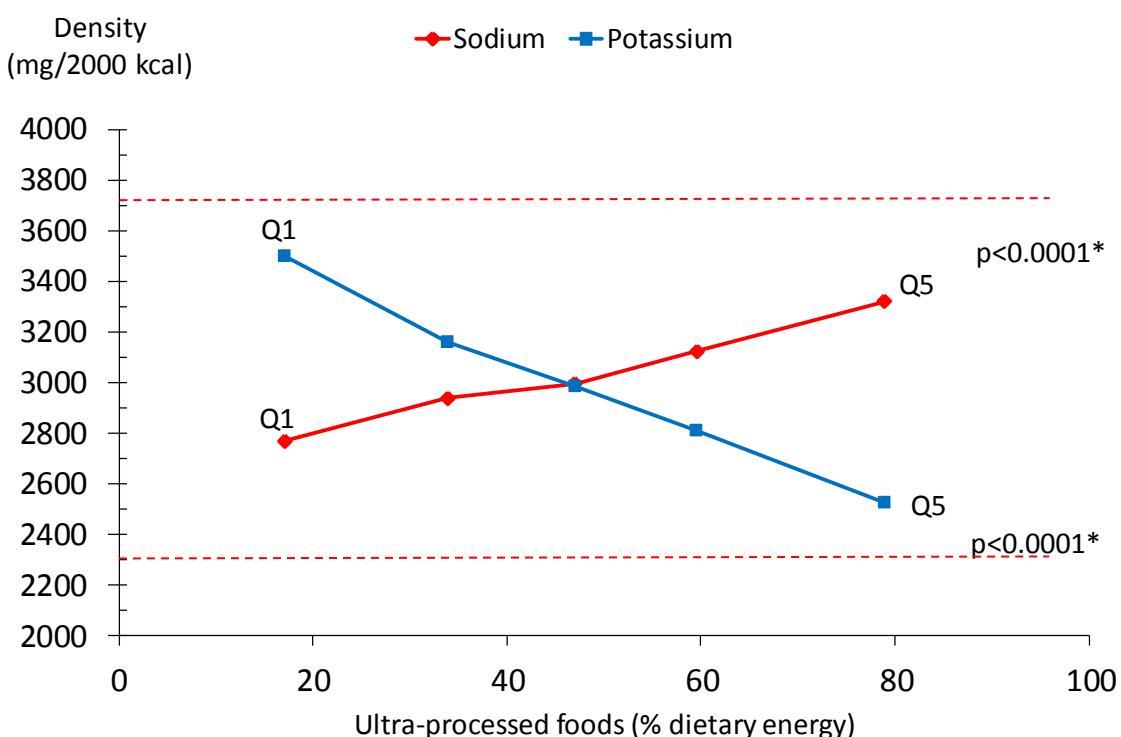
*Significant linear trend across all quintiles ($p<0.0001$) using general linear models, both in unadjusted and models adjusted for sex, age, residential location, income and education

As shown in figure 4, the difference in free sugars content was impressive, more than doubling from quintile 1 to quintile 5 (from 6.3 to 15.2% of total dietary energy). As shown in figure 5, intake of sodium also substantially increased (from 2767 to 3321 g/2000 kcal). Some of the micronutrient differences comparing quintiles 1 and 5 were also substantial. Thus as shown in figure 5 potassium dropped (from 3499 to 2523 mg/2000 kcal), as did magnesium (from 392 to 280 mg/2000 kcal), vitamin A shown in figure 6 (from 924 to 546 mcg/2000 kcal) and vitamin D (from 6.7 to 4.2 mcg/2000 kcal).

In summary, the evidence presented in this section shows that the more ultra-processed foods are contained in diets, the poorer the overall nutritional quality in terms of factors and nutrients critical for the prevention of chronic diseases and overweight, as well as maintenance and promotion of good health and well-being.

Figure 5

Sodium and potassium densities according to quintiles of the dietary share of ultra-processed foods, Canadian population 2 years and older, 2015



