Consumption of Milk and Alternatives and Their Contribution to Nutrient Intakes among Canadian Adults: Evidence from the 2015 Canadian Community Health Survey—Nutrition

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MASTER OF SCIENCE

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Abstract (English)

As a staple food and dense source of nutrients, milk and alternatives play an important role in nutrient adequacy. The aims of this study were to quantify the consumption of milk and alternatives within Canadian self-selected diets and determine their contribution to intakes of nutrients and energy. First, 24-h dietary recalls from the 2015 Canadian Community Health Survey—Nutrition were used to assess 1-d food and nutrient intakes among Canadian adults ≥19 y (n = 13,616). Foods were classified as milk and alternatives according to the 2007 Canada’s Food Guide. Descriptive statistics were used to calculate daily servings of milk and alternatives by different age groups and demographic characteristics. Population ratios were used to discern their contribution to total intakes of nutrients and energy. Mean daily servings (±SE) were highest for milk (0.60 ± 0.02) and cheese (0.42 ± 0.01), intermediate for frozen dairy (0.16 ± 0.01) and yoghurt (0.14 ± 0.01), and lowest for soy and other dairy (<0.03). Intakes were lowest among Canadians 51+ y (1.3 ± 0.03), females (1.25 ± 0.03), non-Caucasians (1.06 ± 0.05), those with less than a secondary education (1.19 ± 0.05), and British Columbians (1.17 ± 0.05). Milk and alternatives contributed >20% to total intakes of calcium (52.62 ± 0.46%), vitamin D (38.53 ± 0.78%), saturated fat (28.84 ± 0.51%), vitamin B12 (27.73 ± 0.57%), vitamin A (26.16 ± 0.58%), phosphorus (24.76 ± 0.35%), and riboflavin (24.43 ± 0.37%), of which milk was the top source. Milk and alternatives contribute substantially to nutrient intakes and thus warrant further attention in terms of mitigating nutrient inadequacy among the Canadian population.
Abstract (French)

En tant qu'aliment de base et source compact de nutriments, le lait et substituts contribuent à l'adéquation nutritionnelle. Les objectifs de cette étude étaient de quantifier la consommation de lait et substituts dans les régimes alimentaires des Canadiens et de déterminer leurs apports en nutriments et en énergie. Les rappels alimentaires de 24 heures de l’Enquête sur la santé dans les collectivités canadiennes – Nutrition de 2015 ont été utilisés pour évaluer les apports alimentaires et nutritionnels au cours d’une journée des adultes canadiens ≥ 19 ans (n = 13 616). Les aliments ont été considérés lait et substituts selon leurs conformément au Guide alimentaire canadien 2007. Des statistiques descriptives ont été utilisées pour calculer les portions quotidiennes de lait et substituts pour des groupes d’âge et des caractéristiques démographiques. Les ratios de population ont été utilisés pour déterminer leur contribution aux apports totaux en nutriments et en énergie. Les portions quotidiennes moyennes (± ES) étaient les plus élevées pour le lait (0,60 ± 0,02) et le fromage (0,42 ± 0,01), intermédiaire pour les produits laitiers congelés (0,16 ± 0,01) et le yaourt (0,14 ± 0,01), et les plus faibles pour le soja et les autres produits laitiers (0,03). Les apports étaient les plus faibles pour les Canadiens de 51 ans et plus (1,3 ± 0,03), les femmes (1,25 ± 0,03), les non-Caucasiens (1,06 ± 0,05), les personnes n’ayant pas terminé des études secondaires (1,19 ± 0,05) et les britanno-colombiens (1,17 ± 0,05). Le lait et substituts ont contribué plus de 20% aux apports totaux en calcium (52,62 ± 0,46%), vitamine D (38,53 ± 0,78%), acides gras saturés (28,84 ± 0,51%), vitamine B12 (27,73 ± 0,57%), vitamine A (26,16% ± 0,58%), phosphore (24,76 ± 0,35%) et riboflavine (24,43 ± 0,37%), dont le lait était la source principale. Le lait et substituts contribuent de
manière substantielle aux apports en nutriments et méritent donc une plus grande attention pour atténuer l’insuffisance des nutriments au sein de la population canadienne.
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Contribution of Authors

Chapter 1 – Introduction..............................................................................................................Olivia Auclair

Chapter 2 – Literature Review.................................................................................................Olivia Auclair and Sergio Burgos

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Chapter 4 – Manuscript................................................................................................................Olivia Auclair, Yang Han, and Sergio Burgos

Chapter 5 – Discussion................................................................................................................Olivia Auclair

Chapter 6 – Conclusion................................................................................................................Olivia Auclair

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Chapter 1 – Introduction

Dairy is a long-established staple of Canadian habitual diets, providing a range of essential vitamins, minerals, and high-quality protein. Dairy has been a pillar of food guidance since the publishing of Canada’s Official Food Rules in 1942, the nation’s first official dietary guidelines [1]. The guidelines have undergone a total of eight revisions, the latest having been published earlier this year in January 2019. Prior to its release, Eating Well with Canada’s Food Guide (hereafter referred to as the 2007 CFG) was the nation’s reference for dietary guidance for nearly 15 years. The 2007 CFG consisted of four food groups – vegetables and fruit, grain products, milk and alternatives, and meat and alternatives – and an ‘other foods’ group. Ranges of Food Guide Servings were assigned to each of the four food groups based on age and sex. Milk and alternatives, for example, were recommended at 2 servings/d for males and females between the ages of 19 y and 50 y and 3 servings/d for adults over 50 y of age.

The current Canada’s Food Guide (CFG) deviates from previous ones, dismissing the concept of food groups in place of a food guide snapshot promoting the consumption of largely plant-based diets including vegetables and fruits, whole grains, and protein foods [2]. In particular, the guide emphasizes plant-based sources of protein such as legumes, nuts, seeds, tofu, and fortified soy-based beverages, affirming to choose plant protein more often. In turn, the prominence of dairy and other animal-source foods was lessened as plants were pushed to the forefront of Canadian food guidance.

However, Canadians were not meeting the recommendations outlined in the 2007 CFG. As a result, intakes of various nutrients were inadequate, including that of calcium,
phosphorus, magnesium, zinc, folate, vitamin A, vitamin B6, vitamin B12, vitamin C, and vitamin D [3]. Among these, biomarker data and evidence of clinical signs of deficiency revealed calcium, iron, potassium, and vitamin D as nutrients of public health concern, defined by Health Canada as those for which a significant proportion of the population falls below the Estimated Average Requirement (EAR), a measure of sufficient nutrient intake for half of a healthy population, which may in turn pose significant health implications for Canadians [4]. As a nutrient-dense food source, milk and alternatives have the potential to mitigate nutrient inadequacy in the Canadian population, particularly among those of concern. Therefore, the lesser prominence of milk and alternatives in the most recent version of CFG may pose further implications for nutrient adequacy if not replaced by other nutrient-dense plant-based foods.

The purpose of this research was to gain better insight into the role of milk and alternatives in Canadian self-selected diets by assessing their consumption and contribution to intakes of nutrients and energy. This work will provide the baseline with which to compare future consumption of milk and alternatives in light of the new food guide and the potential impact of shifting dietary trends on nutrient adequacy in Canada.
Chapter 2 – Literature Review

Dairy Consumption in Canada

Trends in Dairy Consumption

Over the past few decades, Canadians’ preferences for dairy products have shifted. Commercial sales for all fluid milk types (i.e., skim, 1%, 2%, and 3.25%) have been in steady decline since 2009, countering an increase observed between 1977 and 2009 [5]. Moreover, milk consumption shifted from 89 L to 67 L per capita between 1998 and 2017 [6]. Figure 2-1 shows the decline in consumption of fluid milk in conjunction with an increase in consumption of solid dairy foods, including cheese and yoghurt. Nevertheless, fluid milk is still the most widely consumed dairy product (Table 2-1).

The decline in consumption of fluid milk may be attributed to the association between decreasing beverage consumption and increasing age (Table 2-2), which is amplified by the large proportion of elderly people in the Canadian population [7,8]. The decline may also be caused by an increase in availability (i.e., supply and disposition) of solid dairy foods. For example, cheddar cheese experienced a 149% increase in availability between 1960 and 2015, whereas per capita availability of variety cheeses increased from 0.6 kg to 7.1 kg [5]. Per capita availability of yoghurt also increased, shifting from 1.6 L in 1979 to 10.9 L in 2015. The decline in availability of ice cream and processed cheese, however, may be indicative of a health-conscious change in consumer preferences as individuals veer towards low-fat and less refined options.
**Figure 2-1.** Per capita consumption of dairy products in Canada between 1998 and 2017.

![Graph showing per capita consumption of dairy products](image)

Source: Canadian Dairy Information Center, 2017.

**Table 2-1.** Per capita consumption of dairy products in Canada in 2017.

<table>
<thead>
<tr>
<th>Dairy Product</th>
<th>Per Capita Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid milk</td>
<td>66.68 L</td>
</tr>
<tr>
<td>Cheese</td>
<td>13.79 kg</td>
</tr>
<tr>
<td>Cream</td>
<td>11.09 L</td>
</tr>
<tr>
<td>Yoghurt</td>
<td>10.31 L</td>
</tr>
<tr>
<td>Ice cream</td>
<td>4.28 L</td>
</tr>
<tr>
<td>Butter</td>
<td>3.23 kg</td>
</tr>
</tbody>
</table>

Source: Canadian Dairy Information Center, 2019.
Table 2-2. Mean daily consumption of fluid milk by age and sex in 2004.

<table>
<thead>
<tr>
<th>Age, sex</th>
<th>Mean consumption of skim, 1% MF*, or 2% MF milk (g)</th>
<th>Mean consumption of whole and flavoured milk (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-50 y, male</td>
<td>164.0</td>
<td>97.0</td>
</tr>
<tr>
<td>19-50 y, female</td>
<td>152.0</td>
<td>87.0</td>
</tr>
<tr>
<td>51-70 y, both sexes</td>
<td>132.0</td>
<td>97.0</td>
</tr>
<tr>
<td>71+ y, both sexes</td>
<td>163.0</td>
<td>114.0</td>
</tr>
</tbody>
</table>

*MF refers to milk fat content.
Source: Garriguet, 2019.

The decline in demand for dairy products may also be due to the increasing popularity of dairy alternatives, particularly plant-based beverages [5]. Although data is not yet existent in Canada, data from the US reveals a 60% increase in sales of almond beverage in conjunction with a 0.7% decline in sales of traditional milk between 2011 and 2012. From 2014 to 2015, sales of almond beverage increased 7.5% while those of traditional milk decreased 7%. Competition from dairy alternatives may be reflective of the increasing prevalence of lactose intolerance and milk protein-allergy. One study surveyed 2,251 Canadians over the age of 19 y in which 16% reported themselves as lactose intolerant, whereas less than 1% of Canadian adults were diagnosed with milk protein-allergy [12]. The increasing popularity of dietary patterns that exclude dairy and other animal-source foods (i.e., veganism) may also account for the rise of dairy alternatives, although no such data exists yet in Canada.
A recent study assessed the psychosocial determinants of milk and cheese consumption among Canadian adults. Individuals (n = 161) between the ages of 19 y and 50 y participated in one of 20 focus groups held in three major Canadian cities (Quebec, Toronto, and Montreal). Cited advantages and disadvantages of milk and cheese consumption included perceived health effects, nutrition, taste, socio-affective aspects, and practicality [13]. Influences of milk consumption included family and friends, health professionals, and the media, whereas barriers of consumption included price, perceived safety, health status, supply, and cultural values. Differences between groups were observed for men and women, as well as for high and low consumers.

**Socioeconomic Factors of Dairy Consumption**

As of 2009, the Canadian dairy industry generated CAD$6 billion in total farm revenue, constituting it the third largest agricultural industry in Canada [5,14]. Despite decreasing sales of fluid milk over recent years (Figure 2-2), the dynamic trends in dairy consumption may also be attributed to economic factors.

Representing the lowest category of spending among food groups, approximately 9% of average household food expenditure is allocated to dairy products (Figure 2-3) [15]. This might be due in part to the lesser number of recommended servings for milk and alternatives outlined in the 2007 CFG compared to the other food groups, as well as the relative affordability of dairy as a source of nutrients [16]. Nevertheless, existing evidence points to an association between dairy consumption and income. One-week food expenditure data collected from 9,793 Canadian households revealed low-income homes as
purchasing fewer servings of milk products [17]. Lower milk product purchasing among low-income households was also observed when stratified by education and expenditure patterns; households with lower levels of education and greater housing payments were found to purchase fewer dairy products. Nevertheless, a larger proportion of expenditure allocated to dairy products among low-income households reflects the prioritization of this food group. A similar study surveyed two communities in Nova Scotia (Glace Bay and King’s County) in an assessment of four socioeconomic factors related to dietary habits: education, income, employment, and health. Despite respondents from Glace Bay scoring lower in all four categories, dairy consumption did not differ between communities [18].

