Design, Implementation, and Scholarship of Knowledge Mobilization

Interventions Related to Dairy Products and Alternatives as Foods for Health in Grade 7 Youth

By

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ABSTRACT

Design, Implementation, and Scholarship of Knowledge Mobilization Interventions Related to Dairy Products and Alternatives as Foods for Health to Grade 7 Youth

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Dairy products are implicated as part of a healthy diet and are a convenient source of nutrients necessary in the diets of pre-adolescents and adolescents. Despite the known health benefits of dairy products, Canadian national data suggest that dairy products are grossly under-consumed by children and adolescents, as 61% of boys and 83% of girls aged 10 to 16 do not meet the minimum recommended three servings of dairy products per day. It is therefore of interest to investigate how we can effectively convey health research regarding dairy products and alternatives as foods for healthy development to pre-adolescents and adolescents.

Previous research has yielded conflicting results regarding why adolescents fail to meet dairy intake requirements and does not present clear techniques that are most effective in creating dietary behaviour change in adolescents. These gaps can be appropriately investigated using the KTA cycle framework to provide a foundation to systematically investigate how to translate research knowledge into components necessary in delivering a successful intervention.

A cluster randomized controlled trial was informed by the KTA cycle framework and developed based on the results from the first two studies of this thesis. Adolescents were randomized by school, into intervention or control. Intervention schools received the WhyDairy intervention with a website component for six to eight weeks and were further randomized to
receive follow-up contact or no contact, while control schools received a DFO education program which spanned four weeks. All groups significantly increased their knowledge post-intervention. While there was moderate engagement with the website during the intervention period, there was poor engagement during the follow-up period. The email campaign was successful in reaching parents, but did not result in high engagement or changes in student outcomes.

Overall, this thesis demonstrates how KTT theory, including consultation with the target audience, can be effectively used in nutrition intervention research. From these results, new knowledge gaps and questions have been identified such as places where more contact and work with the adolescents could have further improved the intervention development and potentially resulted in the desired change in dairy intake.
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thesis and research grew stronger because of each of you. Bronwynne, thank you for bringing me into a new world and helping me connect with agriculture, food, and KTT in industry. I am thankful to have you on my examination committee and to have someone I’m happy to call a “work mom”. And thank you also to Dr. Maureen Dobbins for agreeing to be a part of my examination committee. Your edits to my thesis and questions through my defence brought a new view to my work that I had only touched upon before. I know my work is stronger and more well-rounded thanks to your input.

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mate, study partner, friend, and bride/bridesmaid a girl could ask for and I am so appreciative of our relationship.

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<td>ANCOVA</td>
<td>analysis of covariance</td>
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<tr>
<td>ANOVA</td>
<td>analysis of variance</td>
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<tr>
<td>Avg</td>
<td>average</td>
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<tr>
<td>BCT</td>
<td>behaviour change technique</td>
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<td>BMC</td>
<td>bone mineral content</td>
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<tr>
<td>BMD</td>
<td>bone mineral density</td>
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<tr>
<td>BMI</td>
<td>body mass index</td>
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<tr>
<td>Ca</td>
<td>calcium</td>
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<td>CCHS</td>
<td>Canadian Community Health Survey</td>
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<tr>
<td>CCT</td>
<td>clinical controlled trial</td>
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<tr>
<td>CON</td>
<td>control</td>
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<tr>
<td>CVD</td>
<td>cardiovascular disease</td>
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<tr>
<td>DFO</td>
<td>Dairy Farmers of Ontario</td>
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<tr>
<td>DRIs</td>
<td>dietary reference intakes</td>
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<tr>
<td>ERS</td>
<td>Economic Research Service</td>
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<tr>
<td>ESMP</td>
<td>elementary school milk program</td>
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<tr>
<td>FFQ</td>
<td>food frequency questionnaire</td>
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<tr>
<td>FV</td>
<td>fruit and/or vegetables</td>
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<tr>
<td>ILGF-1</td>
<td>insulin-like growth factor 1</td>
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<tr>
<td>INT</td>
<td>intervention</td>
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<td>INT+FU</td>
<td>intervention with follow-up</td>
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<tr>
<td>KTA</td>
<td>knowledge to action</td>
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<td>KT</td>
<td>knowledge translation</td>
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<td>KTT</td>
<td>knowledge translation and transfer</td>
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<td>NFT</td>
<td>nutrition facts table</td>
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<td>NHANES</td>
<td>National Health and Nutrition Examination Survey</td>
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<tr>
<td>PBC</td>
<td>perceived behavioural control</td>
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<tr>
<td>PBM</td>
<td>peak bone mass</td>
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<tr>
<td>PRISMA</td>
<td>Preferred reporting items for systematic reviews and meta-analyses</td>
</tr>
<tr>
<td>RCT</td>
<td>randomized controlled trial</td>
</tr>
<tr>
<td>SEM</td>
<td>standard error of mean</td>
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<tr>
<td>S.M.A.R.T.</td>
<td>Specific, Measurable, Achievable, Realistic, Time-sensitive</td>
</tr>
<tr>
<td>SSB</td>
<td>sugar-sweetened beverages</td>
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<tr>
<td>T2D</td>
<td>type 2 diabetes</td>
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<tr>
<td>TPB</td>
<td>theory of planned behaviour</td>
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<tr>
<td>UCT</td>
<td>uncontrolled clinical trial</td>
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<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
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<td>YAQ</td>
<td>Youth Adolescent Questionnaire</td>
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CHAPTER 1: LITERATURE REVIEW

1.0 INTRODUCTION

Dairy products are implicated as part of a healthy diet and are a convenient source of vitamins, minerals, and protein necessary in the diets of pre-adolescents and adolescents (Moore, Bradlee, Gao, & Singer, 2008). Across various stages of life, they have been linked to numerous health benefits such as improving bone and tooth health (Moore et al., 2008), reducing the risk of developing obesity (Lu, Xun, Wan, He, & Cai, 2016), and providing hydration and muscle repair after exercise (Gilson et al., 2010). Despite the known health benefits of dairy products, Canadian national survey data suggest that dairy products are under-consumed by children and adolescents, as 61% of boys and 83% of girls aged 10 to 16 do not meet the minimum recommended three servings of dairy products per day (Garriguet, 2007). This leaves children and adolescents with the potential for nutrient deficits as they fail to consume a nutrient dense food, instead often replacing these foods with those of less nutritious quality (Danyliw, Vatanparast, Nikpartow, & Whiting, 2011; Hanson, Neumark-Sztainer, Eisenberg, Story, & Wall, 2005). This is also a concern for younger populations, such as children and adolescents, who are developing eating habits that will carry into adulthood and whose body composition and weight during childhood are associated with adult adiposity and body mass (Chen, Pan, Malik, & Hu, 2012). Therefore, it is of interest to investigate the reasons for these inadequacies and to address them with interventions that increase the knowledge and consumption of dairy products among pre-adolescents and adolescents.

In order to address these inadequacies and develop effective interventions, researchers must carefully plan feasible interventions with proper measures of success. As well, researchers
should be mindful of existing knowledge regarding the topic, their target audience, the changes they intend to make, the barriers and facilitators that influence the behaviour, and the elements that contribute to an effective intervention. However, there is little information to guide researchers in developing effective interventions with sustained knowledge use that can make an impact on health outcomes. Knowledge translation and transfer (KTT) frameworks, such as the Knowledge to Action (KTA) cycle framework, can help some researchers bridge the gap between research and implementation of knowledge with the intention of improving health outcomes. Together, KTT covers the bidirectional process from both sides, with both researchers and end users working together to make an impact and improve outcomes.

This thesis will begin by reviewing dairy products and alternatives, the current guidelines of dairy intake, along with the characterization and components of dairy products. This will be followed by the importance of dairy products in the adolescent diet as well as positive health impacts of dairy consumption and potential reasons for inadequate intake of dairy products. Finally, this chapter will introduce KTT as a way to develop health interventions to effectively address the inadequate intake of dairy products.

2.0 GENERAL DAIRY PRODUCT AND ALTERNATIVE GUIDELINES, SERVING SIZES, AND NUTRIENTS

2.1 Dairy Products and Alternatives Guidelines

Dairy products and alternatives fit into one of the four food groups, known as milk and alternatives, based on Canada’s Food Guide ("What is a Food Guide Serving of Milk and Alternatives," 2008). Canada’s Food Guide is published by Health Canada with the goal of helping Canadians to select the types and amounts of foods that will support nutritional health. It was developed based on scientific evidence regarding dietary reference intakes (DRIs) and
describes a dietary pattern that will meet the nutritional requirements of most healthy Canadians for growth, health, and reducing chronic disease risk. For dairy, the focus is to maintain good bone health and reduce the risk of osteoporosis. It is currently recommended by Canada’s Food Guide that individuals aged 9 to 18 years consume three to four servings of dairy per day (Garriguet, 2007; "What is a Food Guide Serving of Milk and Alternatives," 2008). Compared to all other age groups, this is the highest recommended intake of milk and alternatives for Canadians across their lifespan. Comparatively, children aged 4 to 8 years old and individuals over the age of 19 are recommended to consume two servings of milk and alternatives a day ("What is a Food Guide Serving of Milk and Alternatives," 2008). According to the guide, one serving from this food group amounts to 250 millilitres (one cup) of milk or fortified soy beverage, 50 grams of cheese, or 175 grams (3/4 cup) of yogurt. It is important to note that only soy-based foods, fortified to meet the nutritional equivalencies of dairy, meet Health Canada’s standard for a dairy alternative for those who do not drink milk.