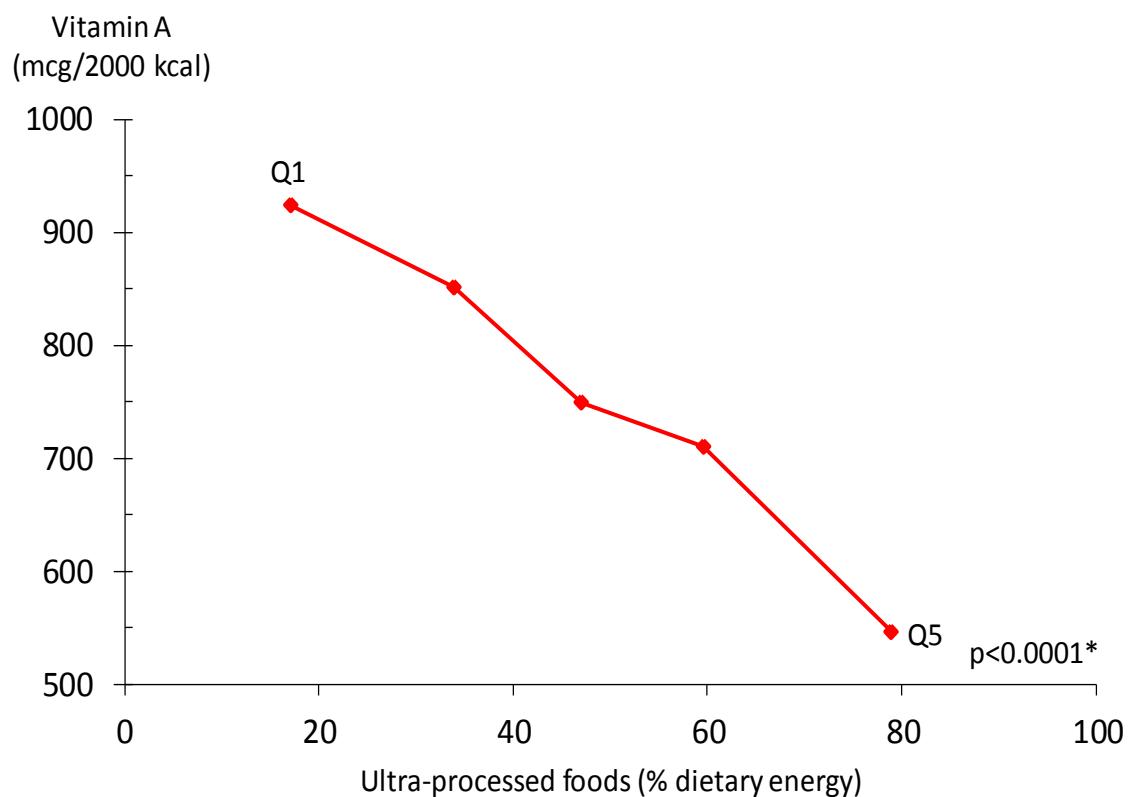
Data source: Statistics Canada: CCHS Nutrition (2015)- FID file

*Significant linear trend across all quintiles ($p<0.0001$) using general linear models, both in unadjusted and models adjusted for sex, age, residential location, income and education

The red dotted lines represent the WHO recommended upper limit for sodium intake (2300 mg/2000 kcal) and recommended minimal intake of potassium (3510 mg/2000 kcal) consumption.

Figure 6

Vitamin A consumption according to quintiles of the dietary share of ultra-processed foods, Canadian population 2 years and older, 2015



Data source: Statistics Canada: CCHS Nutrition (2015)- FID file

*Significant linear trend across all quintiles ($p<0.0001$) using general linear models, both in unadjusted and models adjusted for sex, age, residential location, income and education

Discussion

This study analyzes the dietary patterns of Canadians in 2015 according to food processing, using the NOVA food classification system. Ultra-processed foods make up practically half of all daily dietary energy, and consumption is very high in all socio-demographic groups. It is highest among children aged 9 and over and adolescents aged 14 to 18. This situation is very problematic considering these products are energy dense and nutritionally poor, as shown.

The overall Canadian diet has not changed much between 2004 and 2015 (32). Consumption of ultra-processed foods has risen very slightly, with a corresponding very slight decline in the consumption of unprocessed or minimally processed foods.

There are some noteworthy changes. Average consumption of ultra-processed foods such as sweetened breakfast cereals, sweetened milk-based products, reconstituted meats, and pre-prepared and frozen dishes, have all risen since 2004. Average consumption of carbonated drinks and sweetened fruits juices has substantially declined, but remains at 5.1% of dietary energy, and is especially high among young people and high consumers of ultra-processed foods.

An earlier study showed that the most important changes in Canadian dietary patterns between 1938 and 2001 was the replacement of diets based on freshly prepared meals and dishes made from unprocessed or minimally processed foods for diets dominated by ultra-processed foods (25). Similar trends have been reported from other high income countries and also from middle income countries (26-27). The overall replacement of foods and meals by ultra-processed products has a devastating impact on the quality of diets.

As in 2004, high consumption of ultra-processed foods explains nutritional problems identified in the Canadian diet. In 2004 many Canadians had excessive intakes of dietary energy, free sugars and sodium (73). Many Canadian adults and adolescents had inadequate intakes of dietary fiber and of several minerals and vitamins, including magnesium, potassium, vitamin A and vitamin D (73).