**Figure 2-2.** Fluid milk sales in Canada from 2013 to 2017.

![Fluid milk sales in Canada from 2013 to 2017.](image)

Source: Canadian Dairy Information Center, 2017.
Overall, evidence regarding an association between income and dairy consumption in Canada is confounding. Dairy appears to be a staple in Canadian diets regardless of income, although individuals will purchase what they can afford. A lack of available data hinders the gaining of insight into the economically rooted causative factors associated with dairy consumption.

**History of Dietary Guidance in Canada**

Canada’s Official Food Rules, first published in 1942, were the nation’s first accredited form of dietary guidance [1]. Intended to promote healthy eating and prevent nutrient deficiencies among Canadians during World War II, a time of food rationing and
poverty, the Food Rules consisted of six food groups: milk, fruit, vegetables, cereals and breads, ‘meat, fish, etc.’, and eggs. Daily amounts were suggested for each of the food groups, some of which were recommended at 70% of dietary standards depending on the availability of the food (i.e., milk was in limited supplies during the war, thus it was recommended in smaller quantities).

Historically, the food groups were devised based on agricultural origin, consumer use, and traditional classification [20]. The rationalization of legumes as part of meat and alternatives in the 2007 CFG, for example, is based on their use as a replacement for meat as opposed to their nutrient content, which may have classified them as a grain. Health Canada issued an Interim Marketing Authorization (IMA) in 1997 to permit the optional fortification of plant-based beverages with vitamins and minerals [21]. The IMA outlined strict criteria under which only certain plant-based beverages could be marketed as nutritionally comparable to milk products. For example, the sale of fortified plant-based beverages is only permissible on the grounds that they contain up to 2.5 grams of protein with a 75% similarity in quality to casein per 100 mL. Fortified plant-based beverages that contain negligible amounts of protein, such as almond and rice beverage, must be declared ‘Not a source of protein’ on their packaging. Quality and quantity of fats, vitamins, and minerals were also specified in the IMA.

Throughout the years, dairy became an integral part of the nation’s dietary guidance. In 1944, Canada’s Food Rules promoted the consumption of dairy as a means of improving intakes of riboflavin among the population. The term ‘guide’ replaced ‘rules’ in the title of the 1961 revision of CFG. As with previous versions, milk was the only food group to have been assigned specific servings sizes. In 1977, the milk group was renamed
milk products, which eventually became milk and alternatives in 1996 to reflect the inclusion of fortified plant-based beverages and other dairy products besides milk.

Published in 2007, Eating Well with Canada’s Food Guide consisted of four food groups – vegetables and fruit, grain products, milk and alternatives, and meat and alternatives – and an ‘other foods’ group [22]. Remarkably, the 2007 CFG was not based on the types of foods being consumed by Canadians, as such data was not available at the time [20]. Instead, it was modeled based on a food intake pattern meeting the Dietary Reference Intakes (DRI), being a set of values representing the nutritional needs of a healthy population, while accounting for nutrition-related chronic diseases and input from public consultations.

**Food Consumption in Canada**

**Trends**

According to data extrapolated from the 2004 Canadian Community Health Survey (CCHS) – Nutrition, Canadian adults were not meeting the daily number of servings per food group as recommended in the 2007 CFG [23]. Recommended Food Guide Servings and their status of consumption among Canadian adults are in Table 2-3 [22]. On average, men consumed more daily servings for all food groups compared to women; nevertheless, all adults fell below the recommendations for all food groups outlined in the 2007 CFG, with the exception of meat and alternatives (1 serving being 75 grams).
**Food Expenditure**

Also indicative of food consumption patterns across Canada is food expenditure data gathered from the 2015 Survey of Household Spending. In 2015, the average Canadian household spent CAD$8,629 on food. Vegetables and fruit, non-alcoholic beverages and other food products, and meat, fish, and seafood represent the highest percentage of total annual food expenditure, each approximating 17% (Figure 2-3). Cereal grain and products including bread and other baked goods account for 11% of the total. Dairy products represent the lowest percentage of total food expenditure at 9%.

**Table 2-3.** Recommendations and consumption of 2007 CFG Food Guide Servings by Canadian adults.

<table>
<thead>
<tr>
<th></th>
<th>19-50 y</th>
<th></th>
<th>51+ y</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td><strong>Recommended Food Guide Servings¹</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables and fruit</td>
<td>8-10</td>
<td>7-8</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Grain products</td>
<td>8</td>
<td>6-7</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Milk and alternatives</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Meat and alternatives</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Consumed Food Guide Servings²</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables and fruit</td>
<td>5.31</td>
<td>4.80</td>
<td>5.36</td>
<td>5.0</td>
</tr>
<tr>
<td>Grain products</td>
<td>6.98</td>
<td>5.03</td>
<td>5.67</td>
<td>4.57</td>
</tr>
<tr>
<td>Milk and alternatives</td>
<td>1.79</td>
<td>1.58</td>
<td>1.37</td>
<td>1.26</td>
</tr>
<tr>
<td>Meat and alternatives*</td>
<td>250.50</td>
<td>157.00</td>
<td>215.00</td>
<td>157.00</td>
</tr>
</tbody>
</table>

*Expressed in grams.

**Revision of the 2007 CFG**

Published earlier this year, the current CFG is the first revision of the guide in over a decade. Part of the rationale for the changes captured in the new guide was based on
evidence gathered from the 2015 Evidence Review Cycle (ERC) and public consultations. Health Canada employed the 2015 ERC as a means of assessing the nutrient status and prevalence of nutrition-related chronic disease among Canadians in order to better dietary guidance [3]. Data extrapolated from the 2004 CCHS – Nutrition informed the status of Canadians in meeting the nutrient DRIs, as well as the recommended number and quality of servings per each of the food groups making up the 2007 CFG.

As commissioned by Health Canada, two phases of consultations captured the opinions of professionals, organizations, and the public regarding the 2007 CFG. Among the key themes discussed, there was a consensus pertaining to the extent of usefulness of the food groups. Public participants deemed the food groups useful to some extent due to their simplicity, yet criticism emerged based on their inability to account for specific micro- and macronutrients [24]. Participating professionals had similar opinions regarding the food groups, offering several suggestions as to increase their usefulness; these include a greater emphasis on vegetables as opposed to fruit and a de-emphasis of meat and milk.

2015 Evidence Review Cycle

Status of Canadians’ Food Consumption Relative to Dietary Guidance

The 2015 ERC reported that more than half of all Canadians above the age of two were not meeting the daily recommendations for vegetables and fruit outlined in the 2007 CFG [3,25]. In fact, 93% of men and women between the ages of 19 y and 30 y were failing to meet recommendations [3]. Although 80% of Canadians consumed vegetables and fruit in accordance with those outlined in the 2007 CFG recommendations, 79 and 91% of the
population failed to meet the specific recommendation of one dark green and one orange vegetable per day, respectively. Half of all Canadian adults (excluding females between the ages of 19 y and 30 y) were not meeting the daily recommendations for grain products, with a mere 16% of all grain products being of whole grain origin. Similarly, more than half of the Canadian adult population was not meeting the recommendations for milk and alternatives, mean fluid milk consumption being less than one serving per day. Moreover, merely 40 to 45% of adults were consuming milk and alternatives deemed in line with those posited in the 2007 CFG. The report also revealed inadequate intakes of meat and alternatives among 48 to 69% of female adults, whereas estimates among other age and sex groups were not available. Approximately 38% of adults consumed meat and alternatives that were in line with recommendations. Moreover, only 22% of this food group was consumed as alternatives, 13% of adults consuming pulses such as beans, peas, and lentils [3,26].

**Status of Canadians’ Micronutrient Intakes**

The 2015 ERC also reports on the status of Canadians’ micronutrient intakes. In particular, calcium and vitamin D were of major concern due to the high incidence of deficiency among the Canadian population [3]. In 2011, the US Institute of Medicine revised the DRIs for calcium and vitamin D, replacing the Adequate Intake (AI) with the Recommended Dietary Allowance (RDA) [27]. In the absence of ample data to establish an RDA, the AI is set based on estimates of nutrient intake among seemingly healthy individuals and expected to meet or exceed the needs of most individuals in a particular age and sex group [28]. In contrast, the RDA is a value intended to exceed the needs of 97.5% of the individuals in a population. The 2015 ERC revealed inadequate intakes of
calcium among the Canadian population, which varied from 23 to 87% depending on age and sex; women above the age of 50 y and men above the age of 71 y were the demographics with the highest prevalence of inadequacy. Moreover, food consumption patterns revealed milk and alternatives as the most significant sources of calcium among Canadians. Furthermore, approximately 19% of Canadians above 3 years of age had inadequate blood concentrations of vitamin D, 7% of whom were on the brink of deficiency. Approximately 75 to 96% of individuals had inadequate intakes of vitamin D from food sources alone, excluding those obtained through supplements and exposure to sunlight. The majority of vitamin D derived from food was obtained from fortified products, the most common of which were milk and alternatives, fish, eggs, and margarine.

**Status of Nutrition-Related Chronic Diseases Among Canadians**

The 2015 ERC also presented evidence from the 2012-2013 Canadian Health Measures Survey regarding the most prevalent nutrition-related chronic diseases in Canada, notably cardiovascular disease, cancer, type 2 diabetes, osteoporosis, and obesity [3]. Hypertension was prevalent among 22% of adults, 16% of whom were undiagnosed. The prevalence of cancer diagnoses between the years 1999 and 2009 was 2.4%, the most common forms of which were prostate (21%), breast (19%), and colorectal (13%). According to the same survey, 10% of Canadians above 40 years of age had osteoporosis, prevalence of which was four times higher in women. Moreover, 7% of Canadians were diagnosed with diabetes mellitus, a disease most common among men and adults over the age of 40. Furthermore, body mass index (BMI) revealed 68% of Canadian adults as overweight or obese. Importantly, the majority of nutrition-related chronic diseases as
discussed here are co-morbidities of overweight and obesity, incidences of which are rooted in sedentariness and poor dietary choices.

**Milk and Alternatives**

*Definition*

The most significant change to the new CFG is the stray from food groups and resulting de-emphasis of animal-source foods. Ultimately, the new guide amalgamates the milk and alternatives and meat and alternatives food groups as protein foods, in which consumption of plant protein is recommended more often than the former. Thus, despite the still presence of certain animal products (i.e., egg, lean meats, fish, and low-fat dairy products), the current CFG strongly promotes the consumption of plant-based foods. Yet, many animal-source foods are nutrient dense, providing many nutrients relative to their calories. Therefore, their subsidiary presence in the new guide may pose potential widespread implications on nutrient adequacy among the Canadian population.

For clarity, the term ‘milk and alternatives’ refers to those dairy products posited in line with Canadian food guidance, as outlined in the 2007 CFG. This includes but is not limited to: milk, cheese, yoghurt, and fortified soy-based beverages [22]. Dairy products that are particularly high in fats, sugars, and/or sodium (i.e., butter and cream) are not considered milk and alternatives [29]. In contrast, the term ‘dairy’ refers to all dairy products, regardless of their alignment with food guidance.
**Nutrient Requirements**

Milk and alternatives, specifically, is representative of a set of foods that provide significant sources of key micro- and macronutrients, including high-quality protein, calcium, vitamin D, vitamin A, phosphorus, magnesium, zinc, riboflavin, and vitamin B12 [30]. On a calorie basis, provision of high-quality protein, calcium, magnesium, potassium, zinc, and phosphorus is highest among dairy products in comparison to other foods typical of adult diets [30]. Dairy is also a rich source of vitamin A and vitamin D, fortification of which is mandatory in Canada under the Food and Drugs Act [31].

**Protein**

Protein is the principal macronutrient in milk and alternatives. DRIs for protein are expressed as RDA and Acceptable Macronutrient Distribution Range (AMDR). The RDA for protein intake is 0.8 grams of high-quality protein per kilogram of body weight per day, typically amounting to 56 grams per day for men and 46 grams per day for women [32]. The AMDR is a range of intake for a particular energy source (i.e., protein, carbohydrate, and fat) expressed as a percentage of total caloric intake that is associated with reduced risk of chronic disease while providing adequate intakes of essential nutrients [28]. According to the AMDR, healthy adults should consume 10% to 35% of their total energy intake as protein [32]. As illustrated in **Figure 2-4**, the 2015 ERC reports protein intake as falling within the AMDR for Canadians of all ages and sexes [3].
**Figure 2-4.** Protein as a percentage of total energy intake among men and women in 2004 and 2015.


**Micronutrients**

Milk and alternatives are rich sources of calcium, the DRI of which is set at 1,000 mg/d [34]. The prevalence of calcium inadequacy tends to increase with age, thus is most common among adults. The 2015 ERC reports that half of Canadian adults 19 y of age and older did not meet the recommendation of 2 daily servings of milk and alternatives as outlined in the 2007 CFG [3]. Moreover, merely 40% of milk and alternatives as consumed by the population were deemed in line with food guidance. In addition to food sources, supplements were shown to improve the prevalence of calcium inadequacy among Canadians over the age of 50 y, whereas no improvement was observed below this cutoff.
Nevertheless, 25 to 69% of males and 41 to 63% of females 9 y of age and older were still below the EAR. Milk and alternatives were found to be the most significant sources of food-derived calcium within Canadian diets.