There are many foods and beverages that are included in the dairy product category. Dairy products generally always include all milks (including from other mammals, lactose-free, and lactose-reduced), fortified soy beverages, yogurts, frozen yogurts, dairy desserts, cheeses, and kefir ("What is a Food Guide Serving of Milk and Alternatives," 2008). Most guidelines additionally emphasize consuming fat-free or low-fat dairy products (Garriguet, 2007). These foods are categorized as counting for a serving of milk and alternatives due to their calcium, protein, and vitamin D content. For this reason, cream, sour cream, and cream cheese do not count as a dairy product (Stewart & Carlson, 2013).
2.2 Nutrients in Dairy Products

Dairy products provide a considerable amount of children’s and adolescents’ daily intake of vitamins, minerals, and protein (Table 1.1). Dairy products, particularly milk, are recommended in part because they are a primary source of calcium, as well as vitamin D, which is essential to efficiently absorb calcium in the intestines (Moore et al., 2008). One serving of milk alone accounts for 22% of calcium and 21% of vitamin D daily intake (Garriguet, 2008). One glass of 1% milk provides a significant contribution to male and female adolescents’ daily intake of magnesium (11%), phosphorus (19%), and protein, primarily in the form of whey protein (24%) ("Important nutrients in childhood and adolescence," 2016; Moore et al., 2008). Protein intake is significantly more favourable when individuals consume adequate calcium, adding to the complex benefits of dairy products (Moore et al., 2008). Moreover, milk has also shown to contribute to adolescent’s daily intake of: vitamin B12 (59%), vitamin A (24%), riboflavin (50%), potassium (8%), and zinc (13%) (Garriguet, 2008). Due to the substantial amounts of vitamins, minerals, and protein provided by dairy products, it is highly recommended that they be consumed during the intense growth period of adolescence. However, as subsequently discussed, dairy is under-consumed leading to the potential deficits in nutrient intake despite these recommendations.
Table 1.1. List of major nutrients in one cup (250 mL) of 1% white cow’s milk and the contributions of these nutrients to adolescent dietary needs

<table>
<thead>
<tr>
<th>Nutrients in 1% Milk</th>
<th>Amount</th>
<th>Requirements*</th>
<th>% Nutrients from Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Calories</td>
<td>110 cal</td>
<td>1500-2600 cal</td>
<td>4-7%</td>
</tr>
<tr>
<td>Total Fat</td>
<td>2.37 g</td>
<td>30-40% of total cal</td>
<td>21cal or 1% of total cal</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>1.55 g</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Monounsaturated Fat</td>
<td>0.68 g</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Polyunsaturated Fat</td>
<td>0.09 g</td>
<td>0.6-1.2%</td>
<td>-</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>12 mg</td>
<td>LOW</td>
<td>-</td>
</tr>
<tr>
<td>Sodium</td>
<td>107 mg</td>
<td>1500 mg</td>
<td>7%</td>
</tr>
<tr>
<td>Carbohydrates (lactose sugar)</td>
<td>13 g</td>
<td>130 g</td>
<td>10%</td>
</tr>
<tr>
<td>Protein</td>
<td>8 g</td>
<td>34 g</td>
<td>24%</td>
</tr>
<tr>
<td>Vitamins</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A**</td>
<td>142 mcg</td>
<td>600 mcg</td>
<td>24%</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>1.07 mcg</td>
<td>1.8 mcg</td>
<td>59%</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>0.09 mcg</td>
<td>1.0 mg</td>
<td>9%</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.45 mg</td>
<td>0.9 mg</td>
<td>50%</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>0.88 mg</td>
<td>4 mg</td>
<td>22%</td>
</tr>
<tr>
<td>Vitamin D**</td>
<td>127 IU</td>
<td>600 IU</td>
<td>21%</td>
</tr>
<tr>
<td>Minerals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>290 mg</td>
<td>1300 mg</td>
<td>22%</td>
</tr>
<tr>
<td>Magnesium</td>
<td>27 mg</td>
<td>240 mg</td>
<td>11%</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>232 mg</td>
<td>1250 mg</td>
<td>19%</td>
</tr>
<tr>
<td>Potassium</td>
<td>366 mg</td>
<td>4500 mg</td>
<td>8%</td>
</tr>
<tr>
<td>Zinc</td>
<td>1.02 mg</td>
<td>8 mg</td>
<td>13%</td>
</tr>
<tr>
<td>Selenium</td>
<td>8.1 mcg</td>
<td>40 mg</td>
<td>20%</td>
</tr>
</tbody>
</table>

*daily requirements for adolescents aged 9-13 years
**fortified or added to some degree
Units: g=grams, mg=milligrams, mcg=micrograms, IU=international units, cal=calories
\*\* represents no daily requirement specified

3.0 CURRENT DAIRY PRODUCT AND ALTERNATIVE INTAKE

3.1 Global Trends in Dairy Consumption

Considering all food groups, adolescents fall short of meeting their recommended fruit and vegetable intake and dairy intake, but are close to or adequately meet their grain and meat intake. However, dairy is, by proportion of overall diet, the lowest consumed food group (Statistics Canada, 2004). Globally, and worldwide, similar trends are seen across dairy products (Table 1.2) and the decrease in dairy consumption is not being off-set by increases in dairy
alternative consumption (CDIC, 2015b). Canadian dairy production nearly doubled in volume in 2016 compared to 1920 (CDIC, 2017); however, Canada’s population has more than quadrupled over the same time period. Therefore, production is not matching the growth in population.

Table 1.2. Global milk consumption per capita (in litres)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>78.2</td>
<td>78.0</td>
<td>76.6</td>
<td>75.4</td>
<td>73.3</td>
<td>70.6</td>
</tr>
<tr>
<td>United States</td>
<td>82.7</td>
<td>80.7</td>
<td>78.5</td>
<td>76.1</td>
<td>73.5</td>
<td>71.9</td>
</tr>
<tr>
<td>Europe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU (28)</td>
<td>67.0</td>
<td>66.8</td>
<td>65.2</td>
<td>65.4</td>
<td>64.5</td>
<td>63.2</td>
</tr>
<tr>
<td>Ireland</td>
<td>..</td>
<td>..</td>
<td>125.1</td>
<td>122.2</td>
<td>122.2</td>
<td>126.6</td>
</tr>
<tr>
<td>Finland</td>
<td>136.7</td>
<td>135.3</td>
<td>136.6</td>
<td>135.6</td>
<td>132.7</td>
<td>129.3</td>
</tr>
<tr>
<td>UK</td>
<td>111.5</td>
<td>110.8</td>
<td>109.7</td>
<td>109.8</td>
<td>108.4</td>
<td>105.6</td>
</tr>
<tr>
<td>Sweden</td>
<td>100.4</td>
<td>94.7</td>
<td>94.8</td>
<td>94.7</td>
<td>88.1</td>
<td>87.6</td>
</tr>
<tr>
<td>France</td>
<td>57.4</td>
<td>57.6</td>
<td>55.9</td>
<td>56.1</td>
<td>54.7</td>
<td>53.1</td>
</tr>
<tr>
<td>Italy</td>
<td>58.6</td>
<td>59.0</td>
<td>57.5</td>
<td>55.2</td>
<td>51.8</td>
<td>49.3</td>
</tr>
<tr>
<td>Germany</td>
<td>5.2</td>
<td>56.5</td>
<td>55.2</td>
<td>55.8</td>
<td>58.0</td>
<td>55.9</td>
</tr>
<tr>
<td>Netherlands</td>
<td>51.6</td>
<td>50.6</td>
<td>50.6</td>
<td>49.1</td>
<td>47.0</td>
<td>47.0</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>109.9</td>
<td>111.9</td>
<td>113.3</td>
<td>112.5</td>
<td>114.0</td>
<td>110.3</td>
</tr>
<tr>
<td>Brazil</td>
<td>59.6</td>
<td>59.9</td>
<td>60.9</td>
<td>47.7</td>
<td>47.4</td>
<td>46.1</td>
</tr>
<tr>
<td>China</td>
<td>11.5</td>
<td>12.8</td>
<td>16.4</td>
<td>17.9</td>
<td>18.4</td>
<td>19.3</td>
</tr>
</tbody>
</table>

.. = Data not available
Source: International Dairy Federation and Statistics Canada, 2015

3.2 Dairy Product Consumption in Adolescents

The same trends of low dairy consumption are being seen in Canada and the United States. In Canada, the current consumption of milk, cheese, and yogurt per capita (per person/per day) is 170 ml, 24 g, and 1 tbsp, respectively, which together equivocates to about 1.2 servings of dairy per day (Statistics Canada, 2005). More recent information based on various food items according to availability and disappearance data from the Canadian Dairy Information Centre (2015a) from Agriculture and Agri-food Canada suggest that per capita consumption of dairy products equals about 1.7 servings a day. However, these numbers are based on sales and are an overestimation since they do not include losses (CDIC, 2015a). Per capita consumption data
from Statistics Canada reveal a 21.5% decrease in milk consumption over a twenty-year period from 1996 to 2015 (AAF, 2016). Overall, these data represent a decrease in total population dairy consumption from previous years.