Ultra-processed foods compared with foods that are not ultra-processed are lower in protein and dietary fiber and higher in energy density, carbohydrates, free sugars, and sodium, and lower in zinc, magnesium, calcium, phosphorus and potassium, and in vitamins A, C, D, B6 and B12, niacin and riboflavin. There is not much difference in the cases of fats, saturated fats, iron or thiamine.

As shown in this report, the more ultra-processed foods are contained in diets, the poorer the overall nutritional quality. Only diets in the lowest quintile of ultra-processed consumption had an average of free sugar content below the 10% upper limit recommended by the World Health Organization (72). (Figure 3).

The same trend is true for sodium. In this case, people in all quintiles are above the 2300 mg/2000 kcal Canadian and WHO recommended upper limit. (Figure 4). In the lowest quintile this is because of overuse of salt in culinary preparations, and relatively high consumption of

cheese at 3.6% of dietary energy and of mass-produced packaged breads at 4.9%. Moderate use of salt in cooking and at table, moderate consumption of cheese, and preferring lower-salt bread, can lower sodium towards recommended levels.

All quintiles consume more saturated fat than the 10% WHO recommended upper limit, and less dietary fibre than the 25 g-day recommended amount (21). In the quintile consuming the least ultra-processed foods, the amount of saturated fat at 10.2% of dietary energy was the closest to the recommended limit. It would drop more and the amount of dietary fibre would increase if more plant foods were consumed.

The negative impact of ultra-processed foods on the nutritional quality of diets has been reported in other population-based studies conducted in Canada (32), and in the United States (33-34), France (39) Brazil (37), Mexico (38), Chile (36), and First Nations of Canada (35). All the evidence so far shows that diets based on freshly prepared dishes and meals are healthy, and those that contain substantial amounts of ultra-processed products are unhealthy. This is evidently a universal rule.

The most striking and alarming findings of the present study are the very high consumption of ultra-processed foods by older children and adolescents, and the extremely high consumption of these products by the two highest consumption quintiles. These population groups evidently consume few freshly prepared dishes and meals, and almost no vegetables and legumes.

The positive news is the low consumption of ultra-processed foods by the quintile consuming the lowest amount of these products, and also the relatively low amounts consumed by people who have migrated to Canada from other countries. These two examples indicate that healthy diets based on consumption of unprocessed or minimally processed foods, and of freshly prepared dishes and meals made from these foods with processed culinary ingredients and some processed foods, are realistic targets.

More needs to be known about the ways of life of these population groups. Modelling their diets will help to develop dietary guidelines that are based in foods actually already consumed by substantial fractions of the Canadian population.

Inspiration and examples can also come from other high-income countries like France and Italy, where fresh meals are still commonly eaten, and consumption of ultra-processed foods is much lower than the levels now found in Canada and the United States (39,61). The same applies to many countries where Canadians have migrated from.

Strengths and limitations

This study has important strengths. We used a national representative sample and data covering total food consumption. We analysed Canadian food intake patterns according to the nature, extent and purpose of food processing, using the meticulous NOVA system.

A limitation is that like all food and nutrition surveys, the Canadian Community Health Survey 2015 under-reports dietary intake. A prior validation based on the 2004 CCHS survey showed that this averaged 11% (74). Our study could also underestimate consumption of ultra-processed foods if these are perceived as ‘unhealthy’ and thus more likely to be under-

reported. Plus the nutritional information available in the CCHS is not brand-specific which may introduce under- or over-estimation of nutrient contents.

Also, the method used to estimate free sugars may introduce errors due to the variance of free sugars across brands. However, this methodology was used with CCHS 2004 in a previous study (32) and estimates of free sugars were consistent with those produced by another study using a different methodology (75).

Another limitation of this report is that it makes only brief reference to the facts that ultra-processed foods displace cooking and consumption of freshly prepared dishes and meals, and does not discuss their damage to family life and the harm they do socially, culturally, economically and environmentally. This is beyond the scope of this report.

Conclusions and recommendations

So what are healthy diets, and how best to express this? The answer is indicated in this report, and is consistently supported by recent scientific investigations and recent dietary guidelines (50-56).

The evidence provided support the following recommendations for all Canadians, including those responsible for teaching and food services in schools, hospitals, canteens and other settings. These give clear guidance to the food industry as a whole at all levels from transnational to local, including producers, distributors, retailers and caterers. They also will inform policy-makers in all relevant areas including trade agreement negotiators, and legislators especially at national and provincial levels.