Milk and alternatives are also rich sources of vitamin D. The mandatory fortification of fluid milk and margarine with vitamin D was implemented in the Food and Drugs Act in 1975, the result of which effected the elimination of rickets in children [35]. The DRI for vitamin D is set at 600 mg/d for adults [34]. The RDA for vitamin D is set based on the assumption of minimal exposure to sunlight, ensuring sufficient intake among the majority of Canadians [36]. As mentioned, 1 serving of milk contributes 44% to the RDA for vitamin D, showcasing its importance in deterring nutrient inadequacy [37].

Additional micronutrients present in milk and alternatives include vitamin A, phosphorus, magnesium, zinc, riboflavin, and vitamin B12, whose DRIs are based on the AI. The AI for phosphorus is set at 700 mg/d for healthy adults [32]. There was a 10% to 35% prevalence of inadequate phosphorus intake based on the EAR for adolescent females (9-18 y of age), whereas the majority of adults were meeting recommendations [3]. The AI for magnesium is set at 420 mg/d for men and 320 mg/d for women, respectively [32]. There was a widespread prevalence of insufficient magnesium intakes with approximately 34 to 65% of males and 51 to 66% of females 14 y of age and older below the EAR [3]. The AI for zinc is set at 11 mg/d for men and 8 mg/d for women, respectively [32]. Approximately 13 to 40% of males and 14 to 25% of females had zinc intakes below the EAR [3].

**Saturated fat**

Milk and alternatives are also sources of nutrients to limit, the most prominent of which is saturated fat. Many national dietary guidelines, including that of Canada and the
US, advise limiting consumption of foods rich in saturated fat due to its putative harmful association with nutrition-related chronic diseases [2,38]. In particular, the Dietary Guidelines for Americans 2015-2020 specify limiting intakes of saturated fat to less than 10% of total daily calories [38]. However, more recent analyses have shifted focus from single nutrients to whole foods as a means of elucidating relationships between foods, health, and disease [39]. The DRIs state that consumption of saturated fat should be “as low as possible while consuming a nutritionally adequate diet” [28].

**Energy**

Milk and alternatives are typically deemed nutrient-dense as opposed to energy-dense as they contain many nutrients relative to their calories. The daily energy needs of healthy, normal weight individuals are determined by the Estimated Energy Requirement, a set of equations in the DRIs that define the amount of calories needed to maintain energy balance [28]. The equations are based on age, sex, weight, height, and physical activity and differ depending on individuals’ developmental stage (i.e., children, pregnant, lactating, etc.).

**Implications of Foods on Health and Disease**

The 2007 CFG is geared towards improving health through food recommendations that assist in meeting nutrient requirements while reducing the risk of nutrition-related chronic disease [40]. The most common nutrition-related chronic diseases among Canadian adults are cardiovascular disease (CVD), cancer, diabetes mellitus, osteoporosis, and overweight and obesity [41]. Foods play various roles in the prevention and onset of nutrition-related chronic diseases.
**Cardiovascular Disease**

Research points to an association between dairy consumption and cardiovascular health. A recent study by Thorning et al. [42] criticizes evidence pertaining to the current state of knowledge concerning food and disease as being obtained through reductionist approaches that examine nutrients in isolation. Instead, the authors present the findings of numerous meta-analyses that examined the effects of the entirety of the dairy matrix on health and disease for different dairy products. A meta-analysis by Qin et al. (2015) found an inverse association between total dairy consumption and risk of CVD (9 studies; RR: 0.88; 95% CI: 0.81, 0.96) and stroke (12 studies; RR: 0.87; 95% CI: 0.77, 0.99). Low-fat dairy (6 studies; RR: 0.93; 95% CI: 0.88, 0.99) and cheese (4 studies; RR: 0.91; 95% CI: 0.84, 0.98) were associated with a lower risk of stroke, whereas cheese alone was associated with a lower risk of coronary heart disease (CHD) (7 studies; RR: 0.84; 95% CI: 0.71, 1.00). However, no association was observed between total dairy consumption and CHD (12 studies; RR: 0.94; 95% CI: 0.82, 1.07). A similar meta-analysis based on 31 cohort studies including over 1 million participants also found an inverse association between total dairy intake and stroke risk (RR: 0.91; 95% CI: 0.83, 0.99), as well as cheese consumption and risk of stroke (RR: 0.87; 95% CI: 0.77, 0.99) and CHD (RR: 0.82; 95% CI: 0.72, 0.93) [44]. An inverse association between total dairy consumption and stroke risk (RR: 0.91; 95% CI: 0.83, 0.99) was also purported by de Goede et al. [45]. The meta-analysis, which was based on 18 cohorts including a total of 762,414 individuals who were followed for 8 to 26 years, found that consumption of 200 g per day of 2 or more fermented dairy products (i.e., cheese, yoghurt, and sour milk) was associated with a 9% reduction in stroke risk (RR: 0.91; 95% CI: 0.82, 1.01). It was also found that butter, a dairy product high in saturated fat,
showed no significant association with CVD, CHD, or stroke. On the contrary, a positive association between milk and stroke risk was observed with high-fat milk as opposed to low-fat milk. This finding, however, was purported on a minimal number of studies.

Another of the meta-analyses discussed by Thorning et al. [42] based on 9 prospective cohort studies including 57,256 participants followed between 2 and 15 y found an inverse association between consumption of total dairy (RR: 0.97; 95% CI: 0.95, 0.99), low-fat dairy (RR: 0.96; 95% CI: 0.93, 0.99), and milk (RR: 0.96; 95% CI: 0.93, 0.99) and the risk of hypertension (all per 200 g/d) [46]. Consumption of low-fat dairy was associated with a 4% reduced risk of hypertension, whereas no association was observed with consumption of high-fat dairy (RR: 0.99; 95% CI: 0.95, 1.03). Furthermore, no association was found between consumption of fermented dairy products and hypertension. The evidence presented by Thorning et al. [42] was strong in that it included several meta-analyses that included a large number of studies and participants.. However, several of the studies were lacking in the specification among different products, outcome variables, and dose of consumption. Moreover, the use of observational studies to determine associations between dairy and health outcomes is a limitation in itself due to the large potential for confounding.

Similarly, Drouin-Chartier et al. [47] conducted a systematic review analyzing associations between high- and low-fat dairy products and cardiovascular-related health outcomes. The systematic review included 21 meta-analyses on prospective cohort studies that investigated associations between dairy consumption and CVD, coronary artery disease (CAD), stroke, hypertension, metabolic syndrome, and type 2 diabetes. Quality assessment was performed using the Grading of Recommendations Assessment,
Development, and Evaluation (GRADE) scale and Meta-analysis Of Observational Studies in Epidemiology (MOOSE) checklist. The authors report 3 meta-analyses that predict a favorable or neutral association between total dairy and CVD; O'Sullivan et al. [48] found no association between total dairy and CVD mortality (RR: 0.87; 95% CI: 0.62, 1.20), Qin et al. [43] found an inverse association with nonfatal CVD risk (RR: 0.88; 95% CI: 0.81, 0.96), and Alexander et al. [44] purported no association with CVD (RR: 0.85; 95% CI: 0.75, 1.04). Overall, Drouin-Chartier et al. [47] purport moderate-quality evidence as pointing to an overall neutral association between total dairy consumption and CVD risk. In addition, they found moderate-to-high quality evidence showcasing a neutral association between consumption of cheese (RR: 1.00; 95% CI: 0.81, 1.24) and (RR: 0.89; 95% CI: 0.78, 1.01) from O’Sullivan et al. [48] and Alexander et al. [44], respectively) and yoghurt (RR: 0.93; 95% CI: 0.78, 1.12 from Alexander et al.) and CVD. On the contrary, associations between dairy fat, milk, and fermented dairy products and CVD were inconclusive due to the low-quality nature of existing studies.

Drouin-Chartier et al. also found 3 meta-analyses purporting a neutral association between total dairy consumption and CAD based on high-quality evidence (RR: 1.02; 95% CI: 0.93, 1.11) from Soedamah-Muthu et al. [49], (RR: 0.94; 95% CI: 0.82, 1.07) from Qin et al. [43], and (RR: 0.91; 95% CI: 0.80, 1.04) from Alexander et al. [44]). There was also high-quality evidence from meta-analyses to suggest that high fat intake from dairy products, as well as consumption of low-fat dairy, are not associated with CAD risk; Soedamah-Muthu et al. [49] found no association between high- and low-fat dairy and CAD risk (RR: 1.04; 95% CI: 0.89, 1.21 and RR: 0.93; 95% CI: 0.74, 1.17, respectively), whereas Alexander et al. [44] found a neutral and inverse association between consumption of high-fat (RR: 1.08; 95%
CI: 0.93, 1.19) and low-fat dairy (RR: 0.90; 95% CI: 0.82, 0.98) with CAD risk, respectively. Moreover, consumption of regular- and low-fat dairy, yoghurt, and milk were not shown to be associated with stroke risk, whereas total dairy, low-fat dairy, cheese, and fermented dairy products may be associated with a lower risk of stroke. Lastly, moderate-to-high quality evidence points to an inverse association between consumption of total dairy, low-fat dairy, and milk and hypertension, whereas consumption of cheese, yoghurt, and fermented dairy (deemed high-fat) showed no association with hypertension.

Osteoporosis

Diet is a major determinant of osteoporosis among the elderly. A recent study examined the effect of protein on hip fracture risk in a large sample size of men and postmenopausal women from two long-term cohort studies [50]. Protein has both potential positive and negative effects on bone health. For example, protein from animal sources may contribute to metabolic acidosis, leading to bone demineralization; however, the macromolecule has also been shown to play a role in several mechanisms that enhance bone formation. They observed an inverse association between total protein and animal protein and hip fractures in men for every 10-gram increment. Protein from plant and dairy sources also showed inverse relationships with hip fractures in combined data from both men and women. Moreover, covariates such as smoking, physical activity, and calcium intake, were not shown to modify associations.

There is a large body of research on osteoporosis as it relates to dairy consumption and the individual nutrients, calcium and vitamin D. A recent study examined the association between dairy consumption and hip fractures in men and postmenopausal women [51]. Data from approximately 80,000 women and 43,000 men from two cohort
studies revealed a 6% decrease in hip fracture per daily serving of total dairy foods in both sexes. Fluid milk contributed an 8% decrease in hip fracture for both sexes, whereas cheese consumption showed a decrease solely in women. Yoghurt, on the other hand, showed no association with hip fractures. However, the study did not account for the individual nutrients, calcium, vitamin D, and dairy protein, in the incidence of hip fractures.

Rozenberg et al. [30] recount that nutrient-nutrient interactions within the dairy matrix as preventative of bone resorption, particularly due to the actions of calcium, vitamin D, phosphorus, and protein. Several studies suggest supplements of calcium and vitamin D as benefitting bone health. One study included data from participants of the Framingham Osteoporosis Study and found no association between consumption of dairy foods and BMD in the sample of 863 elderly men and women over a four-year period [52]. However, vitamin D supplementation in addition to dairy product consumption, including milk, yoghurt, and cheese, resulted in greater bone mineral density of the lumbar spine and less resorption of lower trochanter bone. Comparable findings from another study show that calcium and vitamin D from fortified-dairy foods lead to fracture prevention, longevity, and increased quality of life among the elderly population [53]. A review conducted by the Belgian Bone Club reports that consumption of dairy foods may be as effective as calcium supplementation, potentially attributable to calcium absorption as enhanced by other components of the dairy food matrix [30]. More research should be conducted regarding differences in osteoporosis prevention and treatment through the consumption of dairy products in comparison to calcium and vitamin D supplementation, as well as the effects of both.
Type 2 Diabetes Mellitus

Type 2 diabetes mellitus (T2DM) is also common among the various nutrition-related chronic diseases. A systematic review examined various dietary patterns in the development of T2DM. They found that diets composed largely of fruits and vegetables, chicken, fish, and legumes were inversely associated with T2DM whereas red and processed meat, refined grains, high-fat dairy products, eggs and fried foods were positively associated with T2DM [54]. Furthermore, dietary characteristic of patterns of “healthy eating”, particularly the Mediterranean Diet, Dietary Approaches to Stop Hypertension (DASH), and Alternative Healthy Eating Index (AHEI), were associated with a lesser risk of T2DM.

A prospective cohort following 63,257 Chinese adults found a 12% reduction in T2DM risk in individuals who drank milk on a daily basis when adjusted for confounding variables [55]. Furthermore, their results revealed an inverse association between dietary calcium and T2DM, however, no association was observed with regards to calcium obtained from sources other than dairy. Despite a mere 3% of the participants taking a calcium supplement, an inverse association was also observed between total calcium intake, including supplements, and T2DM. However, a systematic review conducted by Drouin-Chartier et al. [47] reveals inconsistencies as to the effects of total dairy and cheese consumption on T2DM, whereas prospective cohort studies of similarly large sample sizes either point to beneficial or neutral effects. Several studies have found a significant inverse association between the consumption low-fat dairy products and yoghurt and T2DM, the finding of which is based on high-quality evidence, whereas high-fat dairy, fluid milk, and
other fermented dairy products showed no association based on high to moderate quality evidence.