The most recent publicly available data regarding Canadians’ eating habits comes from the national 2004 Canadian Community Health Survey (CCHS) – Nutrition. This was the first national survey since the early 1970s that provided current information regarding dairy consumption in Canadian adolescents. The CCHS-Nutrition collected one-time 24-hour dietary recall data from 35,107 people (Danyliw et al., 2011). From these data, it was found that 68% of boys and 64% of girls aged 9 to 13 years had consumed liquid milk the previous day (Garriguet, 2008). However, overall total milk and dairy consumption among children and adolescents had significantly declined compared to previous years, and as individuals got older and transitioned fully into adolescence, there was an even further decrease. Specifically, adolescent boys’ daily consumption had stabilized during adolescence at about one and a third servings of milk per day, while girls’ consumption fell to less than one serving per day. Results of this study indicated that the decline in milk consumption in adolescents was attributable to fewer milk consumers, rather than to less milk being consumed by milk consumers (Garriguet, 2008). That is, those who consumed milk daily were close to attaining their daily target of dairy intake; however, the number of total non-milk consumers had increased. This trend is seen all the way into adulthood as the proportion of adults who drank milk decreased with age, but the amount of milk consumed by those who drink it increased with age (Garriguet, 2008).

Data from the CCHS-Nutrition also revealed that a considerable number of adolescents were not meeting the minimum requirements for dairy products (Figure 1.1). It was found that adolescents were among the lowest consumers of dairy products and alternatives apart from
older adults. Specifically, in children and adolescents aged 10 to 16 years old, 61% of boys and 83% of girls did not meet the recommended minimum of three servings of dairy and/or alternatives per day (Garriguet, 2007). These findings were also confirmed by another group of researchers upon collection of data using a web-based “Food Behaviour Questionnaire”, which included a 24-hour recall and food frequency questionnaire (FFQ) for males and females in grades six, seven, and eight in Ontario (Hanning et al., 2007). The results revealed that females were significantly less likely to meet the minimum daily recommended servings of milk products compared to boys (Hanning et al., 2007). Consequently, females were more likely to consume less than adequate intakes of vitamin D and calcium. This work is also supported by research from the United States. Kranz, Lin, and Wagstaff (2007) collected 24-hour recall interview data from 7,716 American children and adolescents aged 2 to 18 years from the National Health and Nutrition Examination Survey (NHANES) 1999-2002. From these data, it was found that children aged 9 to 18 years old consumed significantly less dairy than the recommended three servings per day, and had significantly lower calcium intake than the daily recommended amount (Kranz et al., 2007). Results from this work demonstrate the consequences of inadequate dairy consumption in relation to nutrient intake, specifically calcium and vitamin D.
Figure 1.1. Percentage below recommended minimum number of servings of milk products, by age, group, and sex. Modified from Garriguet (2007)

1. Significantly different from estimate for previous age group of same sex (p<0.05)
2. Significantly different from estimate for males in same age group (p<0.05)

Notes: Based on usual consumption. Age groups are based on Canada’s Food Guide to Health Eating for People Four Years Old and Over.
Data source: 2004 CCHS – Nutrition

In addition to overall dairy product consumption, studies have also investigated consumption patterns of milk among adolescents. In 2013, the Economic Research Service (ERS) researchers published similar data of American fluid milk consumption, using survey data collected by the United States Department of Agriculture (USDA) between 1977 and 2008. The study focused on data of individuals’ fluid milk consumption during a single 24-hour period. Between 1977-78 and 2007-08, it was found that the percentage of adolescents and adults that did not drink milk on a given day rose from 41% to 54%, and the percentage that drank milk three or more times per day dropped from 13% to 4% (Stewart & Carlson, 2013). The same study also found generational trends and changes in milk consumption among Americans. The results from the study indicated that the decreases in milk consumption are a result of the differences in consumption habits between newer and older generations. Holding all other factors constant, it was found that Americans born in the early 1980s consumed milk on 0.3 fewer
occasions per day than those born in the early 1960s (Stewart & Carlson, 2013). Additionally, Americans aged 13 years and over drank 0.8 cups of milk per day in 1977-78, while individuals this age drank only 0.6 cups of milk per day in 2007-08, representing a 25% decrease. The study also demonstrated significant changes and shifts in how often Americans consume milk at mealtimes. It was found that in 1977-78, 39% of adolescents and adults drank milk during their morning meal; 24% with a midday meal; and 21% with a nighttime meal. Comparatively, in 2007-08, these percentages dropped to 28%, 8%, and 9%, respectively. These results demonstrate the rapid decline in consumption of milk at mealtime, particularly lunch and dinner. Similar to the patterns seen in Canadian adolescents, the decrease in the amount of milk consumed may be due to the fact that Americans are consuming milk on fewer occasions per day.

Despite overall decreases in dairy consumption, several North American studies have found stability or increases in other dairy products. Canadian per capita consumption of flavoured milk and cream have increased significantly to 57.7% and 81% respectively from 1996 to 2015 (AAF, 2016). Interestingly, adolescents aged 9 to 13 years have been found to be the highest consumers of flavoured milk, with 18% of total milk consumed coming from flavoured varieties (Kranz et al., 2007). The popularity of specialty coffee shops in Canada is one of the key factors behind the growing per capita consumption of cream (AAF, 2016). In addition, while yogurt intake does not differ significantly among age groups, studies have demonstrated a significant and positive increase in cheese and ice cream consumption with increasing age (Huang & McCrory, 2005; Kranz et al., 2007). Specifically, cheese consumption has increased 18g over a 20 year period from the 1970s to the 1990s (Huang & McCrory, 2005). Cheese and yogurt consumption are thought to be increasing, even if not significantly, due to current
snacking trends, as both these foods were listed as top snacking categories for Canadians in a recent global survey report on snacking trends (AAF, 2016). It should be noted, however, that on a per-cup equivalent, regular cheddar cheese contains more calories than a glass of whole milk (171 calories versus 149 calories, respectively) (Stewart & Carlson, 2013). So, higher consumption of cheese in place of other dairy products may be a poorer choice in terms of nutrients (such as low vitamin D) for many Canadians. Moreover, despite the increases in consumption of some dairy products, milk consumption has decreased significantly more than the increases seen, resulting in the overall decrease in dairy consumption that is still seen today (Huang & McCrory, 2005).

So, despite the shifts in dairy product consumption, overall adolescent consumption of total dairy products remains below daily intake guidelines. This is a large health concern for adolescents who are not meeting dietary requirements and are potentially putting themselves at risk for nutrient deficiencies.

3.3 Importance of Dairy in the Diet During the Adolescent Period

With the concerning decline in dairy product consumption in all age groups, it is necessary to discuss the need for such high dairy requirements in the pre-adolescent and adolescent diet. As previously mentioned, dairy products account for a significant supply of vitamins and minerals that are crucial for the intense growth period of adolescence. Adolescents have some of the highest recommended intakes for vitamins and minerals across any age group ("Dietary Reference Intakes Tables," 2010). Dairy products provide an efficient way for individuals to meet their recommended intake for calcium and other nutrients, such as protein, vitamin D, magnesium, potassium, zinc, and phosphorous. This is due to the fact that dairy products provide more of these nutrients per calorie than any other food found in a typical North
American diet (Dror & Allen, 2014; Heaney, 2000). The most familiar nutrient in dairy is calcium, which is essential for the strengthening of bones, especially during the pubertal years when nearly 60% of peak bone mass (PBM) is acquired (Hendrie, Brindal, Baird, & Gardner, 2013). It has been additionally shown that calcium is required for the normal mineralization of bone and cartilage matrix (Loud & Gordon, 2006). Thus, dairy consumption is beneficial during adolescence, especially since it has been shown that calcium absorption is enhanced during pubertal years (Loud & Gordon, 2006). An examination of dietary calcium intake in adolescents aged 9 to 18 showed that those consuming dairy-free diets failed to meet their recommended intake of calcium (Gao, Wilde, Lichtenstein, & Tucker, 2006). However, if they consumed calcium-fortified foods, intake levels could be increased to adequacy (Gao et al., 2006). Perhaps not surprisingly, this work shows the importance of consuming dairy for calcium requirements during the intense adolescent growth period.

In addition to the most familiar dairy nutrient, calcium, other important nutrients for this period of intense growth during adolescents such as vitamin D and protein are found in dairy products. Vitamin D, a nutrient that is hard to obtain in typical North American diets and in the Canadian climate, is required for the efficient absorption of calcium (Moore et al., 2008). It is postulated that a deficiency in vitamin D is related to decreased bone density in youth (Moore et al., 2008). Beyond the benefits of calcium and vitamin D in dairy products, the consumption of dairy protein is known to stimulate the production and action of insulin-like growth factor 1 (ILGF-1) in adolescents, which also helps to support bone formation (Moore et al., 2008). Such research strongly supports the significant health benefits of dairy consumption as a convenient source of many nutrients required for proper growth in adolescents.
Apart from the high requirement of nutrients during the pre-adolescent and adolescent period, adolescence is also a period of increased autonomy with regards to eating-related behaviours and choice over food (Ferris, 2012). During these years, adolescents may have greater freedom to make decisions about what types of food they eat, when they eat, and how much they eat, as they strive to control areas of their life once controlled by their parents (Ferris, 2012). Adolescents may also experiment with a range of activities that either negatively or positively influence health (Jenkins & Horner, 2005). Nutritional deficits and poor eating habits established during adolescence can have long-term health, growth, and development consequences (Jenkins & Horner, 2005). Instilling healthy eating habits at this stage are important as they will carry into adulthood. Therefore, adolescence is a critical period in which to learn behaviours that will promote good health and proper eating habits later in life.

4.0 DAIRY PRODUCT INTAKE AND ADOLESCENT HEALTH EFFECTS

This section will first investigate the various health benefits of consuming dairy products during adolescence and adulthood, particularly with respect to bone health and height growth. The association between dairy consumption and weight gain among adolescents will also be addressed. Additionally, the potential for dairy intake to modify sports performance and recovery will be discussed.