The recommendations

- 1 Make fresh or minimally processed foods the basis of diets, preferring plant-based foods.
- 2 Use processed culinary ingredients like sugars, oils and butter and salt in small amounts for cooking and seasoning foods and for creating freshly made dishes and meals.
- 3 Eat processed foods like simple breads and cheese in moderate amounts, preferably as part of dishes and meals based on fresh or minimally processed foods
- 4 Avoid ultra-processed foods.

All this implies that food and its preparation, cooking and enjoyment remains or becomes an important part of social, family and personal life. Thus:

- 5 Eat regularly and carefully, wherever possible in pleasant environments and in company.
- 6 Maintain, develop, learn and share skills in food acquisition, preparation, cooking and presentation.
- 7 Plan your time to make food and eating important in your life.
- 8 Shop in places that offer plenty of variety of fresh or minimally processed foods.
- 9 Out of home, eat at places that serve freshly prepared meals.
- 10 Be wary of all forms of food product advertising and marketing. Protect children from unhealthy food and drink advertising.

Based on the above recommendations, the overall guiding principle for dietary guidelines and all food policies is:

Always prefer fresh or minimally processed foods and freshly made dishes and meals to ultra-processed foods.

A great national effort involving policy-makers supported by professional and civil society organisations and citizens' groups is now needed, to make Canadian food systems and supplies, dietary patterns and family and personal diets, healthy (76). This will require public policies and actions designed to make production and consumption of healthy food available and affordable for all groups and Indigenous peoples, and to make ultra-processed foods subject to regulation. As one example, strong sustained ties are needed between local agriculture and food services in all public institutions.

Policies and actions also need to maintain, protect, valorize and strengthen appreciation of cooking and cooking facilities and skills everywhere, including in schools, workplaces, cafeterias and hospitals, as well as at home, so that Canadians can obtain healthy food and freshly prepared dishes and meals everywhere.



Based on the evidence of this report, the overall guiding principle for dietary guidelines and all food policies should be:

'Always prefer fresh or minimally processed foods and freshly made dishes and meals to ultra-processed foods.'

The context of healthy food

There is a broad context here. Healthy food and nutrition protects the well-being and good health of people now, and protects against disease. As well as this, it is now everywhere agreed that healthy diets should be seen as those that are fully sustainable (77). They should nourish the human species now and in future, support the producers and makers of healthy food, conserve resources, and protect the whole living and physical world.

Food is far more than a mere commodity. Now is the time to end the notion that humans are separate from nature and are its masters, and instead, to accept that we are all one part of the living and physical world. In a phrase, healthy diets always nourish people, populations and the planet, altogether.

As applied to food, this way of thinking is relatively obvious for people who themselves produce food in gardens, smallholdings and farms, and natural for communities whose livelihoods depend on food production, and who have many other uses for much of what is cultivated, reared, hunted and fished for food. It is relatively difficult to grasp and often hard to put into practice when food is a commodity packaged and purchased in supermarkets together with other goods, and where most people rarely see plant foods growing. The recent food movements in Canada's cities, with growing commitment to urban and collective gardens, need more recognition and support.

It is helpful to realize that until recently in history it was very unusual for people anywhere not to eat meals, or to eat in isolation from one another, except in extreme situations such as imprisonment or solitary journeys. Population groups within which meals are no longer shared or even no longer habitually eaten, in a real sense cease to be societies. Cooking is a fundamental part of what makes us human (16,78).

But in the last few decades, especially within high-income countries and communities, the meal has fast diminishing and been largely replaced by snacking. This is a social disaster and also a nutritional calamity. Preparing and eating freshly prepared dishes and meals, always when possible in company, is part of the good life and prosperous, vibrant societies.