More recent analyses have shown neutral or moderately positive associations between dairy consumption and T2DM as evidenced from large prospective cohorts and several randomized controlled trials [56]. Moreover, evidence from prospective cohort studies has shown yoghurt as having the strongest association with lower risk of T2DM among dairy products. The researchers also note the importance of the food matrix in discerning associations between food and health as opposed to saturated fat alone.

**Cancer**

Association between dairy consumption and the prevention and onset of certain types of cancers is not well established. A report conducted by World Cancer Research Fund International indicates there is strong evidence of a probable reduction in colorectal cancer risk associated with the consumption of dairy products, including total dairy, cheese, and dietary calcium [57]. The same was found to be true for the consumption of whole grains, dietary fibre, and calcium supplements. On the contrary, strong evidence suggested a probable association with red meat and colorectal cancer risk and a convincing association with consumption of processed meat.

In a 4,000-person cohort reported by the World Cancer Research Fund [58], the association of distinct dietary patterns, including vegetarianism and veganism, with cancer incidence was assessed. Participants were of North American origin and averaged 62 years of age. Half of the population followed a vegetarian diet and a quarter were of African American or West Indian ethnicities. It was found that the risk of mortality from cancer was similar among those who consumed vegetarian and vegan diet as compared to those
who consumed mixed diets. However, vegetarians were shown to have a lower incidence of gastrointestinal cancers, such as colorectal cancer, and cancers of female reproductive organs. Vegans, which represented 8% of the participants, were 33% less prone to develop prostate cancer. However, it is uncertain as to the amount of men classified as vegan. Half of the participants in the cohort reported consuming soy products in levels similar to Asian levels and were shown to have a 40% reduction in the risk of breast cancer due to the presence of isoflavones.

Another study examined the relationship between consumption of dairy products and breast. Data was obtained from 1941 women diagnosed with breast cancer and 1237 controls that participated in the Roswell Park Cancer Institute Data Bank and BioRepository between 2003 and 2014. Yoghurt consumption was associated with a significant decrease in the risk of breast cancer, whereas fluid milk was associated with a non-significant decrease [59]. Such can be attributed to the presence of pro and prebiotics in yoghurt and absence in fluid milk. Milk, on the other hand, was positively associated with the risk of estrogen receptor cancers. Such findings are likely due to insulin-like growth factor 1 (IGF-1), the presence of which is attributable to the use of growth hormones in American cows for higher milk volumes. Findings of this study are indicative of the uncertainties of dairy in the incidence of breast cancer, however, limitations lie in the dietary data as gathered from food frequency questionnaires. Further research should be garnered with regards to yoghurt as protective against the development of the cancer. In addition to evidence regarding dairy as decreasing the risk of colorectal cancer, a prospective cohort conducted by Park et al. [60] also found a decreased risk of total cancer incidence in women regarding total calcium consumption. However, this association was
not necessarily attributable to dairy foods in particular, as it considered total dietary calcium. The association was nonlinear and was not observed in men, although a weak inverse association between total calcium and the incidence of total cancers was observed in men. Furthermore, combined data from eight prospective cohort studies found no association between the dairy consumption and breast cancer [61]. The same was true for women consuming total meat, red meat and white meat. The evidence pertaining to dairy consumption and the risk of cancers is extensive yet confounding. There is minor evidence that dairy consumption and consumption of particular dairy products may be beneficial in cancer incidence, however, such evidence is inconclusive. Furthermore, there is no strong evidence purporting any negative effects of dairy consumption on cancer risk.
Chapter 3 – Rationale and Objectives

The recent revamp of CFG, which dismisses the traditional concept of food groups, promotes a largely plant-based diet, encouraging consumption of vegetables and fruit, whole grains, and protein foods, suggesting plant protein be consumed more often. Given the prominence of dairy as a staple in Canadian habitual diets, it is of interest as to how Canada’s newfound dietary guidelines may impact future consumption of dairy and thus, nutrient intakes. As a dense source of high-quality protein and essential vitamins and minerals, dairy plays a major role in nutrient adequacy, particularly with regards to nutrients of public health concern. Therefore, the characterization of dairy consumption at this point in time is necessary to properly pinpoint any future potential implications on nutrient adequacy attributable to changes in diet that may arise in light of the new CFG.

The 2015 CCHS – Nutrition is the most up-to-date and comprehensive dataset providing detailed information as to the foods and beverages constituting Canadian diets. Therefore, the overall objective of this research was to employ the CCHS to assess the intake and contribution of milk and alternatives (as defined by the 2007 CFG) to nutrients and energy in Canadian habitual diets. In turn, this research provides insight into the role of milk and alternatives in Canadian diets in 2015, which can eventually be used as a baseline with which to compare future dietary trends.
Chapter 4 – Manuscript

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**Article**

**Consumption of Milk and Alternatives and Their Contribution to Nutrient Intakes among Canadian Adults: Evidence from the 2015 Canadian Community Health Survey—Nutrition**

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Abstract: As a staple food and dense source of nutrients, milk and alternatives play an important role in nutrient adequacy. The aims of this study were to quantify the consumption of milk and alternatives within Canadian self-selected diets and determine their contribution to intakes of nutrients and energy. First, 24-h dietary recalls from the 2015 Canadian Community Health Survey—Nutrition were used to assess 1-d food and nutrient intakes among Canadian adults ≥19 y (n = 13,616). Foods were classified as milk and alternatives according to the 2007 Canada’s Food Guide. Descriptive statistics were used to calculate daily servings of milk and alternatives by different age groups and demographic characteristics. Population ratios were used to discern their contribution to total intakes of nutrients and energy. Mean daily servings (±SE) were highest for milk (0.60 ± 0.02) and cheese (0.42 ± 0.01), intermediate for frozen dairy (0.16 ± 0.01) and yoghurt (0.14 ± 0.01), and lowest for soy and other dairy (<0.03). Intakes were lowest among Canadians 51 + y (1.3 ± 0.03), females (1.25 ± 0.03), non-Caucasians (1.06 ± 0.05), those with less than a secondary education (1.19 ± 0.05), and British Columbians (1.17 ± 0.05). Milk and alternatives contributed >20% to total intakes of calcium (52.62 ± 0.46%), vitamin D (38.53 ± 0.78%), saturated fat (28.84 ± 0.51%), vitamin B12 (27.73 ± 0.57%), vitamin A (26.16 ± 0.58%), phosphorus (24.76 ± 0.35%), and riboflavin (24.43 ± 0.37%), of which milk was the top source. Milk and alternatives contribute substantially to nutrient intakes and thus warrant further attention in terms of mitigating nutrient inadequacy among the Canadian population.

Keywords: dairy products; self-selected diets; nationally representative survey; Canada’s Food Guide; dietary intake.
1. Introduction

Dairy is a dense source of essential nutrients, ranging from vitamins and minerals to high-quality protein. However, dairy is often subject to scrutiny due to its saturated fat content, a nutrient that many national dietary guidelines, including those of the USA and Canada, recommend limiting due to its putative harmful association with cardiovascular health [1,2]. However, as a staple food within Canadian diets, it is important to quantify the consumption and contribution of dairy to nutrient intakes as a means of implementing proper policies to ensure the overall health of Canadians.

Consumption of dairy products in Canada is shifting. Over the past two decades, the intake of fluid milk has been declining concurrently with a rise in the consumption of solid dairy foods, such as cheese and yoghurt [3]. These changes can be attributed to the large proportion of elderly people in the Canadian population, a demographic known to consume fewer beverages such as milk [4,5]. Shifts in dairy consumption can also be caused by changing dietary preferences and the increasing popularity of plant-based alternatives, such as soy, coconut, and almond beverages [4,6].

Canada’s Food Guide (CFG) is a set of dietary guidelines intended to promote healthy eating among Canadians [1]. Published in 2007, Eating Well with Canada’s Food Guide (referred to here as the 2007 CFG) reflects a food intake pattern that accounts for nutrient adequacy based on the Dietary Reference Intakes (DRI), nutrition-related chronic diseases, and input from public consultations [7]. The 2007 CFG consisted of four food groups—vegetables and fruit, grain products, milk and alternatives, and meat and alternatives—and an ‘other foods’ group, each assigned a daily number of servings recommended based on age and sex. In January 2019, Health Canada released an updated
version of CFG. The recommendations outlined in the new guide were informed by high-quality evidence, including that from systematic reviews, assessing relationships between food and health [1]. The new guide took major strides away from the previous one, dismissing the concept of food groups in place of a food guide snapshot illustrated by a plate containing vegetables and fruits, whole grains, and protein sources. The current CFG places a major emphasis on plant-based sources of protein, resulting in the overall lower prominence of milk and alternatives within the nation’s present dietary guidelines. According to Health Canada, many Canadians were not meeting the recommendations outlined in the 2007 CFG [8]. As a result, the prevalence of nutrient inadequacy was high, particularly for calcium, magnesium, zinc, vitamin A, and vitamin C. Constituting one of the few food groups containing considerable amounts of a wide range of nutrients, milk and alternatives have the potential to mitigate inadequate intakes of nutrients of concern in Canada. The de-emphasising of milk and alternatives in the new CFG may have further implications in terms of nutrient adequacy for Canadians. Therefore, the aims of this study were to quantify the consumption of milk and alternatives within the self-selected diets of Canadian adults, as well as their contribution to total intakes of nutrients and energy based on data from the 2015 Canadian Community Health Survey (CCHS)—Nutrition.

2. Materials and Methods

2.1. The 2015 CCHS—Nutrition

The CCHS is a nationally representative cross-sectional survey that collects information regarding Canadians’ health status, health determinants, and utilization of the
healthcare system [9]. Administered annually, the survey is a multistage clustered design to ensure the inclusion of a minimum number of respondents from each of the provinces, from both rural and urban dwellings, and from each age–sex group corresponding to those in the DRIs. The 2015 CCHS—Nutrition constitutes the second of two nutrition-focused surveys, the first having been conducted in 2004 (CCHS, Cycle 2.2, Nutrition (2004), later renamed the 2004 CCHS—Nutrition). The 2015 CCHS—Nutrition consists of two components: (1) 24-h dietary recall and (2) health. The 24-h dietary recall component collects information pertaining to the foods and beverages consumed by respondents 24 h prior to the interview, from midnight to midnight. The automated multiple-pass method is a computer-assisted interviewing instrument aimed at helping respondents recollect and report their consumption. The health component gathers information pertaining to respondents’ weight and height, physical activity, chronic health conditions, sociodemographic characteristics, and supplement intake. The 2015 CCHS—Nutrition targeted Canadians ≥1 y of age residing within the provinces. Members of the Canadian forces, individuals living on reserves or Aboriginal settlements, and the institutionalized population were excluded from the survey.

For the purpose of this study, respondents below 19 y of age were excluded (n = 6,568; 32.06% of sample). Pregnant (n = 116; 0.57% of sample) and breastfeeding (n = 187; 0.91% of sample) women were excluded due to a lack of data with which to calculate their total energy expenditure (TEE) [10]. Data from the first 24-h dietary recalls were utilized as only 37% of respondents completed a second recall [9]. Nutrient intakes from supplements were excluded in the present analyses to obtain estimates of the percent contribution of nutrients and energy from food sources alone, although this may lead to
underestimations of intakes for specific nutrients. The final sample size was 13,616. Access to the 2015 CCHS—Nutrition Master Files was granted by Statistics Canada (Project No. 18-SSH-MCG-5516). Population surveys conducted by Statistics Canada were granted ethical approval under the authority of the Statistics Act of Canada. According to Article 2.2 of the Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans [11], research involving information that is legally accessible to the public is based on the presence of a legally designated custodian/steward that protects its privacy and proprietary interests, such as Statistics Canada, and so is exempt of institutional Research Ethics Board review. All analyses were conducted at the McGill-Concordia Laboratory of the Quebec Inter-University Centre for Social Statistics (QICSS).

### 2.2. Data File Structure

Files in the 2015 CCHS—Nutrition that were used in the present analyses include the health component, vitamin and mineral supplements, 24-h dietary recall (HS) file, food and ingredient details (FID) file, and CFG description (CFGD) file [12]. The HS file contains information pertaining to total nutrient intakes derived from food sources reported in the first 24-h dietary recalls, as well as socio-demographic variables and sample weights. The FID file contains the nutrient values for all items reported in the 24-h dietary recalls, including basic foods and recipe components. The CFGD file is a supporting file linking foods listed in the FID file to the 2007 CFG, which includes a variable referencing the CFG serving size for food items, standardized to grams (i.e., one food guide serving of 2% milk is equivalent to 250 mL or 257.819 g). The CCHS also contains a bootstrap weight file, each record containing 500 bootstrap weights, which are used to calculate confidence intervals around point estimates.
2.3. **Food Classification**

The Canadian Nutrient File (CNF) is Canada’s reference food composition database containing the nutrient profiles of over 5000 foods [9]. Data from the CNF and an accompanying recipe file, both from Health Canada, were used to assign food codes to items reported in the 24-h dietary recalls. Additionally, the CNF/CFG classification was developed by Health Canada as a surveillance tool to assess Canadians’ compliance with the 2007 CFG [13]. It constitutes a set of food codes that facilitates the classification of foods in the CNF into food groups and subgroups. Foods within the four core food groups were further classified into tiers based on how well they align with the guidance outlined in the 2007 CFG. The CNF/CFG classification divides milk and alternatives into two groups: (1) fluid milk and fortified soy-based beverages and (2) other milk alternatives (cheese, yoghurt). Despite being a plant-based alternative, Health Canada considered fortified soy-based beverages part of the milk and alternatives group as a high-calcium option for non-milk drinkers [14]. Some dairy products that are particularly high in fats, sugars, and/or sodium (i.e., butter and cream) are not considered within milk and alternatives according to the 2007 CFG and were therefore excluded from the analyses. Flavoured milks and yoghurts were considered within milk and alternatives and subsequently included in the analyses if they were below the upper thresholds for two or more of the following: total fat, sugars, and sodium [13]. A different set of thresholds was used with which to assign flavoured dairy products to tiers in order to distinguish between the naturally occurring and added sugar content of flavoured milks and yoghurts.