4.1 Bone Health

Overall bone health is the result of a combination of factors including bone mass, bone architecture, and body mechanics. Bone mass increases through additions in density and height until around age 20, with additional gains in density occurring for another decade, or until approximately the age of 30 (Heaney, 2009). Bone architecture is maintained through a process
of bone remodeling which is influenced by several nutritional factors, including nutrients found in milk and dairy products such as calcium, phosphorous, vitamin D, potassium, whey protein, and lactoferrin (Dror & Allen, 2014). The three principal nutrients that support the components of bone health are calcium, protein, and vitamin D. However, it can be difficult to get a “bone healthy” diet without including three servings of dairy per day, not just because of dairy calcium, but also due to dairy protein, vitamin D, and potassium as these nutrients tend to be low in the typical North American diet and foods (Heaney, 2009).

The current trend and lack of consumption of dairy products can result in poor bone health and subsequent health issues. Adolescence is a critical time for the development of optimal PBM, and dairy intake during this period can have a beneficial effect on bone health (Rizzoli, 2014). Early childhood dairy consumption is especially critical, as a prospective study has provided evidence for a beneficial effect of childhood dairy consumption on bone health in adolescents. Moore et al. (2008) collected data from the Framingham Children’s Study that evaluated multiple 3-day diet records from 106 Caucasian children and their parents from 1987 to 1999. The study found that consuming two or more servings of dairy per day was associated with significantly higher mean bone mineral content (BMC) and bone area (BA) (Moore et al., 2008). Interestingly, dairy intake between 13 to 17 years of age was the strongest predictor of bone health when compared to dairy intake during the preceding years. Research has shown that children who avoid milk typically do not use calcium-rich food substitutes appropriately, and therefore have been found to have low calcium intakes and low bone mineral density (BMD) values (Goulding et al., 2004). A study with 50 children who avoided milk due to taste, intolerance, or lifestyle choice, found that these children were significantly shorter, had smaller skeletons, and poor BMD scores at multiple skeletal locations than did control children of similar
age and sex (Black, Williams, Jones, & Goulding, 2002). The impact of dietary calcium or dairy supplementation on BMC in children was systematically evaluated in a meta-analysis of RCTs and observational studies (Huncharek, Muscat, & Kupelnick, 2008), which found that in children with low baseline intakes of calcium, increased dietary calcium and/or dairy product intake significantly increased total body and lumbar spine BMC. Such research supports a relationship between dairy intake, calcium levels, and improved bone health in children and adolescents.

Poor bone health resulting in bone fractures are a frequent problem for growing and developing children and adolescents. Low BMD and high body weight can increase fracture risk during this period of growth (Goulding et al., 2004). Multiple studies have also shown that children who avoid milk report significantly more fractures, many of which occurred before puberty, and the majority of the fractures were associated with only slight trauma (Black et al., 2002; Goulding et al., 2004). Children in New Zealand with a history of milk avoidance had significantly lower total body BMC, were shorter, and were more likely to experience prepubertal bone fractures than age-matched controls (Dror & Allen, 2014). The results of these studies provide support for the importance of early and consistent childhood patterns of dairy consumption on PBM and protection against fractures in adolescence. As well, establishing habits at a younger age greatly increases the likelihood that these habits will persist to include the consumption of milk into adulthood (Caroli, Poli, Ricotta, Banfi, & Cocchi, 2011).

Adolescent dairy consumption is also associated with benefits in adulthood, particularly with respect to adult bone health (Kalkwarf, Khoury, & Lanphear, 2003). A study conducted to assess the effects of adolescent milk consumption on adult female bone health demonstrated that milk intake during childhood and adolescence was associated with increased adult bone mass and BMD, and a decreased incidence of osteoporotic fractures in women, even when current
calcium intake had been controlled for in the study (Kalkwarf et al., 2003). Low milk intake during childhood and adolescence was also associated with a two-fold increase in risk of fracture for women over 50 years of age (Kalkwarf et al., 2003). Similarly, Opotowsky and Bilezikian (2003) found that female adolescent milk consumption was significantly associated with post-menopausal BMD among women 20 to 39 years of age. Other research has also confirmed that higher PBM, which is achieved during adolescence, is favourable for prevention of osteoporosis and fractures later in life (McCabe et al., 2004). While the validity of such studies can be questioned due to recall bias, these studies collectively suggest a significant and positive effect of adolescent milk consumption on BMD throughout life.

Bone health is also characterized by the length of the bone, which translates to overall height. Childhood and adolescent dairy consumption has further been shown to positively affect height or linear growth. A study of 5,101 female adolescents who completed yearly FFQs for eight years found that those who consumed more than three servings of milk per day grew 0.11 inches more and had larger peak velocities than those who had consumed less than one serving of milk per day (Berkey, Colditz, Rockett, Frazier, & Willett, 2009). This resulted in a net increase in adult height of 2.3 cm. As well, authors reported that dairy protein was the strongest predictor of height. Furthermore, a recent review of health outcomes related to dairy consumption stated that 14 out of 17 intervention and observational studies found a positive association between milk or dairy product consumption and height in children and adolescents (Dror & Allen, 2014). These results are in agreement with a meta-analysis that concluded that 0.4 cm extra growth per year was a conservative estimate of the effect of 1 cup of milk supplementation daily (de Beer, 2012). This work further supports the role of dairy and its associated nutrients in promoting bone health in adolescents.
Contrary to previous research, a recent study found that increased milk consumption during adolescence was not associated with a lower risk of hip fracture in older adults (Feskanich, Bischoff-Ferrari, Frazier, & Willett, 2014). Researchers analyzed milk consumption patterns during ages 13 to 18 years from a prospective cohort study of more than 96,000 post-menopausal women and men aged 50 years and older. While it was found that each additional glass of milk consumed per day during adolescence was associated with a significant 9% higher risk of hip fracture in men, this was attenuated when height was added into the model (Feskanich et al., 2014). For women, no significant association between adolescent milk consumption and hip fractures was found. In addition, a recent systematic review investigating RCTs and observational studies of dietary calcium intake (supplemental calcium, milk, or dairy intake) in adults >50 years old with fracture as an endpoint found mixed results (Bolland et al., 2015). For dietary calcium, most studies reported no association between calcium intake and fracture (Bolland et al., 2015). The same results were seen for milk and dairy intake. Therefore, the evidence is not fully conclusive and has lead researchers to investigate the reasons for these discrepancies.

There are multiple reasons for these discrepancies in the literature. Firstly, the evidence that supports a positive association between milk/dairy and bone mineralization has been criticised for lack of consistency across measurements taken at different skeletal sites (Dror & Allen, 2014). As well, researchers need to better separate groups based on baseline intakes of calcium. Supplementing an adequately nourished experimental arm is unlikely to show significant effects on the outcome measured (Huncharek et al., 2008). It is likely that calcium intake has a more profound impact on bone health in children with low intakes and this effect may be lost when research is conducted with populations already meeting requirements.
Additionally, it is possible that the advantages of dairy consumption are strongest during growth and the adolescence period. This could explain why most research done with younger age groups shows positive effects of dairy on bone health, while research with older populations does not show the same benefits. Finally, there is risk of recall and memory bias when assessing adolescent dietary trends in an adult population. Together, these reasons may highlight the discrepancies in the research and support an overall positive influence of dairy on bone health.

4.2 Body Weight and Body Composition

In addition to bone health and height, there is considerable research relating dairy product consumption in adolescence to body weight and body composition. Currently, a controversy exists as estrogen and whey protein in dairy products are believed by some researchers to cause weight gain (Berkey, Rockett, Willett, & Colditz, 2005), while others assert that calcium and dairy product consumption in children is a significant negative predictor of percent body fat and fat mass (Carruth & Skinner, 2001). Research into the association between adolescent dairy consumption and body weight have reported conflicting results (Louie, Flood, Hector, Rangan, & Gill, 2011). Work to consider whether there is an association between dairy and body weight has been conducted in adolescents, particularly girls who may avoid dairy consumption due to concerns that these foods and beverages may be ‘fattening’ and result in weight gain (Wingrove, 2006). A prospective study examined dairy consumption in 196 non-obese premenarchal girls aged 8 to 12 years through the use of FFQs until four years postmenarche (Phillips et al., 2003). While there was an overall approximate 50% decrease of total servings of dairy products for the duration of the study, there was no statistically significant relationship between dairy product consumption and BMI scores over the adolescent period (Phillips et al., 2003). Additionally, there were no significant relationships between daily calories from dairy products or daily
servings of dairy with percent body fat. However, due to the small number of participants in this study (n = 132), these results must be interpreted with caution. A review of the research found significant negative associations between calcium intake from dairy products, and weight in young adults (Davies et al., 2000). Their work calculated that 1000 mg of calcium intake difference is associated with an 8kg difference in mean body weight (Davies et al., 2000). To add to the support of dairy and body weight management, a recent systematic review found that the majority of studies with data collected in the United States reported null and/or inverse associations between dairy intake and BMI or body fat (Dror & Allen, 2014). The totality of evidence seems to suggest that dairy consumption during adolescence or young adulthood may not be related to body fat in adolescents or may even be protective; however, further research is needed in this area.

Despite the support for dairy and body weight, a 2012 analysis of the relationship between beverage consumption and overweight and obesity found no protective effect of milk consumption against overweight and obesity (Danyliw, Vatanparast, Nikpartow, & Whiting, 2012). Furthermore, Berkey et al. (2005) conducted a longitudinal study that assessed FFQs for 16,771 American children age 9 to 14 years. It was found that children who consumed more than three servings of milk per day increased their BMI more than those who consumed smaller amounts. The quantities of 1% milk consumed by boys, and skim milk consumed by girls, were significantly associated with BMI gain, as well as total dietary calcium intake (Berkey et al., 2005). Notably, increases in BMI appeared to be due to the added calories consumed from the dairy products and not from the dairy fat. This study differed from previous work mentioned as almost one quarter of boys and 17% of girls were overweight or obese at the time of this study (Berkey et al., 2005). Moreover, the significant results related to increased BMI occurred in
those consuming more than three servings per day, which could exceed the recommendations from Canada’s Food Guide of three to four servings. This highlights the fact that moderation and meeting requirements is critical, and that exceeding recommendations is not suggested. So, while this study did not provide evidence to support the weight control effects of dairy products, it must be considered with its noted limitations.