References

- 1) NCD Risk Factor Collaboration. Trends in adult body-mass index in 200 countries from 1975 to 2014: A pooled analysis of 1698 population-based measurement studies with 19.2 million participants. *The Lancet*. 2016 Apr 2;387(10026):1377-96. doi: 10.1016/S0140-6736(16)30054-X.
- 2) NCD Risk Factor Collaboration. Worldwide trends in diabetes since 1980: A pooled analysis of 751 population-based studies with 4.4 million participants. *The Lancet*. 2016 Apr 9;387(10027): 1513-30. doi.org/10.1016/S0140-6736(16)00618-8.
- 3) Public Health Agency of Canada. Canadian Chronic Disease Indicators, Quick Stats, 2017 edition. Ottawa: Public Health Agency of Canada; 2017. 4p.
- 4) Statistics Canada. Health Fact Sheet: The 10 leading causes of death, 2013. Ottawa: Statistics Canada; 2017. Available from: <https://www.statcan.gc.ca/pub/82-625-x/2017001/article/14776-eng.htm>
- 5) Public Health Agency of Canada, Canadian Institute for Health Information. Obesity in Canada. A joint report from the Public Health Agency of Canada and the Canadian Institute for Health Information. Ottawa: Public Health Agency of Canada & Canadian Institute for Health Information; 2009. 62p.
- 6) Katzmarzyk PT. The Canadian obesity epidemic: an historical perspective. *Obes Res*. 2002 Jul;10(7):666-74.
- 7) Government of Canada. Regulations Amending the Food and Drug Regulations (Nutrition Labelling, Other Labelling Provisions and Food Colours). Ottawa: Government of Canada; December 2016. Available from: <http://gazette.gc.ca/rp-pr/p2/2016/2016-12-14/html/sor-dors305-eng.php>
- 8) World Health Organization, Public Health Agency of Canada. Preventing Chronic Diseases: a Vital Investment: WHO global report. Geneva: World Health Organization; 2005. p.200.
- 9) Liu AG, Ford NA, Hu FB, Zelman KM, Mozaffarian D, Kris-Etherton PM. A healthy approach to dietary fats: understanding the science and taking action to reduce consumer confusion. *Nutr J*. 2017 Aug 30;16(1):53. doi: 10.1186/s12937-017-0271-4.
- 10) Jacobs DR, Gross MD, Tapsell LC. Food synergy: an operational concept for understanding nutrition. *Am J Clin Nutr*. 2009 May;89(5):1543S-1548S. doi: 10.3945/ajcn.2009.26736B.
- 11) Vandevijvere S, Monteiro CA, Krebs-Smith SM, Lee A, Swinburn B, Kelly B, et al. Monitoring and benchmarking population diet quality globally: a step-wise approach. *Obes Rev*. 2013 Oct;14 Suppl 1:135-149. doi:10.1111/obr.12082.
- 12) Mozaffarian D. Foods, nutrients, and health: when will our policies catch up with nutrition science? *Lancet Diabetes Endocrinol*. 2017 Feb;5(2):85-88. doi: 10.1016/S2213-8587(16)30265-0.
- 13) Kourlaba G, Panagiotakos DB. Dietary quality indices and human health: A review. *Maturitas*. 2009 Jan 20;62(1):1-8. doi: 10.1016/j.maturitas.2008.11.021.
- 14) Monteiro CA. Nutrition and health. The issue is not food, nor nutrients, so much as processing. *Public Health Nutr*. 2009 May;12(5):729-31. doi: 10.1017/S1368980009005291.

- 15) Moubarac J-C, Parra DC, Cannon G, Monteiro CA. Food classification systems based on food processing: Significance and implications for policies and actions: A systematic literature review and assessment. *Curr Obes Rep.* 2014 Jun;3(2):256-72. doi: 10.1007/s13679-014-0092-0.
- 16) Wrangham RW. *Catching Fire : How Cooking Made us Human*. New York: Basic Books; 2009. p.320.
- 17) Ludwig DS. Technology, diet, and the burden of chronic disease. *JAMA*. 2011 Apr 6;305(13):1352-3. doi: 10.1001/jama.2011.380.
- 18) Weaver CM, Dwyer J, Fulgoni VL, King J, Gilbert A, Leveille A, et al. Processed foods: contributions to nutrition. *Am J Clin Nutr.* 2014 Jun;99(6):1525-42. doi: 10.3945/ajcn.114.089284.
- 19) Hotz C, Gibson RS. Traditional food-processing and preparation practices to enhance the bioavailability of micronutrients in plant-based diets. *J Nutr.* 2007 Apr;137(4):1097-100.
- 20) Armelagos GJ. Brain evolution, the determinates of food choice, and the omnivore's dilemma. *Crit Rev Food Sci Nutr.* 2014;54(10):1330-41. doi: 10.1080/10408398.2011.635817.
- 21) World Health Organization. Diet, Nutrition and the Prevention of Chronic Diseases. Report of a joint WHO/FAO expert consultation. WHO Technical Report Series no.916. Geneva: WHO; 2003. p.160.
- 22) World Cancer Research Fund/American Institute for Cancer Research. Policy and Action for Cancer Prevention. Food, Nutrition, and Physical Activity: A Global Perspective. Washington, DC: AICR; 2009. p.201.
- 23) International Food Policy Research Institute. Global Nutrition Report 2016: From Promise to Impact: Ending Malnutrition by 2030. Washington, DC: IFPRI; 2016. p.182.
- 24) Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with non-communicable diseases. *Am J Clin Nutr.* 2006 Aug;84(2):289-98.
- 25) Moubarac JC, Batal M, Martins AP, Claro R, Levy RB, Cannon G, et al. Processed and ultra-processed food products: Consumption trends in Canada from 1938 to 2011. *Can J Diet Pract Res.* 2014 Spring;75(1):15-21.
- 26) Juul F, Hemmingsson E. Trends in consumption of ultra-processed food and obesity in Sweden between 1960 and 2010. *Public Health Nutr.* 2015 Dec;18(17):3096-107. doi: 10.1017/S1368980015000506.
- 27) Monteiro CA, Levy RB, Claro RM, de Castro IR, Cannon G. Increasing consumption of ultra-processed foods and likely impact on human health: Evidence from Brazil. *Public Health Nutr.* 2011 Jan; 14(1):5-13. doi: 10.1017/S1368980010003241.
- 28) Monteiro CA, Moubarac J-C, Cannon G., Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. *Obes Rev.* 2013 Nov;14 Suppl 2:21-8. doi: 10.1111/obr.12107.
- 29) Moodie R, Stuckler D, Monteiro C, Sheron N, Neal B, Thamarangsi T, et al. Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultraprocessed food and drink industries. *The Lancet.* 2013 Feb 23;381(9867):670-9. doi: 10.1016/S0140-6736(12)62089-3.
- 30) Pan-American Health Organization. Ultra-Processed Food and Drink Products in Latin America: Trends, Impact on Obesity, Policy Implications. Washington DC.: PAHO; 2015. p.76.