The Bureau of Nutritional Sciences (BNS) food codes were developed by Health Canada as a means of determining the contribution of select food categories to total
nutrient intakes [12]. In this study, the BNS codes were utilized to classify foods within the CNF/CFG classification of milk and alternatives into sources, including milk, cheese, yoghurt, and frozen dairy. The Nutrition Survey System (NSS) food codes, as assigned uniquely to each food item, were used to identify soy products within the CNF/CFG classification of milk and alternatives, which consisted of fortified soy-based beverages as a standalone product or component of a product. Milk and alternatives that did not fall into these categories, typically in the form of recipe ingredients (i.e., cakes, milk-based beverages, soups, sauces, etc.), were classified as other dairy. Despite the classification method used, food items constituting milk and alternatives included both basic foods and recipe components. The classification of milk and alternatives based on their respective food codes are listed in Appendix A.

2.4. Data Handling

Consumption of milk and alternatives was assessed by age and demographic characteristics in terms of the 2007 CFG servings. A new variable was created for food guide servings by dividing the food weight (g) by the Food Guide Serving (g). New variables were created to classify individuals into age groups according to those in the 2007 CFG: 19–50 years and 51+ years. New variables were also created for sex, level of education, household income, ethnicity, and province of residence.

As a self-reported dietary assessment tool, 24-h recalls are prone to bias due to misreporting. Energy intake tends to be under-reported, particularly in North America, Europe, and Australia [15]. Misreporting was detected based on a method outlined by Garriguet (2018) [15]. Respondents were classified as energy under-reporters, plausible-reporters, and over-reporters based on the ratio of their energy intake (EI) to TEE. The
Institute of Medicine (IOM) equations were used to estimate TEE based on sex, age, height, weight, and physical activity [1]. Individuals were assumed to be sedentary based on Statistics Canada data regarding measured physical activity of adults from 2007 to 2015 [15]. The method of McCrory et al. [16] was used to classify respondents as under-reporters, plausible-reporters, or over-reporters if the percentage of their TEE that was reported as EI was <70%, 70–142%, or >142%, respectively. Only respondents with measured heights and weights were used in the IOM equations.

2.5. Statistical Analyses

Twenty-four-hour dietary recalls are not necessarily representative of an individual’s usual dietary intake, which varies from day to day. This within-person variation can lead to overestimations regarding the proportion of individuals with high or low intakes of a given food or nutrient [17]. The average of individuals’ 1-d intakes is, however, an appropriate estimate of the average usual intakes of a population [10]. Therefore, descriptive statistics were used to calculate intakes of milk and alternatives across age groups and demographic variables in order to assess compliance with the recommendations outlined in the 2007 CFG (two servings/d for 19–50 y and three servings/d for 51+ y, regardless of sex) [18]. T-tests were used to test whether mean intakes differed among demographic variables.

The percentage contribution of nutrients and energy from milk and alternatives to total intakes were calculated as population ratios, which have been shown to provide better estimates of population usual intakes in contrast to other methods [19]. To calculate population ratios, nutrients deriving from milk and alternatives were summed across all individuals and divided by the sum of total intakes of that nutrient for all individuals, as
done previously by Kirkpatrick et al. [19]. Ratios were used to rank nutrients and energy from milk and alternatives based on their percentage contribution to total intakes. Similarly, milk and alternative sources were ranked according to their percentage contribution to total intakes of nutrients and energy. The ranking of milk and alternative sources is attributable to how often the source is consumed and the quantity of the nutrient present in the source [19]. In order to aid in the interpretation of the ranking of milk and alternative sources, cross-tabulations were employed to determine the proportion of individuals who reported consuming milk and alternatives. Consumers were identified as individuals who reported >0 g of milk and alternatives in their 24-h dietary recall. Descriptive statistics were further utilized to discern 1-d intakes of nutrients and energy from milk and alternatives per capita (all respondents) and per consumer.

Weighting was used to obtain representative estimates for the Canadian population. As calculated by Statistics Canada, sample weights are assigned to each respondent and correspond to the number of individuals within the Canadian population represented by that respondent. To account for the complex multistage sampling frame of the 2015 CCHS—Nutrition, variance estimation was performed using the bootstrap balanced repeated replication technique [20,21]. All statistical analyses were performed using SAS (version 9.3; SAS Institute Inc., Cary, NC, USA) and SAS-callable SUDAAN software. Alpha was set at 0.05 for all statistical tests.
3. Results

3.1. Sample Characteristics

As shown in Table 3-1, the sample was split evenly among males and females. The majority of surveyed individuals were 19–50 y of age, Caucasian, had some post-secondary education, a household income less than CAD$50,000/y, resided within the province of Ontario, and were plausible energy reporters.

Table 3-1. Demographic characteristics of the study sample from the 2015 Canadian Community Health Survey – Nutrition (n = 13,616).

<table>
<thead>
<tr>
<th>Demographic variable</th>
<th>Percentage (%)±SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group</td>
<td></td>
</tr>
<tr>
<td>19-50 y</td>
<td>54.31±0.09</td>
</tr>
<tr>
<td>51+ y</td>
<td>45.69±0.09</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>49.99±0.10</td>
</tr>
<tr>
<td>Female</td>
<td>50.01±0.10</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>73.69±0.94</td>
</tr>
<tr>
<td>Non-Caucasian</td>
<td>26.31±0.94</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Less than secondary</td>
<td>12.34±0.49</td>
</tr>
<tr>
<td>Secondary</td>
<td>25.96±0.76</td>
</tr>
<tr>
<td>Some-post secondary</td>
<td>34.00±0.83</td>
</tr>
<tr>
<td>Post-secondary</td>
<td>27.70±0.86</td>
</tr>
<tr>
<td>Income ($CAD/y)</td>
<td></td>
</tr>
<tr>
<td>&lt;50,000</td>
<td>34.19±0.85</td>
</tr>
<tr>
<td>50,000-100,000</td>
<td>32.42±0.82</td>
</tr>
<tr>
<td>100,000-150,000</td>
<td>19.67±0.75</td>
</tr>
<tr>
<td>&gt;150,000</td>
<td>13.73±0.68</td>
</tr>
<tr>
<td>Province</td>
<td></td>
</tr>
<tr>
<td>Province</td>
<td>Consumption (±SEM)</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>British Columbia</td>
<td>13.36±0.05</td>
</tr>
<tr>
<td>Alberta</td>
<td>11.31±0.07</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>2.95±0.01</td>
</tr>
<tr>
<td>Manitoba</td>
<td>3.33±0.02</td>
</tr>
<tr>
<td>Ontario</td>
<td>38.72±0.11</td>
</tr>
<tr>
<td>Quebec</td>
<td>23.58±0.07</td>
</tr>
<tr>
<td>Atlantic provinces</td>
<td>6.75±0.03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status</th>
<th>Consumption (±SEM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plausible reporters</td>
<td>59.35±0.99</td>
</tr>
<tr>
<td>Under-reporters</td>
<td>32.21±0.96</td>
</tr>
<tr>
<td>Over-reporters</td>
<td>8.44±0.54</td>
</tr>
</tbody>
</table>

### 3.2. Consumption of Milk and Alternatives by Age and Demographics

Consumption of milk and alternatives among age groups and demographic variables are presented in Table 3-2. Daily servings of milk and alternatives averaged 1.36 ± 0.03. Consumption of milk and cheese constituted ~44% and ~30% of mean total intakes, whereas yoghurt and frozen dairy each made up ~10%, respectively. Other dairy and soy products were consumed in negligible amounts (<3% each) and thus are not reported in the tables. Exclusion of fortified soy-based beverages from milk and alternatives altered the estimates to such a small degree that the overall conclusions remained unchanged.

Overall, the 19–50 y age group consumed more daily servings of milk and alternatives compared to the 51+ y group (+0.12 servings/d; p = 0.02). Specifically, those 19–50 y had higher intakes of milk (+0.07 servings/d; p = 0.04) and cheese (+0.12 servings/d; p < 0.0001) compared to those 51+ y. Consumption of yoghurt and frozen dairy did not differ among age groups.
Table 3-2. Daily servings of milk and alternatives for all energy reporters by age groups and demographics characteristics based on mean 1-d intakes from the 2015 Canadian Community Health Survey – Nutrition (n = 13,616).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Milk and alternatives</th>
<th>Milk</th>
<th>Cheese</th>
<th>Yoghurt</th>
<th>Frozen dairy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19-50 y Mean±SE</td>
<td>51+ y Mean±SE</td>
<td>19-50 y Mean±SE</td>
<td>51+ y Mean±SE</td>
<td>19-50 y Mean±SE</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>1.57±0.06a</td>
<td>1.36±0.04a</td>
<td>0.69±0.04a</td>
<td>0.62±0.03a</td>
<td>0.56±0.04a</td>
</tr>
<tr>
<td>Females</td>
<td>1.26±0.05</td>
<td>1.24±0.03</td>
<td>0.56±0.03</td>
<td>0.51±0.02</td>
<td>0.37±0.02</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>1.56±0.05b</td>
<td>1.38±0.03b</td>
<td>0.68±0.03b</td>
<td>0.59±0.02b</td>
<td>0.56±0.03b</td>
</tr>
<tr>
<td>Non-Caucasian</td>
<td>1.14±0.07</td>
<td>0.88±0.05</td>
<td>0.53±0.04</td>
<td>0.46±0.04</td>
<td>0.3±0.03</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than secondary</td>
<td>1.09±0.1</td>
<td>1.23±0.05</td>
<td>0.46±0.06</td>
<td>0.6±0.04</td>
<td>0.44±0.06</td>
</tr>
<tr>
<td>Secondary</td>
<td>1.33±0.06c</td>
<td>1.28±0.05</td>
<td>0.61±0.04c</td>
<td>0.52±0.03</td>
<td>0.47±0.03</td>
</tr>
<tr>
<td>Some post-secondary</td>
<td>1.54±0.08c</td>
<td>1.33±0.06</td>
<td>0.67±0.05c</td>
<td>0.57±0.03</td>
<td>0.53±0.04</td>
</tr>
<tr>
<td>Post-secondary</td>
<td>1.41±0.06c</td>
<td>1.32±0.05</td>
<td>0.62±0.04c</td>
<td>0.58±0.03</td>
<td>0.41±0.03</td>
</tr>
<tr>
<td>Income ($CAD/y)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;50,000</td>
<td>1.46±0.1</td>
<td>1.26±0.04</td>
<td>0.71±0.07</td>
<td>0.57±0.03</td>
<td>0.45±0.05</td>
</tr>
<tr>
<td>50,000-100,000</td>
<td>1.33±0.05</td>
<td>1.31±0.05</td>
<td>0.58±0.03</td>
<td>0.52±0.02</td>
<td>0.43±0.03</td>
</tr>
<tr>
<td>100,000-150,000</td>
<td>1.49±0.08</td>
<td>1.37±0.07</td>
<td>0.65±0.05</td>
<td>0.61±0.05</td>
<td>0.51±0.04</td>
</tr>
<tr>
<td>&gt;150,000</td>
<td>1.42±0.08</td>
<td>1.33±0.11</td>
<td>0.56±0.04</td>
<td>0.6±0.05</td>
<td>0.52±0.06</td>
</tr>
<tr>
<td>Province</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Province</td>
<td>Under-reporters</td>
<td>Plausible-reporters</td>
<td>Over-reporters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------</td>
<td>---------------------</td>
<td>---------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>British Columbia</td>
<td>1.12±0.08</td>
<td>1.23±0.07</td>
<td>0.49±0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alberta</td>
<td>1.49±0.08d</td>
<td>1.34±0.011</td>
<td>0.6±0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>1.31±0.13</td>
<td>1.52±0.011d</td>
<td>0.61±0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manitoba</td>
<td>1.41±0.11d</td>
<td>1.45±0.14</td>
<td>0.69±0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ontario</td>
<td>1.36±0.08d</td>
<td>1.2±0.05</td>
<td>0.62±0.04d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Québec</td>
<td>1.67±0.09d</td>
<td>1.41±0.05d</td>
<td>0.74±0.07d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atlantic provinces</td>
<td>1.42±0.06d</td>
<td>1.31±0.05</td>
<td>0.63±0.04d</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reporter status**

<table>
<thead>
<tr>
<th>Under-reporters</th>
<th>Plausible-reporters</th>
<th>Over-reporters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.82±0.06e</td>
<td>0.81±0.04e</td>
<td>2.64±0.17e</td>
</tr>
</tbody>
</table>

Superscript letters indicate significance levels:

- **a** p<0.05, significantly different from estimate for females within same age group.
- **b** p<0.05, significantly different from estimate for non-Caucasians within same age group.
- **c** p<0.05, significantly different from estimate for those with less than secondary education within same age group.
- **d** p<0.05, significantly different from estimate for residents of British Colombia.
- **e** p<0.05, significantly different from estimate for plausible-reporters.
Males had higher intakes of milk and alternatives compared to females (+0.22 servings/d; p < 0.0001). Consumption of milk and cheese was also higher for males (+0.12 and +0.15 servings/d, respectively; p < 0.0001), whereas consumption of yoghurt was higher for females (+0.05 servings/d; p = 0.0002). Similar results were obtained among sexes within the 19–50 y and 51+ y age groups.