The existence of conflicting evidence for the relation between dairy consumption and body weight in adolescents has led some researchers to investigate possible reasons for such results. Study designs and durations often vary widely between studies, and confounders such as total energy intake, physical activity level, pubertal status, and baseline BMI are often not accounted for in the analysis (Dror & Allen, 2014). Moreover, studies do not always take into consideration dietary intake plausibility of what is being reported by participants. In fact, in the studies that did take this into account, a weaker inverse association between dairy intake and adiposity among plausible dietary reporters was described (Dror & Allen, 2014). These issues with study design and analysis further complicates interpretation of the research, which suggests that more standardized methods are needed to ensure consistent and accurate conclusions are reached.

In addition to methodology, a number of hypotheses have been proposed to explain the observations that milk and dairy product intake in children and adolescents is not positively, and may be inversely, associated with energy balance, body fat, and/or body weight. A literature review by Huang and McCrory (2005) found that components of dairy as well as their unique combination may mitigate fat deposition. Specifically, consumption of calcium reduces 1,25-dihydroxyvitamin D activity and intracellular calcium influx, which in turn results in a decrease of fatty acid synthase transcription in adipocytes and insulin secretion by the pancreas (Huang &
McCror, 2005). This may result in net fat loss, as lipogenesis and insulin secretion are both reduced, and lipolysis is enhanced. Potential mechanisms that can be inferred from research on dietary calcium (including calcium from dairy but not from supplements) include reduced lipogenesis and stimulation of lipid metabolism, fat oxidation, fatty acid absorption, and postprandial fat metabolism (Abargouei, Janghorbani, Salehi-Marzijarani, & Esmailzadeh, 2012; Chen et al., 2012). These mechanisms may also explain why the study by Phillips et al. (2003) found no relation between dairy consumption and body weight, as they measured mainly BMI. Changes in BMI may not be as rapid as a loss in body fat but an increase in lean muscle can result in little to no changes in overall BMI. Huang and McCror (2005) also suggest that the whey fraction in milk might act independently or synergistically with calcium to attenuate lipogenesis and accelerate lipolysis. There is also a proposed effect of angiotensin-converting enzyme inhibitory peptides found in the whey protein of dairy products, which limits angiotensin II production and thereby stimulates adipocyte lipogenesis (Dror & Allen, 2014). Finally, there is emerging evidence that protein-rich animal foods, and especially dairy proteins, better support muscle protein synthesis than plant foods (Dror & Allen, 2014). While enhanced anabolism could potentially increase energy expenditure, there is insufficient evidence to fully draw this conclusion (Dror & Allen, 2014). The branched-chain amino acid leucine, which is relatively abundant in dairy products, may play a role in the repartitioning of dietary energy from adipose tissue to skeletal muscle, thereby promoting fat loss; however, more work needs to be conducted in this field to substantiate the claim (Dror & Allen, 2014). Clearly, the multiple components of dairy products as a nutrient-dense food work together to modulate bodily functions that affect body weight and composition.
Another hypothesis regarding the mixed results of dairy and body weight relates to the dietary habits of children and adolescents. While milk is a nutrient-dense beverage that is linearly associated with energy intake in absolute terms, when removed from the diet, it is replaced by other potentially energy-dense foods and beverages (Dror & Allen, 2014). It has been noted that children who obtain calories from sources other than milk and dairy products tend to obtain calories from other high carbohydrate sources such as sugar-sweetened beverages which translates into a difference in the proportion of calories from fat, protein, and carbohydrates (Moore, Bradlee, Gao, & Singer, 2006). Dairy proteins have been suggested to regulate appetite and spare muscle, thus promoting a feeling of satiation and promote better body composition in those who consume these foods (Chen et al., 2012). This work further highlights the importance of dietary balance and how dairy products can contribute to a healthy diet.

Adding to the strength of the association between dairy consumption and weight control in adolescents, researchers have conducted similar studies that generalize this trend in adults. A systematic review and meta analysis by Abargouei et al. (2012) assessed RCTs that investigated the effect of dairy consumption on weight, body fat mass, lean mass, and waist circumference in adults. It was found that increasing dairy consumption among adults in the context of an energy-restricted weight loss diet significantly decreased weight, waist circumference, and body fat mass, and increased lean mass, when compared to usual weight loss diets or increased dairy diets without energy restriction. In contrast, another meta analysis of RCTs by Chen et al. (2012) found that increasing dairy consumption did not have a beneficial effect on body weight and fat loss in long term studies or studies without energy restriction. However, researchers noted that consumption of dairy products may have modest effects in facilitating weight loss in short term or energy-restricted diets (Chen et al., 2012). It is also important to consider that adults only need
one to two servings of dairy products or alternatives per day, so increasing dairy above this could necessitate a reduction in calories from other foods in the diet. Combined, these data suggest a possible weight controlling benefit of dairy consumption that can help to cultivate a healthy lifestyle among adults. Such data suggest the importance of developing and maintaining dairy consumption habits in childhood and adolescence to carry forward into adulthood; however, controversy still exists and further research is needed.

4.3 Sports Performance and Recovery

Sports performance and recovery are closely linked to proper nutrition (Moore, 2015). Dairy products, specifically chocolate milk, are being increasingly researched for their potential as a functional food for sports performance for many reasons, most notably, their protein and carbohydrate content. While protein is crucial for the muscle synthesis and repair that happens after exercise, more important is the combination of high quality carbohydrates and protein, rather than just protein on its own (Moore, 2015). Dairy products could be used as an alternative to sports supplements because of their unique nutrient profile (Elliot, Cree, Sanford, Wolfe, & Tipton, 2006). This has led researchers to investigate the benefits of milk and chocolate milk after exercise based on their hydration potential, carbohydrate content, protein content (namely casein and whey), essential amino acid content, and vitamin and mineral content which are higher than other sports drinks (Lunn et al., 2012).

Much of the research focuses on milk products for recovery after exercise, mostly looking at protein turnover and muscle glycogen. In addition to timing and amount, the quality of protein is an important consideration for athletes looking to maximise recovery and muscle reconditioning after training and competition (Reid, 2013). The protein source, its amino acid profile, and the precise pattern of amino acid delivery to peripheral tissues have been shown to
influence the uptake of amino acids in muscle, which, in turn, can promote positive nitrogen balance and protein gain after resistance exercise (Reid, 2013). Dairy proteins, specifically whey and casein, are most effective in stimulating muscle protein synthesis (Reid, 2013). This is possibly because of the higher proportion of essential amino acids, particularly leucine, in dairy proteins (Katsanos, Kobayashi, Sheffield-Moore, Aarsland, & Wolfe, 2006; Miller, Alexander, & Perez, 2014). Whey protein has been found to enhance muscle protein synthesis rates over casein because of the differences in digestion and adsorption affecting the uptake of amino acids into the muscle (Wilkinson et al., 2007). Research has shown a larger uptake of amino acids after consuming milk that resulted in increased rate of muscle synthesis (Wilkinson et al., 2007).

Studies support a relationship between whole milk ingestion and both enhanced muscle protein synthesis rates and gains in fat-free mass post-exercise. Men who consumed milk after resistance training exercise compared with soy protein or a carbohydrate drink had improved gains in lean muscle mass and greater hypertrophy after 12 weeks of training (Hartman, et al., 2007). The same results were seen in women undergoing resistance training. Those who consumed milk saw larger muscle mass accretion, strength gains, and fat loss compared to females who consumed a carbohydrate beverage (Josse, Tang, Tarnopolsky, & Phillips, 2010). Another study compared semi-skimmed milk and a flavoured milk drink with a sports drink or water after eccentric exercise (Cockburn, Hayes, French, Stevenson, & St Clair Gibson, 2008). Results showed improved recovery from muscle damaging exercise with lower circulating levels of markers of structural muscle damage in those who consumed either milk beverage, but not those who consumed the sports drink or water. Therefore, it is evident that milk consumption post-exercise helps with muscle recovery, muscle synthesis, and increases in lean body mass.
Muscle glycogen synthesis is also an important marker for recovery post-exercise (Fogelholm, 2003). It has been hypothesized that the leucine in dairy products may interact to enhance glycogen re-synthesis after exercise (Moore, 2015). However, when comparing milk or flavoured milk to a carbohydrate drink, no differences in glycogen synthesis were observed in the previously mentioned study (Cockburn et al., 2008) or in other similar work (Lunn et al., 2012). In general, the suggested ratio of dairy protein to carbohydrates to optimally stimulate recovery is 1:3, which can be appropriately obtained from a glass of chocolate milk (Naclerio & Larumbe-Zabala, 2016). However, further research is necessary to investigate this hypothesis.

Fluid deficits that occur during exercise, mostly through sweating, can compromise the next exercise session if adequate fluid replacement does not happen, thus making re-hydration another important factor to recovery post-exercise (Shirreffs, Watson, & Maughan, 2007). Milk has a naturally high electrolyte content that has been shown to aid fluid retention and to confer additional benefits post-exercise in comparison to a high carbohydrate rehydration drink (Reid, 2013). Other studies have also suggested that consumption of low-fat milk post-exercise was more effective than water or a 6% carbohydrate electrolyte sports drink at restoring and maintaining hydration (Shirreffs et al., 2007; Watson, Love, Maughan, & Shirreffs, 2008). Thus, milk can further aid in recovery in terms of rehydration in between exercise sessions.