- 31) Baker P, Friel S. Food systems transformations, ultra-processed food markets and the nutrition transition in Asia. *Global Health*. 2016 Dec 3;12(1):80.
- 32) Moubarac J-C, Batal M, Louzada ML, Martinez SE, Monteiro CA, et al. Consumption of ultra-processed foods predicts diet quality in Canada. *Appetite*. 2017 Jan 1;108:512-520. doi: 10.1016/j.appet.2016.11.006.
- 33) Martinez Steele E, Popkin BM, Swinburn B, Monteiro CA. The share of ultra-processed foods and the overall nutritional quality of diets in the US: evidence from a nationally representative cross-sectional study. *Popul Health Metr*. 2017 Feb 14;15(1):6. doi: 10.1186/s12963-017-0119-3.
- 34) Poti JM, Mendez MA, Ng SW, Popkin B. Is the degree of food processing and convenience linked with the nutritional quality of foods purchased by US households? *Am J Clin Nutr*. 2015 Jun;101(6):1251-62. doi: 10.3945/ajcn.114.100925.
- 35) Batal M, Johnson-Down L, Moubarac JC, Ing A, Fediuk K, Sadik T, et al. Quantifying associations of the dietary share of ultra-processed foods with overall diet quality in First Nations peoples in the Canadian provinces of British Columbia, Alberta, Manitoba and Ontario. *Public Health Nutr*. 2017 Jul 25:1-11. doi: 10.1017/S1368980017001677.
- 36) Crovetto MM, Uauy R, Martins AP, Moubarac J-C, Monteiro CA. Household availability of ready-to-consume food and drink products in Chile: impact on nutritional quality of the diet. *Rev Med Chil*. 2014 Jul;142(7):850-8. doi: 10.4067/S0034-98872014000700005.
- 37) Louzada MLDC, Ricardo CZ, Steele EM, Levy RB, Cannon G, Monteiro CA. The share of ultra-processed foods determines the overall nutritional quality of diets in Brazil. *Public Health Nutr*. 2017 Jul 17:1-9. doi: 10.1017/S1368980017001434.
- 38) Marrón-Ponce JA, Sánchez-Pimienta TG, Louzada MLDC, Batis C. Energy contribution of NOVA food groups and sociodemographic determinants of ultra-processed food consumption in the Mexican population. *Public Health Nutr*. 2017 Sep 22:1-8. doi: 10.1017/S1368980017002129.
- 39) Julia C, Martinez L, Allès B, Touvier M, Hercberg S, Méjean C, Kesse-Guyot E. Contribution of ultra-processed foods in the diet of adults from the French NutriNet-Santé study. *Public Health Nutr*. 2017 Jul 13:1-11.
- 40) Luiten CM, Steenhuis IH, Eyles H, Ni Mhurchu C, Waterlander WE. Ultra-processed foods have the worst nutrient profile, yet they are the most available packaged products in a sample of New Zealand supermarkets. *Public Health Nutr*. 2016 Feb;19(3):530-8. doi: 10.1017/S1368980015002177.
- 41) Fardet A. Minimally processed foods are more satiating and less hyperglycemic than ultra-processed foods: A preliminary study with 98 ready-to-eat foods. *Food Funct*. 2016 May 18;7(5):2338-46. doi: 10.1039/c6fo00107f.
- 42) Wahlqvist ML. Food structure is critical for optimal health. *Food Funct*. 2016 Mar;7(3):1245-50. doi: 10.1039/c5fo01285f.
- 43) Moreira PV, Baraldi LG, Moubarac JC, Monteiro CA, Newton A, Capewell S, et al. Comparing different policy scenarios to reduce the consumption of ultra-processed foods in UK: impact on cardiovascular disease mortality using a modelling approach. *PloS One* 2015 Feb 13;10(2):e0118353. doi: 10.1371/journal.pone.0118353.
- 44) Health Canada. The Development and Use of a Surveillance Tool: The Classification of Foods in the Canadian Nutrient File According to Eating Well with Canada's Food Guide. Ottawa, Canada: Health Canada; 2014. p.27.