Caucasians had higher intakes of milk and alternatives compared to non-Caucasians (+0.41 servings/d; p < 0.0001). Consumption among Caucasians was higher for milk (+0.12; p = 0.001), cheese (+0.21; p < 0.0001), and yoghurt (+0.03; p = 0.0002). Similar observations were obtained across age groups, with the exception of Caucasians 19–50 y, whose consumption did not differ from that of non-Caucasians. Consumption of frozen dairy did not differ among ethnicities except in the 51+ y age group, for which Caucasians had higher intakes than non-Caucasians (+0.09 servings/d; p = 0.002).

The less than secondary education level was used as a reference with which to make comparisons regarding the consumption of milk and alternatives among age groups and education levels. Respondents with less than secondary education had lower intakes of milk and alternatives compared to those with some post-secondary (−0.26 servings/d; p = 0.0005) and post-secondary education (−0.19 servings/d; p = 0.005). The same pattern was observed in the 19–50 y age group, but not in the 51+ y group, for which consumption did not differ by education. Similarly, daily servings of milk differed among those 19–50 y; consumption was lower for those with less than secondary education compared to those with secondary (−0.15 servings/d; p = 0.03), some post-secondary (−0.21 servings/d; p = 0.01), and post-secondary education (−0.16 servings/d; p = 0.02). Cheese intake was higher among those with less than secondary compared to those with some post-secondary
education (−0.12 servings/d; p = 0.003), yet differences were not observed among age groups. Consumption of yoghurt was also lower for those with less than secondary education compared to all other levels (−0.06, −0.08, and −0.11, respectively; p < 0.0001), a similar pattern of which was observed among all age groups. Finally, daily servings of frozen dairy did not differ among education levels except in the 19–50 y age group, consumption of which was lower for those with secondary compared to post-secondary education (−0.08 servings/d; p = 0.04).

Total daily servings of milk and alternatives did not differ among income levels, nor did they differ among age groups. Cheese consumption, however, was lower for households with <CAD$50,000/y compared to those with CAD$100,000–150,000/y (−0.08 servings/d; p = 0.03). Alternatively, daily servings of milk were higher for households with <CAD$50,000/y compared to those with CAD$50,000–100,000/y (+0.08 servings/d; p = 0.03). Consumption of yoghurt and frozen dairy did not differ among income levels.

British Columbia was used as a reference by which to draw comparisons among consumption of milk and alternatives among age groups and provinces. Residents of British Columbia consumed fewer daily servings of milk and alternatives compared to those of Quebec (−0.37; p < 0.0001), Alberta (−0.26; p = 0.001), Manitoba (−0.26; p = 0.01), Saskatchewan (−0.23; p = 0.02), and the Atlantic provinces (−0.19; p = 0.003). Daily servings of milk and alternatives were also lowest for British Columbians among all age groups. In particular, the consumption of milk was lowest for residents of British Columbia compared to all other provinces. Cheese intake was also lower for residents of British Columbia compared to Quebec (−0.16; p = 0.0003) and Alberta (−0.15; p = 0.002); the same differences were observed in the 19–50 y age group, whereas consumption only differed
with respect to Quebec in the 51+ y group. Compared to British Columbians, daily servings of yoghurt were higher among residents of Quebec (+0.06; p = 0.007) and lower among residents of Ontario (-0.03; p = 0.03). In the 19–50 y age group, British Columbians also had lower intakes compared to Quebec (-0.1; p = 0.002), whereas in the 51+ y group, residents had higher intakes compared to those of Saskatchewan (+0.07; p = 0.007) and Ontario (-0.06; p = 0.009). No differences were observed for intakes of frozen dairy among age groups and provinces.

Intakes of milk and alternatives among energy reporters are also reported in Table 3-2. Generally, intakes were lowest for under-reporters, intermediate for plausible-reporters, and highest for over-reporters. Total consumption of milk and alternatives, as well as cheese and yoghurt, was higher for plausible-reporters compared to under-reporters, regardless of age. Daily servings of frozen dairy for plausible-reporters in the 19–50 y group, however, did not differ from that of under-reporters.

3.3. Contribution of Nutrients and Energy from Milk and Alternatives to Total Nutrient Intakes

The percentage contribution of nutrients and energy from milk and alternatives to total intakes and their per capita mean 1-d intakes are in Table 3-3. Nutrients from milk and alternatives contributing more than 20% to total intakes included calcium, vitamin D, saturated fat, vitamin B12, vitamin A, phosphorus, and riboflavin. Between 10% and 20% of Canadian adults’ total intakes of protein, sugar, zinc, total fat, cholesterol, potassium, sodium, monounsaturated fat, and energy were obtained from milk and alternatives. Finally, milk and alternatives contributed less than 10% to total intakes of magnesium,
niacin, carbohydrates, linolenic acid, vitamin B6, thiamine, folate, polyunsaturated fat, linoleic acid, iron, fibre, and vitamin C.

Table 3-3. Percentage contribution of nutrients and energy from milk and alternatives and mean intakes based on 1-d intakes from the 2015 Canadian Community Health Survey – Nutrition (n = 13,616).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Nutrient/energy</th>
<th>Contribution (%) ±SE</th>
<th>Per capita mean 1-d intake±SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Calcium (mg)</td>
<td>52.62±0.46</td>
<td>411.61±7.41</td>
</tr>
<tr>
<td>2</td>
<td>Vitamin D (mcg)</td>
<td>38.53±0.78</td>
<td>1.82±0.04</td>
</tr>
<tr>
<td>3</td>
<td>Saturated fat (g)</td>
<td>28.84±0.51</td>
<td>6.55±0.15</td>
</tr>
<tr>
<td>4</td>
<td>Vitamin B12 (mcg)</td>
<td>27.73±0.57</td>
<td>1.13±0.02</td>
</tr>
<tr>
<td>5</td>
<td>Vitamin A (mcg)</td>
<td>26.16±0.58</td>
<td>170.43±3.15</td>
</tr>
<tr>
<td>6</td>
<td>Phosphorus (mg)</td>
<td>24.76±0.35</td>
<td>316.45±5.68</td>
</tr>
<tr>
<td>7</td>
<td>Riboflavin (mg)</td>
<td>24.43±0.37</td>
<td>0.47±0.01</td>
</tr>
<tr>
<td>8</td>
<td>Protein (g)</td>
<td>16.30±0.28</td>
<td>12.96±0.24</td>
</tr>
<tr>
<td>9</td>
<td>Sugar (g)</td>
<td>16.22±0.32</td>
<td>14.09±0.3</td>
</tr>
<tr>
<td>10</td>
<td>Zinc (mg)</td>
<td>15.63±0.27</td>
<td>1.65±0.03</td>
</tr>
<tr>
<td>11</td>
<td>Total fat (g)</td>
<td>15.49±0.32</td>
<td>10.83±0.25</td>
</tr>
<tr>
<td>12</td>
<td>Cholesterol (mg)</td>
<td>14.22±0.35</td>
<td>38.73±0.84</td>
</tr>
<tr>
<td>13</td>
<td>Potassium (mg)</td>
<td>12.58±0.22</td>
<td>337.91±6.39</td>
</tr>
<tr>
<td>14</td>
<td>Sodium (mg)</td>
<td>12.15±0.25</td>
<td>332.31±7.71</td>
</tr>
<tr>
<td>15</td>
<td>Energy (kcal)</td>
<td>11.25±0.19</td>
<td>211.3±4.02</td>
</tr>
<tr>
<td>16</td>
<td>Monounsaturated fat (g)</td>
<td>11.10±0.25</td>
<td>61.9±0.07</td>
</tr>
<tr>
<td>17</td>
<td>Magnesium (mg)</td>
<td>9.65±0.17</td>
<td>29.7±0.54</td>
</tr>
<tr>
<td>18</td>
<td>Niacin (mg)</td>
<td>8.61±0.18</td>
<td>3.38±0.07</td>
</tr>
<tr>
<td>19</td>
<td>Carbohydrates (g)</td>
<td>7.00±0.14</td>
<td>15.58±0.33</td>
</tr>
<tr>
<td>20</td>
<td>Linolenic acid (g)</td>
<td>5.69±0.16</td>
<td>0.09±0.003</td>
</tr>
<tr>
<td>21</td>
<td>Vitamin B6 (mg)</td>
<td>5.53±0.11</td>
<td>0.09±0.002</td>
</tr>
<tr>
<td>22</td>
<td>Thiamin (mg)</td>
<td>4.98±0.11</td>
<td>0.08±0.002</td>
</tr>
<tr>
<td>23</td>
<td>Folate (mcg)</td>
<td>3.48±0.07</td>
<td>15.35±0.3</td>
</tr>
<tr>
<td>24</td>
<td>Polyunsaturated fat (g)</td>
<td>3.28±0.09</td>
<td>0.49±0.01</td>
</tr>
<tr>
<td></td>
<td>Nutrient</td>
<td>Mean (mg)</td>
<td>SD (mg)</td>
</tr>
<tr>
<td>---</td>
<td>----------</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td>25</td>
<td>Linoleic acid (g)</td>
<td>2.92±0.08</td>
<td>0.37±0.01</td>
</tr>
<tr>
<td>26</td>
<td>Iron (mg)</td>
<td>1.67±0.04</td>
<td>0.21±0.01</td>
</tr>
<tr>
<td>27</td>
<td>Fibre (g)</td>
<td>1.03±0.07</td>
<td>0.18±0.01</td>
</tr>
<tr>
<td>28</td>
<td>Vitamin C (mg)</td>
<td>0.67±0.09</td>
<td>0.66±0.08</td>
</tr>
</tbody>
</table>

Nutrient intakes are those reported from food sources alone and do not account for those from supplements. Missing values for vitamin A (n = 5; 0.03%), sugar (n = 20; 0.1%), total fat (n = 5; 0.03%), cholesterol (n = 5; 0.03%), potassium (n = 5; 0.03%), sodium (n = 5; 0.03%), monounsaturated fat (n = 5; 0.03%), niacin (n = 25; 0.13%), linolenic acid (n = 48; 0.25%), vitamin B6 (n = 25; 0.13%), thiamine (n = 24; 0.13%), folate (n = 5; 0.03%), polyunsaturated fat (n = 5; 0.03%), linoleic acid (n = 48; 0.25%), iron (n = 5; 0.03%), fibre (n = 60; 0.31%), and vitamin C (n = 5; 0.03%).

The percentage contribution of nutrients and energy from milk and alternative sources to total intakes, as well as the per capita and per consumer mean 1-d intakes, are in Table 3-4. On any given day, 91.49 ± 0.51% of Canadian adults reported consuming milk and alternatives. Consumption was highest for milk (76.45 ± 0.75%) and cheese (54.74 ± 0.87%), intermediate for yoghurt (19.06 ± 0.72%) and frozen dairy (11.06 ± 0.58%), and lowest for other dairy (2.78 ± 0.22%) and soy (1.67 ± 0.21%). Milk and cheese ranked as the top milk and alternative sources contributing to total nutrient intakes. Milk was the primary contributor among all nutrients, contributing >20% to total intakes of sugar, potassium, magnesium, carbohydrates, thiamine, vitamin B6, folate, and vitamin C. Cheese was the top contributor for all remaining nutrients, as well as energy. Frozen dairy was the top contributor of fibre, but in negligible amounts (<1%).