In slight contrast to recovery after exercise, performance on subsequent exercise trials is also important for athletes needing to train and compete on successive days, particularly with less than 24 hours of rest in between sessions (Watson et al., 2008). Relatively few studies have examined the influence of fluid milk after exercise on subsequent endurance performance (Lunn et al., 2012), and contrasting results have been seen in the small number of studies that have investigated this question. Ingestion of carbohydrates during the recovery period can enhance
exercise capacity in subsequent bouts of exercise, highlighting the importance of restoring muscle glycogen to the recovery process (Watson et al., 2008). Thus, it is hypothesized that the co-ingestion of carbohydrates and protein after exercise would further enhance recovery. Lunn et al. (2012) conducted a crossover trial to examine treadmill time to exhaustion in male runners after a determined recovery period following an exercise bout, and found that consuming milk after exercise resulted in significantly greater time to exhaustion when compared to an isocaloric carbohydrate beverage (Lunn et al., 2012). A randomized controlled trial (RCT) found similar results as athletes consuming milk or a milk-based carbohydrate-protein beverage performed better in the days following the exercise trial than those consuming water or a carbohydrate sports beverage (Cockburn et al., 2008). In contrast, other studies have failed to report similar results and have not detected any differences in time to exhaustion in a second bout of exercise with groups consuming a milk-based beverage, carbohydrate beverage, and/or water (Pritchett, Bishop, Pritchett, Green, & Katica, 2009; Watson et al., 2008). However, all of these studies had very small treatment groups of six to 10 participants and focused solely on males. As well, the participants were trained athletes that may have already had optimal nutritional habits, thus making the addition of a recovery beverage not significantly different than their usual recovery strategy. As was noted earlier, the addition of protein in the form of a milk-based beverage did not enhance glycogen synthesis compared to a carbohydrate only beverage; therefore, it is not surprising that exercise performance also may not be enhanced. Regardless of the controversy, there is research to suggest that dairy products, specifically milk and chocolate/flavoured milk, can contribute to the recovery and performance of athletes.
5.0 REASONS FOR INADEQUATE DAIRY INTAKE IN ADOLESCENTS

There are many factors driving the decrease in milk and dairy consumption across Canada. Firstly, there has been an increased demand for “solid” dairy product options (AAF, 2016). Sales data from Nielsen Canada show that during 2015, Canadian milk sales have declined by more than $25 million – a 2% reduction from 2014. Specifically, sales of single-serve 250 ml milk containers grew 22% over the last year, while sales of bottles of one liter or more declined, thus supporting the notion that consumers are still drinking milk, but are drinking less at each occasion. In contrast, more “solid” dairy products such as yogurt and cheese, saw sales increases of about 4% each during the same 10-year period. As mentioned earlier, the uptrend for yogurt and cheese is more likely the result of current snacking trends. Fluid milk still represents the largest dairy segment in Canada, so despite increases in “solid” dairy products, the trend still shows a general decrease in overall dairy consumption.

The current shortfall in dairy consumption among adolescents specifically has been demonstrated in numerous studies, which has led researchers to investigate the possible causes for this trend. Adolescent eating behaviours have long been studied to investigate the influences among adolescents when making food choices and some of these factors also impact dairy consumption. Neumark-Sztainer, Story, Perry, and Casey (1999) collected data from 21 focus groups with 141 adolescents in Grades 7 and 10 from two urban schools. The adolescents indicated that their food choices were influenced primarily by hunger and food cravings, food appeal, and the amount of time available to eat. Other factors cited by the adolescent included convenience, food availability, parental influences, media, cost, and lack of concern about healthy eating. Understanding the various and complex factors that underlie dietary patterns, including dairy consumption, is necessary to properly develop effective interventions.
To demonstrate specific correlates of calcium, dairy, and milk intake among adolescents, a study was conducted by Larson, Story, Wall, and Neumark-Sztainer (2006). This cross-sectional study design was used to assess 4,079 adolescents’ self-reported measures from the Project EAT (Eating Among Teens) survey, as well as completed Youth Adolescent Food Frequency Questionnaires (YAQs). The study found that male adolescent calcium intake was significantly and positively related to availability of milk at meals, taste preference for milk, eating breakfast, higher socioeconomic status of family, and social support for healthful eating (Larson et al., 2006). On the other hand, female calcium intake was significantly and positively related to many of the same factors, but also personal health/nutrition attitudes, and self-efficacy to make healthy food choices (Larson et al., 2006). For both males and females, fast-food consumption was significantly and inversely associated with calcium intake. Other studies have found similar results, and showed that knowledge of calcium-rich foods, self-efficacy toward consuming calcium-rich foods, calcium outcome expectations, and milk availability at home were significantly and positively associated with the amount of calcium consumed per day (Sharma, Hoelscher, Kelder, Day, & Hergenroeder, 2009). Moreover, availability of milk at home was a significant predictor of calcium intake (Sharma et al., 2009). Not only do these results provide insight about the social and environmental factors that can influence dairy consumption, but they also highlight additional factors such as personal preferences, knowledge regarding dairy products, and self-efficacy in food choice.

With the goal of providing detailed American national information about the environmental and familial influences on adolescent eating patterns, Videon and Manning (2003) analyzed data based on 18,177 adolescent interviews. It was found that parental education had a positive effect on adolescent dietary consumption patterns, and higher levels of parental
education were associated with lower odds of poor dairy consumption. The most significant parental influence was increased parental presence and frequently eating meals as a family. Adolescents who ate four or five family meals per week were 19% less likely to report poor dairy intake (Videon & Manning, 2003). The positive effects of family meals increased as the number of meals per week increased. Arcan et al. (2007) set out to further examine the role of parental eating behaviours and the home food environment with respect to adolescent dairy intake. They conducted a longitudinal study investigating 509 pairs of parents/guardians and adolescents who completed the Project EAT survey and YAQs from 1999 to 2004. It was found that having milk served at meals was significantly associated with dairy intakes of young adults five years after the study (Arcan et al., 2007). This association was greater for females than males. These results are not surprising as food choices and food availability at home are usually determined by the parents (Jenkins & Horner, 2005). In fact, only 66% of parents reported serving milk at meals (Hanson et al., 2005) and there is a direct correlation in adolescents between provision of milk at mealtimes and consumption of dairy products (J. O. Fisher, Mitchell, Smiciklas-Wright, Mannino, & Birch, 2004). Parents’ food consumption can also directly influence adolescent eating habits as there is a positive association between parental and child intake of dairy (Hanson et al., 2005). Together, these studies suggest the potential for a long-term role from parental modeling of dairy intake and home dairy availability on dietary patterns of adolescents.

There are other environmental settings and factors that play a role in adolescent dietary choices and which influence eating habits. Adolescents spend a good portion of their time away home and in school with friends (Jenkins & Horner, 2005). While at school, adolescents are faced with time limits and resource availability that create barriers to healthy eating. School is a
setting where they receive education on what food they should eat and what foods to avoid; however, adolescents identify time as one of biggest barriers to eating healthy food while in school due to short snack or lunch breaks (Jenkins & Horner, 2005). These issues can lead to skipping meals and eating fast food, both of which are barriers to adolescent dairy intake (Larson et al., 2006). It is known that students prefer to bring prepackaged food in their lunches and buy easily available, but unhealthy, food (Jenkins & Horner, 2005). Students who eat fast food or dine out frequently are at increased risk of not meeting their dairy requirements as it has been reported that approximately 93% of milk is consumed at home (Wingrove, 2006). Therefore, the school is an important environmental setting that creates barriers that should be addressed when targeting adolescent dairy intake.

Competition with other beverages, including sugar-sweetened beverages (SSBs) and alternatives that do not count as a dairy alternative, is another environmental factor that affects intake of dairy products, specifically milk. The demand for milk alternatives is on the rise due to increases, whether real or perceived, in lactose intolerance and milk allergies. People are also favouring milk alternatives due to concerns about animal welfare in the dairy industry, general health and wellbeing trends, concerns over hormones and additives, and preferences for diets such as veganism and paleo diets (AAF, 2016). While Health Canada specifies that only fortified soy milk counts as a dairy serving, the general public sees a variety of beverages as constituting the milk alternatives industry, including almond milk, rice milk, coconut milk, oat milk, hemp milk, and hazelnut milk. Canadian sales data of almond milk have tripled over the past two years to January 2016 and rice milk has grown by 6%. In contrast, soy milk sales have declined by 7% over the same period, likely due to concerns over plant estrogen or iso-flavones found in soy milk (AAF, 2016). A similar story is seen in the US and global market. Almond milk is now
America’s favourite milk substitute, boasting sales growth of 250% over a five-year period from 2010 to 2015. The global market for milk substitutes has reached $5.8 billion USD in 2014 and has continued to grow since then. Utilizing data from the 2004 CCHS-Nutrition, Danyliw et al. (2011) analyzed the beverage intake habits of Canadian children and adolescents by developing beverage intake cluster patterns. Boys and girls aged 12-18 years were divided into four clusters based on their beverage consumption: soft drinks, fruits drinks, milk, and moderate. While all adolescent boys showed a mean daily intake of calcium from food over 1000 mg a day, the boys in the ‘milk’ cluster had significantly higher intakes of calcium compared to the boys in the other clusters (Danyliw et al., 2011). It was also found that adolescent girls in the ‘soft drink’ and ‘fruit drink’ clusters consumed significantly less milk compared to the ‘moderate’ and ‘milk’ clusters. Other previous work supports this notion that sports drinks and SSBs compete with dairy products and alternatives (Wingrove, 2006). While plain and flavoured milk consumption was correlated with dairy and high calcium intake (Murphy, Douglass, Johnson, & Spence, 2008), high SSB consumption was directly and negatively associated with dairy intake (Hanson et al., 2005). The information from this study provides further evidence that there is a shortfall in milk consumption among Canadian adolescents. The combination of increased consumption of milk substitutes that do not count as a serving of dairy and SSBs has resulted in an overall decrease in beverages contributing to individuals’ consumption of dairy products.