- 45) Jessri M, Nishi SK, L'Abbe MR. Assessing the nutritional quality of diets of Canadian children and adolescents using the 2014 health Canada surveillance Tool tier system. *BMC Public Health.* 2016 May 10;16:381. doi: 10.1186/s12889-016-3038-5.
- 46) Canadian Standing Senate Committee on Social Affairs, Science and Technology. *Obesity in Canada. A Whole-of-Society Approach for a Healthier Canada.* Ottawa: The Standing Senate Committee on Social Affairs, Science and Technology; 2016. 56p.
- 47) Heart and Stroke Foundation of Canada. Saturated Fats. *Heart Disease and Stroke. Position Statement.* Ottawa: Heart Disease and Stroke. p.12.
- 48) Monteiro CA, Cannon G, Moubarac J-C, Levy RB, Louzada ML, Jaime PC. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr.* 2017 Mar 21:1-13. doi: 10.1017/S1368980017000234.
- 49) Pan American Health Organization. Nutrient Profile Model. Washington DC: PAHO; 2016. p.34.
- 50) US Department of Health and Human Services, US Department of Agriculture. Scientific Report of the 2015 Dietary Guidelines Advisory Committee. Washington: DHHS/USDA; 2015. Available from: <http://www.health.gov/dietaryguidelines/2015-scientific-report/>
- 51) Ministry of Health, Brazil. *Dietary Guidelines for the Brazilian Population.* Brasília: Ministry of Health; 2014. p.154. Available from: http://bvsms.saude.gov.br/bvs/publicacoes/dietary_guidelines_brazilian_population.pdf
- 52) Katz DL, Meller S. Can we say what diet is best for health? *Annu Rev Public Health.* 2014;35:83-103. doi: 10.1146/annurev-publhealth-032013-182351.
- 53) National Health and Medical Research Council. Eat For Health: Australian Dietary Guidelines Summary. Canberra: National Health and Medical Research Council; 2013. p.54. Available from: https://www.eatforhealth.gov.au/sites/default/files/files/the_guidelines/n55a_australian_dietary_guidelines_summary_book.pdf
- 54) Swedish National Food Agency. Find Your Way to Eat Greener, Not Too Much and Be Active. Swedish National Food Agency: Uppsala, Sweden; 2015. p.26. Available from: <https://www.livsmedelsverket.se/globalassets/english/food-habits-health-environment/dietary-guidelines/kostrad-eng.pdf>
- 55) Mithril C, Dragsted LO, Meyer C, Blauert E. Guidelines for the New Nordic Diet. *Public Health Nutr.* 2012 Oct;15(10):1941-7. doi: 10.1017/S136898001100351X.
- 56) Romagnolo DF, Selmin OI. Mediterranean diet and prevention of chronic diseases. *Nutr Today.* 2017 Sep;52(5):208-222. doi: 10.1097/NT.00000000000000228.
- 57) World Health Organization (2017) The Influence of Ultra-processed Foods on the Dietary Content of Free Sugars in the US, Canada, Brazil and Colombia. Geneva: WHO (In Press)
- 58) Food and Agriculture Organization of the United Nations. *Guidelines on the Collection of Information on Food Processing Through Food Consumption Surveys.* Rome: FAO; 2015. p.44.
- 59) Kelly B, Jacoby E. Public Health Nutrition special issue on ultra-processed foods Editorial. *Public Health Nutr.* 2018 Jan; 21(1): 1-4. doi:10.1017/S1368980017002853.
- 60) Adams J, White M. Characterisation of UK diets according to degree of food processing and associations with socio-demographics and obesity: Cross- sectional analysis of UK National diet and nutrition survey (2008-12). *Int J Behav Nutr Phys Act.* 2015 Dec 18;12:160. doi: 10.1186/s12966-015-0317-y.