Table 3-4. Percentage contribution of nutrients and energy from milk and alternative sources and mean intakes per capita and per consumer based on 1-d intakes from the 2015 Canadian Community Health Survey—Nutrition (n = 13,616).
Nutrient or energy | Top source | Contribution (%)±SE | Per capita mean 1-d intake±SE | Per consumer mean 1-d intake±SE
--- | --- | --- | --- | ---
Vitamin D (mcg) | Milk | 33±0.74 | 1.56±0.04 | 2.04±0.05
Calcium (mg) | Milk | 24.20±0.47 | 189.30±4.66 | 247.64±5.62
Vitamin B12 (mcg) | Milk | 18.06±0.46 | 0.74±0.02 | 0.96±0.02
Saturated fat (g) | Cheese | 16.53±0.46 | 3.75±0.12 | 6.86±0.2
Riboflavin (mg) | Milk | 14.88±0.32 | 0.29±0.01 | 0.37±0.01
Vitamin A (mcg) | Milk | 14.55±0.39 | 94.80±2.24 | 124.01±2.68
Phosphorus (mg) | Milk | 11.47±0.25 | 146.59±3.6 | 191.76±4.36
Sugar (g) | Milk | 9.59±0.22 | 8.33±0.2 | 10.9±0.25
Total fat (g) | Cheese | 8.88±0.27 | 6.21±0.21 | 11.34±0.33
Potassium (mg) | Milk | 8.46±0.2 | 227.4±5.61 | 297.48±6.78
Sodium (mg) | Cheese | 8.44±0.24 | 230.67±7.2 | 421.37±11.1
Cholesterol (mg) | Cheese | 7.62±0.25 | 20.76±0.66 | 37.93±1.06
Protein (g) | Cheese | 7.33±0.21 | 5.82±0.17 | 10.64±0.27
Zinc (mg) | Cheese | 7.12±0.21 | 0.75±0.02 | 1.37±0.04
Monounsaturated fat (g) | Cheese | 6.19±0.2 | 1.62±0.05 | 2.96±0.09
Magnesium (mg) | Milk | 5.63±0.14 | 17.35±0.43 | 22.69±0.52
Energy (kcal) | Cheese | 4.49±0.13 | 84.36±2.65 | 154.1±4.16
Niacin (mg) | Milk | 4.27±0.14 | 1.26±0.03 | 1.65±0.04
Carbohydrates (mg) | Milk | 3.70±0.09 | 10.95±0.33 | 14.32±0.4
Thiamin (mg) | Milk | 3.56±0.09 | 0.06±0.002 | 0.07±0.002
Vitamin B6 (mg) | Milk | 3.41±0.09 | 0.06±0.002 | 0.08±0.002
Linolenic acid (mg) | Cheese | 2.55±0.08 | 0.04±0.001 | 0.07±0.003
Folate (mcg) | Milk | 1.77±0.05 | 7.79±0.2 | 10.19±0.23
Polyunsaturated fat (g) | Cheese | 1.59±0.06 | 0.24±0.01 | 0.43±0.01
Linoleic acid (g) | Cheese | 1.45±0.06 | 0.18±0.01 | 0.33±0.01
Iron (mg) | Cheese | 0.58±0.02 | 0.07±0.002 | 0.13±0.003
Fibre (g) | Frozen dairy | 0.53±0.06 | 0.09±0.01 | 0.82±0.09
Vitamin C (mg) | Milk | 0.41±0.08 | 0.4±0.08 | 0.53±0.11

Nutrient intakes are those reported from food sources alone and do not account for those from supplements. Missing values for vitamin D (n = 12; 0.07%), calcium (n = 12; 0.07%), vitamin B12 (n = 1; 0.006%), riboflavin (n = 1; 0.006%), vitamin A (n = 1; 0.006%), phosphorus (n = 1; 0.006%), sugar (n = 12; 0.07%), potassium (n = 12; 0.07%), magnesium (n = 1; 0.006%), niacin (n = 1; 0.006%), carbohydrates (n = 1; 0.006%), thiamin (n = 12; 0.07%), vitamin B6 (n = 1; 0.006%), folate (n = 1; 0.006%), and vitamin C (n = 1; 0.006%) from milk. Missing values for total fat (n = 130; 1.13%), sodium (n = 3;
0.03%), cholesterol (n = 3; 0.03%), zinc (n = 3; 0.03%), energy (n = 848; 7.86%), linolenic acid (n = 3; 0.03%), polyunsaturated fat (n = 3; 0.03%), linoleic acid (n = 3; 0.03%), and iron (n = 3; 0.03%) from cheese.

4. Discussion

The present study characterizes the consumption of milk and alternatives among different age groups and demographic variables, as well as their contribution to total intakes of nutrients and energy. Milk and alternatives are staples within Canadian diets, providing many nutrients relative to their calories. Consequently, the de-emphasis of milk and alternatives in the current CFG may have negative consequences in terms of nutrient adequacy if Canadians fail to replace dairy with other nutrient-dense foods. Even so, the quantity and quality of nutrients from plant sources vary from those of milk and alternatives. It is therefore imperative that Canadians are made aware of the nutritional trade-offs regarding the replacement of milk and alternatives within habitual diets.

Canadian adults did not meet the recommended daily servings for milk and alternatives, regardless of the stratification method. Mean intakes of milk and alternatives among Canadian adults averaged 1.36 ± 0.03 servings/d. Based on data from the 2004 CCHS—Nutrition, the Evidence Review Cycle for Dietary Guidance (ERC) 2015 is a technical report commissioned by Health Canada to review the evidence underpinning dietary guidance [8]. Findings from the ERC 2015 revealed that more than half of Canadian adults did not meet the recommended number of servings for milk and alternatives outlined in the 2007 CFG and that daily servings of milk did not exceed two for any of the age–sex groups. This study also found that adults 51+ y consume fewer servings of milk and alternatives compared to those 19–50 y, despite the higher number of servings
recommended. Averaging 1.6 servings/d for all energy reporters and ages combined, Tugault-Lafleur and Black (2019) also reported intake of milk and alternatives as decreasing with age. With milk as the most commonly consumed dairy product with the highest average daily servings, the lower mean tabulated for adults is likely due to the association between decreasing beverage consumption and increasing age [5]. Low intakes of milk and alternatives have various health implications, particularly with regards to the maintenance of bone and muscle mass in the elderly population [22,23].

Health Canada considers fortified soy-based beverages part of milk and alternatives, while excluding dairy products that are particularly high in fat (i.e., butter and cream). Therefore, while a direct comparison can be made with other studies assessing the intake of milk and alternatives, comparing with those on dairy intake must be done with caution. Like the 2007 CFG, the 2015–2020 Dietary Guidelines for Americans (DGA) recommends fortified soy-based beverages as a component of their dairy food group [2]. There are some apparent differences in dairy consumption trends in the USA and Canada; for one, dairy consumption in the USA is higher than in Canada. The consumption is approximately 1.7 servings/d for adults 19–50 y, which decreases to 1.3 servings/d for those above 70 y of age [24]. Among individuals 19–50 y, consumption of milk and cheese is the same (0.8 servings/d); whereas cheese consumption decreases with age, milk intake increases to 0.9 servings/d in the 71+ y age group. Yoghurt consumption is lower than that of Canadians at 0.1 servings/d. Furthermore, like Canadians, approximately 99% of American adults do not meet the 2.5–3 servings/d recommendation for dairy outlined in the DGA.

Consumption of milk and alternatives varied among demographic variables. Caucasians consumed more daily servings of milk and alternatives compared to non-
Caucasians. The higher daily servings of milk and alternatives amongst Caucasians could be attributed to their proportion in the Canadian population, constituting >70% of the study sample. Additionally, other studies have found that African Americans and other ethnic minorities consume less milk and alternatives compared to Caucasians [25,26]. The high incidence of lactose intolerance and lactase nonpersistence, as well as varying cultural preferences among ethnic minorities, may play a role in the lower consumption of dairy among such groups [27,28]. Canadians with less than secondary education consumed fewer daily servings of milk and alternatives compared to other education levels. Furthermore, the consumption of milk and alternatives did not differ among household income levels apart from milk and cheese, the consumption of which was lower in the <CAD$50,000/y income group. Associations between the consumption of milk and alternatives and variables such as education and income are inconsistent [29,30]. Darmon and Drewnowski (2008) reported no difference in the consumption of milk and alternatives among individuals of low and high socioeconomic status (education and income being indices of socioeconomic status), with the exception of cheese, which was consumed in greater amounts among individuals of high socioeconomic status [31]. Moreover, Kirkpatrick and Tarasuk [32] found that lower-income households consume fewer servings of dairy compared to higher income households, despite allocating a greater proportion of their spending towards milk and alternatives.

Nutrients from milk and alternatives contributed >20% to total intakes for calcium, vitamin D, saturated fat, vitamin B12, vitamin A, phosphorus, and riboflavin, among which milk was the top contributor. The contribution of milk and alternatives to nutrient intakes among Canadian adults is similar to those observed in other countries. In the USA, dairy
contributed 47% to total calcium intakes, 42% to retinol, and 65% to vitamin D [33]. Among French adults, dairy consumption contributed significantly (>25%) to intakes of calcium, iodine, and riboflavin and moderately (between 10% and 25%) to intakes of phosphorus, zinc, retinol, and vitamin D [34]. In the Netherlands, the contribution of dairy to nutrient intakes was highest for calcium, vitamin B12, zinc, selenium, and folic acid and lowest for vitamin D, vitamin C, copper, and iron among adults [35]. Nevertheless, there is a high prevalence of nutrient inadequacy among the Canadian population. As evidenced from the ERC 2015, Canadian adults had inadequate intakes of calcium, magnesium, zinc, vitamin A, and vitamin C, most of which are abundantly present in milk and alternatives [8].

Approximately half of Canadian adults’ daily calcium intakes are derived from milk and alternatives. Evidence from the ERC 2015 confirms milk and alternatives as the most significant sources of calcium for Canadians [8]. However, the prevalence of calcium inadequacy in Canada ranged from 23% to 97% depending on age and sex, being highest among women >50 y and men >71. Calcium is an essential nutrient, particularly with regards to bone health. In the long term, deficiency caused by inadequate dietary intake or poor absorption can diminish bone mass and lead to osteoporosis [36]. Osteoporosis is one of the top nutrition-related chronic diseases in Canada, affecting 10% of the population above the age of 40, the prevalence of which is four times higher in women [8]. Postmenopausal women are particularly at risk of calcium deficiency due to decreased levels of oestrogen, which increases bone resorption [37]. Osteoporosis leads to increases in bone fracture risk, which is associated with higher overall morbidity and mortality [38]. Milk and alternatives were also prominent contributors to intakes of vitamin D.
(approximately 38%). Despite 75% to 96% of Canadians having inadequate intakes, blood measures did not point to widespread deficiency [8]. According to the IOM, vitamin D blood status is the best indicator of deficiency because it reflects vitamin D from all sources, including exposure to sunlight, foods, and supplements. Consequently, blood measures showed much lower levels of inadequacy and deficiency; 19% of the population 3 to 79 y of age were estimated as having inadequate intakes (blood concentrations of 25-hydroxyvitamin D less than 40 nmol/L), whereas 7% were estimated as deficient (blood concentrations less than 30 nmol/L). The mandatory fortification of fluid milk with vitamin D, implemented in the Food and Drugs Act of 1975, led to the elimination of rickets in children [39]. The ERC 2015 revealed that the majority of Canadians obtain vitamin D through fortified foods such as milk; however, the contribution of vitamin D from milk and alternative sources was found to decrease with age. Calcium and vitamin D work synergistically, so inadequate intakes can lead to reduced calcium absorption and loss of bone mass [40,41]. Since milk and alternatives are primary contributors of calcium and vitamin D, their lesser prominence within the current dietary guidelines may have further repercussions for the intakes of these two nutrients.

The contribution of milk and alternatives to magnesium intakes among Canadian adults was low (approximately 5%). In Canada, >10% of males and females >14 y had inadequate intakes of magnesium [8]. Magnesium is an essential mineral that functions as a cofactor in a number of enzymatic reactions [36]. Evidence from epidemiological studies points to an inverse association between magnesium intake and cardiovascular disease [42]. Although rare among healthy individuals, long-term magnesium deficiency is
associated with hypocalcaemia and hypokalaemia, characterized by low calcium and potassium levels, respectively, thus exacerbating deficiencies of these nutrients [43,44].

Milk and alternatives contributed approximately 15% to Canadians’ total zinc intakes. However, more than 10% of males >30 y and females 9–50 and >70 y had inadequate intakes of zinc [8]. Zinc is an essential trace mineral and antioxidant involved in cell proliferation, reproduction, and immune function [45]. Deficiency is most common in developing countries, imparting harmful effects on pregnancy, susceptibility to infection, and neurobehavioral development [46,47]. Zinc can be obtained from dietary sources other than milk and alternatives, including oysters, red meat, poultry, beans, and nuts, but is less bioavailable from plant-based foods due to the presence of anti-nutritional factors that decrease its absorption in the small intestine [48]. Therefore, milk and alternatives are important sources of zinc, which is provided in abundance and in a bioavailable form.