In addition to environmental and social factors such as home, parental influences, and school community, adolescents’ personal attitudes and knowledge regarding dairy products can influence their intake of these foods. A direct correlation has been observed in children between knowledge of foods that contain calcium and their self-efficacy, or belief that they are capable, in consuming these foods (Sharma et al., 2009; Thompson, Bachman, Watson, Baranowski, &
Cullen, 2008). This is also true in adults as work has cited that lack of knowledge about the benefits of milk and milk products is a barrier to their consumption (Jung et al., 2015). Moreover, adolescents who perceived themselves to be overweight were significantly more likely to report poor consumption of dairy products in the previous day, suggesting a strong negative perception between dairy consumption and body weight (Videon & Manning, 2003). This may be due to the misconception and concern that milk and other dairy products such as cheese are high in fat and that consumption of high fat foods can lead to increased body weight or body fat (Wingrove, 2006). A healthy body image is a facilitator to dairy intake and supports increased dairy product consumption (Larson et al., 2006). Any of these factors could be targeted when attempting to improve adolescent dairy intake.

6.0 KNOWLEDGE TRANSLATION AND TRANSFER

In order to address the decline in dairy and target the aforementioned barriers and facilitators, effective and strategically planned interventions need to be formulated. Interventions that have been developed and tested have employed a variety of techniques and methods in an attempt to impact adolescent dietary habits and change their eating behaviour. Some of the most effective techniques include targeting students in the school environment to communicate the health effects of dairy products and alternatives (Lo et al., 2008; O'Connell, 2005; Watson, Kwon, Nichols, & Rew, 2009), expanding reach of the intervention to family members or the home environment (O'Connell, 2005), and use of social media (O'Connell, 2005) or website technologies (DeBar et al., 2009). Specific components of interventions such as these will be reviewed in further detail in Chapter 2. As well, researchers should be mindful of existing knowledge regarding the topic, their target audience, and the changes they intend to make. KTT frameworks can help researchers bridge the gap between research and implementation of
knowledge into practice. The next section will introduce knowledge translation and transfer as a way to bring all this information together and develop health interventions to effectively address nutrition research questions.

6.1 What is Knowledge Translation and Transfer?

The roots of knowledge translation (KT) can be traced back to the field of agriculture at the beginning of the 20th century (Curran, Grimshaw, Hayden, & Campbell, 2011). Early diffusion research was mostly situated within disciplinary silos such as sociology, anthropology, and education; however, by the mid-1960s, these boundaries began to break down (Curran et al., 2011). Although the term ‘knowledge translation’ was used in adult education research in the 1950s, the term became more commonly used in the context of implementation of best evidence in the health sector and was more recognized and studied in this context in the late 1990s (McKibbon et al., 2010). Healthcare organizations were focusing heavily on evidence-based medicine that moved the healthcare field towards sustained quality improvement research and helped drive the progression of KT. The first article indexed on Medline under ‘knowledge translation’ was published in 1972 (Greenhalgh & Wieringa, 2011) and proposed ‘bench to bedside’ translation, or measures to ensure that laboratory discoveries would be applied in the diagnosis or treatment of disease. These were the beginnings of the KT field as it is known today.

Over the past decade, there have been large investments in KT research, and a number of high profile reports have stressed the importance of KT, particularly within healthcare. In 2006, the US National Institutes of Health introduced an award with the goal of funding 60 centres by 2012, at an annual cost of $500 million USD (Greenhalgh & Wieringa, 2011). In the same year, the United Kingdom Cooksey Report set out a strategy for translation research in basic and
clinical sciences. The World Health Organization has called for a closer working relationship between producers and users of research to ensure that research is used to improve health (Ward, House, & Hamer, 2009). Of 27 journals containing the word ‘translational’ listed in the NCBI index of medical journals, 18 have been launched since 2008 (Greenhalgh & Wieringa, 2011). In 2006, the open-access journal Implementation Science was launched, with a mandate to publish research relevant to the scientific study of methods to promote the uptake of research findings into routine health care in both clinical and policy contexts (Curran et al., 2011). These investments, reports, and journals are just a snapshot of the global movement towards KT activities and research.

Knowledge translation (KT) can be defined as a “dynamic and iterative process that includes synthesis, dissemination, exchange, and ethically sound application of knowledge to improve the health of Canadians, provide more effective health services and products, and strengthen the healthcare system” (CIHR, 2015). While this definition is specific to healthcare, a more general definition could be “the transformation of knowledge into use through synthesis, exchange, dissemination, dialogue, collaboration, and brokering among researchers and research users” (OMAFRA, 2017). Regardless of the definition, KT, the term most frequently used in Canada, can be thought of as an information exchange process aimed at getting science “off the shelf or bench and into the hands of the people who need it” in the most effective format possible (OMAFRA, 2017). The primary purpose of KT is to address the gap between what is known from research and knowledge synthesis and implementation of this knowledge by key stakeholders with the intention of improving outcomes (Graham et al., 2006). At the same time, KT is used to describe the process of getting knowledge used by stakeholders. Together, KTT
covers the bidirectional process from both sides, with both researchers and end users working together to make an impact.

Despite the increasing interest in this field, there is also great confusion. Contributing to the confusion is the use of multiple terms to describe all or part of the KTA process. A study by Graham et al. (2006) conducted with 33 applied research funding agencies in nine countries identified 29 terms used to refer to some aspect of the concept of KTA. Another study collected 100 words and found research using 46 different terms to describe KT research (McKibbon et al., 2010). Some of the more common terms applied to the “KTA” process are knowledge translation, knowledge transfer, knowledge exchange, research utilization, implementation, dissemination, and diffusion (Graham et al., 2006). A Google search from 2006 generated over 11,800 hits for knowledge translation, 300,000 for knowledge transfer, 114,000 for knowledge exchange, 59,800,000 for implementation, 18,400 for research utilization, 8,930,000 for dissemination, and over 7,000,000 for diffusion (Graham et al., 2006). In comparison, the same search in 2017 generates 7,520,000 hits for knowledge translation, 19,800,000 for knowledge transfer, 35,900,000 for knowledge exchange, 462,000,000 for implementation, 1,210,000 for research utilization, 50,900,000 for dissemination, and 121,000,000 for diffusion. Although there is widespread agreement about the importance of transferring knowledge into action, it is evident that consolidation and consistent use of fewer terms related to KT research is needed.

6.2 Why is Knowledge Translation and Transfer Important?

Despite considerable resources that are devoted to health science research, a consistent finding from the literature is that the transfer of research findings into practice is often a slow and haphazard process (Graham et al., 2006). Overall, research knowledge is underutilized by practitioners and policy makers. This means that patients or the general public are denied
treatments or “campaigns” of proven benefit because the time it takes for research and experience to become incorporated into practice and policy is unacceptably long (Graham et al., 2006). A recent study by Bartlett and Gagnon (2016) found that research takes an estimated 17 years to reach clinicians and an estimated 30 years to reach the general population. Researchers from the United States and the Netherlands have estimated that 30% to 35% of patients are not receiving care according to scientific evidence and that 20% to 25% of the care provided is not needed or potentially harmful (Graham et al., 2006). At the same time, there are problems with premature adoption of some treatments before they have been shown to be beneficial (Graham et al., 2006). Even if programs are evidence-based, knowledge or programs are not being implemented as intended, very few monitor implementation of the program for quality or evaluate outcomes, and the programs or knowledge are often not sustained (McGlynn et al., 2003). Therefore, it is evident that we need to work to identify the gaps in the research and minimize these by getting research into action. One such way of doing this could be through the use of KTT frameworks.

Most importantly, KTT attempts to bridge the gap between knowledge and its use. KTT can achieve many outcomes, but primarily it raises awareness and prompts change. It can draw attention to current research, create effective and sustainable change, induce cultural shifts, and improve client, patient, and participant outcomes (CIHR, 2015). Where in the research process KTT is utilized depends on one’s goals; however, there are two main forms of KTT known as integrated KT (iKT) and end-of-grant or end of research KT (CIHR, 2015). In iKT, potential knowledge users, or individuals who are likely to be able to use research results to make informed decisions, are engaged throughout the research process (CIHR, 2015). Knowledge users are seen as equal partners alongside researchers, which aims to create research that is more
relevant to and more likely to be used by the knowledge users. In contrast, end-of-grant KT focuses primarily on sharing research results and implications after the research is complete with those who can use the information (CIHR, 2015). It can involve more intensive dissemination activities that tailor the message to a specific audience. KT activities for any form of KTT can include conference presentations, publications, web-based activities, educational materials/sessions, workshops, plain language summaries, conferences or events, networking, communities of practice, and more. These and other activities help researchers to bridge the “know-do” gap and ensures research findings get into the hands of those who can use them (CIHR, 2015).

6.3 The ‘Knowledge to Action’ Cycle

The goal of KT research is to develop a generalizable, empirical, and theoretical basis to optimize KT activities (Curran et al., 2011). While the field of KT research is growing, it continues to face a number of conceptual and methodological challenges. KT interventions are generally complex to design and evaluate making it difficult to draw conclusions about what are the most effective approaches in specific settings (Curran et al., 2011).