- 61) Monteiro CA, Moubarac JC, Levy RB, Canella DS, Louzada MLDC, Cannon G. Household availability of ultra-processed foods and obesity in nineteen European countries. *Public Health Nutr.* 2017 Jul;17:1-9. doi: 10.1017/S1368980017001379.
- 62) Mendonça RD, Pimenta AM, Gea A, Arrillaga CF, Martinez-Gonzalez MA, Lopes ACS, et al. Ultra-processed foods consumption and risk of overweight/obesity: The SUN cohort study. *Am J Clin Nutr.* 2016 Nov;104(5):1433-1440.
- 63) Mendonça RD, Lopes ACS, Pimenta AM, Gea A, Martinez-Gonzalez MA, Bes-Rastrollo M. Ultra-processed food consumption and the incidence of hypertension in a Mediterranean cohort: The Seguimiento Universidad de Navarra Project. *Am J Hypertens.* 2017 Apr 1;30(4):358-366. doi: 10.1093/ajh/hpw137.
- 64) Canella DS, Levy RB, Martins AP, Claro RM, Moubarac J-C, Baraldi LG, et al. Ultra-processed food products and obesity in Brazilian households (2008-2009). *PLoS One.* 2014 Mar 25;9(3):e92752. doi: 10.1371/journal.pone.0092752
- 65) Louzada ML, Baraldi LG, Steele EM, Martins AP, Canella DS, Moubarac J-C, et al. Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. *Prev Med.* 2015 Dec;81:9-15. doi: 10.1016/j.ypmed.2015.07.018.
- 66) Tavares LF, Fonseca SC, Garcia Rosa ML, Yokoo EM. Relationship between ultra-processed foods and metabolic syndrome in adolescents from a Brazilian Family Doctor Program. *Public Health Nutr.* 2012 Jan;15(1):82-7. doi: 10.1017/S1368980011001571.
- 67) Rauber F, Campagnolo PD, Hoffman DJ, Vitolo, MR. Consumption of ultra-processed food products and its effects on children's lipid profiles: a longitudinal study. *Nutr Metab Cardiovasc Dis.* 2015 Jan;25(1):116-22. doi: 10.1016/j.numecd.2014.08.001.
- 68) Nasreddine L, Tamim H, Itani L, Nasrallah MP, Isma'el H, Nakhoul NF, et al. A minimally processed dietary pattern is associated with lower odds of metabolic syndrome among Lebanese adults. *Public Health Nutr.* Oct 2:1-12. doi: 10.1017/S1368980017002130.
- 69) Lavigne-Robichaud M, Moubarac JC, Lantagne-Lopez S, Johnson-Down L, Batal M, Laouan Sidi EA, et al.. Diet quality indices in relation to metabolic syndrome in an Indigenous Cree (Eeyouch) population in northern Québec, Canada. *Public Health Nutr.* Jul 7:1-9. doi: 10.1017/S136898001700115X.
- 70) Statistics Canada. Canadian Community Health Survey (CCHS)-Nutrition 2015. Manuel user guide. August 2017. Statistics Canada: Ottawa.
- 71) Bernstein JT, Schermer A, Mills CM, L'Abbé MR. Total and free sugar content of Canadian prepackaged foods and beverages. *Nutrients.* 2016 Sep 21;8(9). pii: E582.
- 72) World Health Organization. Guideline: Sugars Intake for Adults and Children. Geneva: WHO; 2015. p.59.
- 73) Health Canada. Do Canadian Adults Meet their Nutrient Requirements through Food Intake Alone? Ottawa, Canada: Health Canada; 2016. p.8. Available from: https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/fn-an/alt_formats/pdf/surveill/nutrition/commun/art-nutr-adult-eng.pdf
- 74) Garriguet, D. Diet quality in Canada. *Health Rep.* 2009 Sep;20(3):41-52.
- 75) Brisbois TD, Marsden SL, Anderson GH, Sievenpiper JL. (2014). Estimated intakes and sources of total and added sugars in the Canadian diet. *Nutrients.* 2014 May 8;6(5):1899-912. doi: 10.3390/nu6051899.
- 76) World Health Organization. The Ottawa Charter for Health Promotion. Geneva: WHO; 1986. <http://www.who.int/healthpromotion/conferences/previous/ottawa/en/>

- 77) Food and Agriculture Organization of the United Nations. Sustainable diets and biodiversity: directions and solutions for policy, research and action. Proceedings of the International Scientific Symposium 'Sustainable diets and biodiversity', 3-5 November 2010, Rome. Rome: FAO; 2012, p.309.
- 78) Pollan M. Cooked: a natural history of transformation. New York: Penguin Press; 2013. p.480.



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