The provision of vitamin A from milk and alternatives approximated 26%. The fortification of milk and butter substitutes with vitamin A, mandatory under Canada’s Food and Drugs Act, aids in providing Canadians with sufficient amounts of the vitamin to prevent deficiency [49]. However, the prevalence of vitamin A inadequacy was >10% for the Canadian population >9 y and highest for elderly men >70 [8]. Although rare in high-income countries, severe vitamin A deficiency leads to xerophthalmia, a disease characterized by blindness, impaired growth, and increased morbidity and mortality [50,51]. Preformed vitamin A from animal sources, including fortified milk and eggs, is more readily bioavailable than provitamin A carotenoids from plant sources [52]. As a matter of both quantity and quality, current recommendations towards primarily plant-based diets may have implications for vitamin A adequacy.
In addition to micronutrients, milk and alternatives are sources of high-quality protein. Animal sources, including dairy, are deemed of high quality due to their provision of all nine essential amino acids in forms that are readily available to the body [53,54]. In contrast, plant sources of protein are typically lacking in one or more essential amino acids and are therefore considered of lesser quality. The digestible indispensable amino acid score (DIAAS) is a measure of protein quality that uses the ileal digestibility of amino acids to determine their bioavailability [55]. Animal proteins are known to have a higher standard ileal digestibility than plant proteins. With a DIAAS ≥100, dairy proteins are considered excellent/high-quality sources compared to most other foods. Intake of high-quality protein supports muscle protein synthesis and the maintenance of muscle mass [56]. These attributes are most beneficial for the elderly population, a demographic at risk of sarcopenia, a disease characterized by progressive loss of muscle mass that leads to impaired physical function, frailty, and mortality [57]. Inadequate protein intake is one of the risk factors for sarcopenia. Thus, consumption of high-quality protein, particularly from dairy, is an important nutritional intervention strategy to promote muscle health [58].

Among Canadian adults, one-tenth of total energy intake was attributed to milk and alternatives. Relative to their calories, milk and alternatives are nutrient-dense food sources, providing a range of vitamins, minerals, and high-quality protein in compact form [59]. In contrast, energy-dense foods are those that contain a high amount of calories relative to their nutritional content. One study from the US found that the top dietary sources of calories were also some of the top contributors of nutrients, particularly among those of concern [60]. For example, seven of the top ten calorie sources, including, beef, cheese, milk, poultry, ‘cakes, cookies, quick bread, pastry, and pie’, ‘yeast, breads, and rolls’,
and ‘crackers, popcorn, pretzels, chips’, provided notable amounts of calcium, vitamin D, fibre, potassium, vitamin B12, iron, and folate. Therefore, the trade-offs between energy and nutrients as provided by various food sources are important considerations towards their inclusion in a healthful diet.

Milk and alternatives provide a range of essential nutrients, but are also sources of nutrients to limit. Saturated fat was the third most abundant nutrient contributed by milk and alternatives (approximately one-third of total intakes), to which cheese was the largest contributor. Kirkpatrick et al. (2019) reported milk as the second highest contributor of saturated fat in Canadian self-selected diets, behind cheese, although they accounted for the consumption of respondents ≥19 y of age [19]. Excessive intakes of saturated fat are associated with nutrition-related chronic diseases including cardiovascular disease and type 2 diabetes [61,62]. Nonetheless, nutrition research is shifting focus away from single nutrients and towards whole foods [63]. Despite the high concentration of saturated fat inherent to dairy, epidemiological studies have not shown negative associations regarding the consumption of regular-fat dairy products and cardiovascular-related clinical outcomes [64,65]. In addition to saturated fat, the current dietary recommendations outlined in the new CFG encourage limiting the intake of added sugars. Excessive sugar intakes are associated with a range of noncommunicable diseases, including obesity, cardiovascular disease, and dental caries [66]. As opposed to naturally occurring sugars such as lactose in unsweetened milk, dietary guidelines pinpoint added and free sugars as those to limit because they tend to be present in foods with few nutrients [67,68]. Although the CNF does not distinguish between naturally occurring and added sugars, the CNF/CFG classification set thresholds to detect the presence of added sugars in flavoured milks and yoghurts. The
upper thresholds for flavoured milks and yoghurts were set at $\leq 22$ g and $\leq 28$ g per reference amount (quantity typically eaten in one sitting), respectively [13]. Flavoured dairy products with sugar contents beyond such thresholds were not considered within milk and alternatives according to the 2007 CFG if they were also above the thresholds for total fat and/or sodium. This distinction between total, added, and free sugars warrants attention when assessing the contribution of milk and alternatives to sugar intake by Canadians.

There are several strengths to our study, including the use of the 2015 CCHS—Nutrition as a nationally representative survey. Furthermore, there were few missing values for nutrients due to the extensive nature of the CNF, which is 100% complete for macronutrients and energy and >95% complete for vitamins and minerals. However, there are some limitations to our study. Firstly, 1-d food and nutrient intakes collected from 24-h dietary recalls are not necessarily representative of usual dietary intakes. Distributions of usual intake would allow for estimates of the prevalence of Canadians below the recommendations for milk and alternatives outlined in the 2007 CFG [9]. Secondly, although energy misreporting was detected using previously validated methods, no adjustments were employed to correct for under- and over-reporting. However, as stated by Garriguet (2018), energy misreporting is a minimal source of bias in the 2015 CCHS—Nutrition. Thirdly, nutrient profiles from the CNF database are not complete for all foods reported in the 2015 CCHS—Nutrition [9]. As a result, several essential nutrients, including chromium, fluoride, iodine, and molybdenum, are not accounted for in this study.
5. Conclusions

Milk and alternatives are commonly consumed within the Canadian diet and provide a range of essential nutrients. However, Canadians are not meeting the recommendations for milk and alternatives outlined in the 2007 CFG. Intakes of milk and alternatives were found to be lowest among Canadians 51+ y and females, demographics that may benefit the most from such rich sources of calcium and high-quality protein. With the new food guide in place, the de-emphasis of animal-based foods such as dairy may compromise nutrient adequacy if not carefully replaced by nutrient-dense, plant-based protein sources. Therefore, consumers and policy-makers must take caution to ensure nutrient requirements are met, especially for those of concern, in the face of new recommendations to moderate the consumption of animal-based food sources. This research provides a baseline with which to compare future consumption of milk and alternatives and the top dietary sources contributing to the provision of nutrients and energy with the new food guide in place.

Author Contributions

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**Conflicts of Interest**

The authors declare no conflict of interest.
## Appendix A

### Table A1. Food classifications and codes used to classify milk and alternatives.

<table>
<thead>
<tr>
<th>Food source</th>
<th>Food classification</th>
<th>Food codes and descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk and alternatives</td>
<td>CNF/CFG</td>
<td>3101, 3102, 3103, 3104: fluid milk and fortified soy-based beverages; 3201, 3202, 3203, 3204: other milk and alternatives (cheese, yoghurt)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14A: cottage cheese; 14B: cheese, less than 10% B.F.; 14C: cheese, 10% B.F. to 25% B.F.; 14D: cheese, more than 25% B.F.</td>
</tr>
<tr>
<td>Cheese</td>
<td>BNS</td>
<td>10A: milk, whole; 10B: milk, 2%; 10C: milk, 1%; 10D: milk, skim; 10E: milk, evaporated, whole; 10F: milk, evaporated, 2%; 10G: milk, evaporated, skim; 10H: milk, condensed; 10I: other types of milk (whey, buttermilk); 10K: goat and sheep milk</td>
</tr>
<tr>
<td>Milk</td>
<td>BNS</td>
<td>15A: yoghurts, less than 2% B.F.; 15B: yoghurts, more than 2.1% B.F.</td>
</tr>
<tr>
<td>Yoghurt</td>
<td>BNS</td>
<td>09A: ice cream; 09B: ice milk; 09C: frozen yoghurt</td>
</tr>
<tr>
<td>Frozen dairy</td>
<td>BNS</td>
<td>08B: cakes, commercial (frozen cake); 18A: regular tub margarine; 231D: milk-based beverages (milk shakes, malted milk, hot cocoa, instant breakfast, etc.); 43C: jello, dessert toppings and pudding mixes, commercial; 46D: other beverages (malted milk, chocolate beverage); 50A: soups with vegetables; 50B soups without vegetables; 50D: sauces (white, bearnaise, soya, tartar, ketchup, etc.)</td>
</tr>
<tr>
<td>Other dairy</td>
<td>BNS</td>
<td>5241: plant-based beverage, soy, original and vanilla, unenriched; 5429: plant-based beverage, soy, unenriched, chocolate; 6329: plant-based beverage, soy, enriched, chocolate; 6330: plant-based beverage, soy, enriched, all flavours, unsweetened; 6332: plant-based beverage, soy, enriched, all flavours, fat free; 6666: plant-based beverage, soy, enriched, with Omega-3 fatty acids added; 6720: plant-based beverage, soy, enriched, all flavours, reduced fat; 404054: cheese, soy, slices; 404064: soy-based beverage, powder; 504723: pudding, all flavours, prepared with soy beverage</td>
</tr>
</tbody>
</table>

**Abbreviations:** CNF/CFG, Canadian Nutrient File/Canada's Food Guide classification; B.F., butter fat; BNS, Bureau of Nutritional Sciences; NSS, Nutrition Survey System.
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Chapter 5 – Discussion

The CCHS – Nutrition is an important tool that can be used to assess the health status of Canadians. The 2015 CCHS – Nutrition is the second of two nutrition-focused surveys, the first having been conducted in 2004. Over time, the surveys has been used to analyze the consumption of specific foods (i.e., pulses and soya protein) [26,62] and nutrients [63,64], determine the incidence of energy misreporting inherent to 24-h dietary recalls [65], assess food insecurity [66], examine relationships between dietary patterns and nutrition-related chronic diseases [67], and compare consumption trends in 2004 and 2015 [68].

This work delves into the role of milk and alternatives in Canadian habitual diets, highlighting their importance as a compact source of nutrients. Milk and alternatives are nutrient-dense and provide a range of high-quality protein as well as vitamins and minerals, many of which are deemed of concern in Canada. Data from the 2004 CCHS – Nutrition presented in the 2015 ERC revealed inadequate intakes of calcium, magnesium, zinc, vitamin A, and vitamin C in the Canadian population [3]. This project shows milk and alternatives as contributing significantly to intakes of calcium, zinc, vitamin A, and to a lesser extent, magnesium. Among milk and alternative sources, fluid milk was shown to contribute the most to 6 of the 7 nutrients contributing >20% to total intakes; cheese was the top contributor of saturated fat, a nutrient that many dietary guidelines suggest limiting [2,38,67].

The status of nutrient inadequacy in Canada is relevant in several regards. First and foremost, understanding which nutrients are most commonly lacking in the diets of
Canadians is important for consumers and policy makers in making informed decisions as to promote the consumption of foods and supplements working to curve nutrient deficiencies. Food fortification is one common measure to improve the nutrient status of Canadians, as with the fortification of milk with vitamin A and vitamin D under the Food and Drugs Act [31]. This information also plays a role in informing the core nutrients forming the basis of the Canadian Nutrition Facts tables, found on most pre-packaged foods in consistent format under the Food and Drug Regulations [4]. The Canadian Nutrition Facts tables provide detailed information as to the energy value and nutrient content of foods, which are intended to promote the health of Canadians by encouraging them to make informed dietary decisions. With the exception of sodium, the rationale for the mandatory listing of 13 core nutrients in the Canadian Nutrition Facts tables stem from public health concern linked to inadequate intakes. These nutrients are: fat, saturated fat, \textit{trans} fat, cholesterol, sodium, carbohydrate, fibre, sugars, protein, vitamin A, vitamin C, calcium, and iron. Nutrients are considered of public health concern if a large proportion of the population is below the EAR, incidence of which is tied to imperative consequences on health.

Given the recent changes to CFG, which promotes largely plant-based diets, the lesser prominence of milk and alternatives may pose further implications for nutrient adequacy among the Canadian population. As this work shows, milk and alternatives are staples of Canadian diets and contribute significantly to intakes of various nutrients, particularly among those of concern. In turn, consumers must take caution in substituting their consumption of milk and alternatives and other de-emphasized animal-source foods with nutrient-dense plant-based foods. Therefore, this work provides the grounds for
consumers and policy makers in which to make informed decisions regarding dietary intake and promoting healthy diets through foods that are both nutrient-dense and prominent within Canadian habitual diets, respectively.

This analysis also provides the basis for comparison with future dietary consumption among Canadians in light of the new CFG. It will become pressingly important to devise tools with which to assess Canadians’ compliance with dietary guidance, given the removal of food groups and Food Guide Servings as metrics of the 2007 CFG. These assessment tools will prove important for examining the effectiveness of the new dietary guidance, as well as the influence of the new CFG on the status of Canadians’ nutrient intakes and adequacy.
Chapter 6 – Conclusion

This work provides insight into the role of milk and alternatives in Canadian habitual diets, including their consumption as per the 2007 CFG and contribution to intakes of nutrients and energy. As nutrient-dense staples of Canadian diets, milk and alternatives contribute significantly to intakes of calcium, vitamin D, saturated fat, vitamin B12, vitamin A, phosphorus, and riboflavin, several of which are deemed of public health concern by Health Canada. In turn, the lesser prominence of milk and alternatives in the new CFG may pose further implications for nutrient adequacy if not replaced by nutrient-dense plant-based foods. This analysis provides the basis for which to compare future food consumption, compliance with the new food guide, and the status of Canadians’ nutrient intakes and adequacy.
Chapter 7 – References


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