Much of the current work into KTT focuses on the theories, models, or frameworks of the knowledge transfer process (Ward et al., 2009). The systematic use and evaluation of knowledge transfer methods such as targeted dissemination, involvement of end users in the research process, development of networks between researchers and users, and the use of knowledge brokers are rarely reported in the literature. A 2007 review identified only 18 studies which described the implementation of a specific knowledge transfer mechanism (Mitton, Adair, McKenzie, Patten, & Waye Perry, 2007), although this number is most likely much higher at present. Reviews have identified as many as 63 different theories or models of knowledge
transfer across field as diverse as healthcare, social care, and management. The number and diversity of these models or frameworks makes it difficult for researchers to navigate and select an appropriate model for their needs. In addition, many models remain largely unrefined and untested, such that their suitability as tools for designing and evaluating interventions is unknown (Ward et al., 2009). One of a few exceptions to this is Graham et al. (2006)’s KTA cycle framework which has been tested as a model for planning and evaluating KT strategies (Straus, Graham, Taylor, & Lockyer, 2008).

The KTA cycle framework was developed in the early 2000s in response to the consistent observation that the transfer of research findings into practice is slow and haphazard, as well as the increased emphasis in Canada on evidence-based, cost-effective, and accountable healthcare. Graham et al. (2006) reviewed 31 planned action theories about the process of change in developing the KTA cycle framework. Planned action refers to deliberately engineering change in groups that vary in size and setting. Planned action theories or models are intended to help planners or change agents control variables that increase or decrease the likelihood of the occurrence of change. Commonalities among planned action theories or frameworks were used when developing the KTA cycle framework. The KTA process is divided into two concepts, knowledge creation and action, with each concept comprised of ideal phases or categories (Figure 1.2). However, it is not a step-by-step approach, as the boundaries between the two concepts and their phases are fluid and permeable (Graham et al., 2006). The funnel symbolizes knowledge creation and is comprised of three phases, while the cycle represents the activities and processes related to use or application of knowledge. Integral to the framework is the need to consider various stakeholders who are the end-users of the knowledge that is being implemented.
6.3.1 Knowledge Creation

The funnel representing knowledge creation or production consists of the major types of knowledge or research that exist in many health-related fields. As knowledge moves through the funnel, it becomes more distilled and refined with the goal of becoming more useful to stakeholders (Graham et al., 2006). At each phase of knowledge creation, knowledge producers can tailor their activities to the needs of potential users. For example, they can tailor their research questions to address problems identified by users. They can tailor or customize the message of their results for the different intended users. Furthermore, they can tailor or customize the method of dissemination to better reach the intended users.

The first phase, knowledge inquiry, represents the plethora of primary research studies or knowledge of variable quality that exists through a variety of sources that may, or may not, be
easily accessed. This can also be thought of as ‘first-generation knowledge’ that is largely unrefined.

The second phase is known as knowledge synthesis, or second-generation knowledge. It represents the aggregation of existing knowledge through a process that involves the application of explicit and reproducible methods to identify, appraise, and synthesize studies or information relevant to specific questions. This process is conducted to bring together disparate findings, to identify common patterns from the relevant first-generation knowledge, and often takes the form of systematic reviews and meta-analyses.

The third phase consists of the development of knowledge tools or products and is known as third-generation knowledge. Associated knowledge tools seen in research utilizing the KTA cycle framework have included, practice guidelines or synopses, summaries of evidence targeted at specific audiences, continuing health care education modules, information posted on websites, and decision aids among others (Field, Booth, Ilott, & Gerrish, 2014). The purpose of these tools is to present the best quality knowledge in a clear, concise, and user-friendly format. Ideally, the tools will also provide explicit recommendations with the intent of influencing what stakeholders do and to meet the stakeholders’ knowledge or informational needs.

6.3.2 Action Cycle

The action cycle is a set of seven phases that can occur sequentially or simultaneously and is thought of as a cycle leading to the implementation or application of knowledge (Graham et al., 2006). These phases are dynamic, can influence each other, and can be influenced by the knowledge creation phases.

The first phase typically evolves in one of two ways. A problem or issue is identified and then knowledge or research that might address the problem is investigated and critically
appraised. Alternatively, researchers may become aware of the knowledge and then determine if there is a knowledge-action gap that needs to be filled. Regardless of the order, an issue or gap is identified and knowledge is needed to address the problem.

The second phase involves adapting or customizing the knowledge to the local context. This process involves making decisions about the value, usefulness, and appropriateness of particular knowledge to the setting and circumstances of the target audience. This process may be more or less formal, but is a crucial step as generic knowledge is seldom taken directly off the shelf and applied without some sort of vetting or tailoring to the local context (Graham et al., 2006).

The third phase relates to the uptake of knowledge which can be influenced by issues related to the knowledge to be adopted, the target audience, and the context in which the knowledge is to be used. Therefore, at the barriers assessment phase, it is necessary for the change agents to assess potential barriers that may impede or limit the uptake of knowledge so that these barriers may be targeted and overcome or diminished by intervention strategies. At the same time, supports or facilitators that can be used to promote the uptake of knowledge are identified. Common methods to identify barriers to change include questionnaires, interviews, workshops, focus groups, and needs assessments (Field et al., 2014).

The fourth phase involves the planning and execution of intervention strategies to facilitate and promote awareness and implementation of knowledge (Graham et al., 2006). This process is usually equated with the concept of dissemination or knowledge transfer strategies and involves selecting and tailoring intervention to the identified barriers, facilitators, settings, and audiences. The more targeted, focused, and well-planned these strategies and interventions are, the more likely they will promote change (Graham et al., 2006).
The fifth phase is monitoring knowledge use or application. At least three different types of measurable knowledge use have been previously described: (1) conceptual use of knowledge describes changes in levels of knowledge, understanding or attitudes; (2) instrumental use of knowledge describes changes in behaviour or practice and often translates into improved health outcomes; and (3) strategic use of knowledge relates to the manipulation of knowledge to attain specific power or profit goals (Graham et al., 2006). It is important to define what constitutes knowledge use for the specific intervention so that it can be appropriately measured. As well, monitoring knowledge use is necessary to determine how and the extent to which it has diffused throughout the target audience. Moreover, it can also be used to determine whether the interventions have brought about the desired change or whether additional intervention is required.

The sixth phase is to determine the impact of using the knowledge. This is to evaluate whether application of the knowledge actually makes a difference in terms of such things as health, practitioner, and system outcomes. Evaluating the impact of knowledge use is the only way to determine whether the efforts to promote its uptake were successful and worthwhile (Graham et al., 2006).

The seventh and last phase of the action cycle involves determining strategies to ensure sustained use of the knowledge. After intervention implementation, barriers or facilitators that need to be addressed may change, for example. The sustainability phase sets in motion a feedback loop that cycles through the action phases again and re-addresses the phases based on the new information learned. This phase is the least reported to be carried out in studies utilizing the KTA cycle framework to guide their activities (Field et al., 2014).
In general, the monitoring, outcomes or impacts, and sustaining phases of the Action Cycle are less often described in research. This may reflect a lack of funding or time. Researchers have reported that these phases were beyond the scope of their project as such work would require additional funding for longer term monitoring or to develop strategies to sustain knowledge use over time (Field et al., 2014). It may also reflect challenges for defining and reporting outcomes for KT projects. Much health-related research uses specific biomarkers to measure changes in participants following an intervention. In contrast, KT work may be evaluating the interventions’ impact on participants’ ability to understand their choices and to make informed decisions that will impact their health or treatment of a disease (Field et al., 2014). Researchers need to be clear about their outcomes and knowledge use measures to help make these distinctions clear.

It is important to re-iterate that each action phase can be influenced by the phases that precede it and that there may be feedback between the phases. It is also important to emphasize that both local and external knowledge creation (the funnel) can be integral to each action phase. For example, local research can be done to determine the magnitude of the problem or the care gap, to assess barriers to knowledge using qualitative or survey methods, and to monitor knowledge use and outcomes. External knowledge from the literature can be used to identify potential barriers to knowledge use and implementation interventions that have been shown to be effective. Integration of research at each action phase should not only help to develop the scientific basis of KTA, but also bring about more effective uptake of knowledge.

6.4 Use of the KTA Cycle Framework in Research

Due to the relatively new focus on KT activities, the use of theories or frameworks to inform research has not been extensively reviewed. Despite this, it is one of the most frequently
cited conceptual frameworks for KT work in a variety of disciplines including public health, health promotion, clinical, academic, or nurse education, and in specific conditions such as stroke, cerebral palsy, motor difficulties, or osteoarthritis. A citation search of three databases tracking the source paper of the KTA cycle framework (Graham et al., 2006) identified 1,787 records between 2006 and 2013 (Field et al., 2014). Target audiences for this work ranged widely, from the public and patients to occupational therapists, speech therapists, physiotherapists, and educationalists/academics within universities, thereby illustrating the diverse application of the KTA cycle framework.

A recent review by Field et al. (2014) sought to investigate if and how the KTA cycle framework is being used in practice. Overall, the authors found that the KTA cycle framework is being used in practice, but with varying degrees of completeness and theory fidelity. From their systematic search, the authors found 146 papers, from 2006 to 2013, that made mention of using the KTA cycle framework (Field et al., 2014). The papers were coded into five categories based on the extent in which the KTA cycle framework was used. Of the 146 papers, 62 (43%) were classified as ‘referenced’, meaning the framework was cited with little, if any, further explanation being provided. In contrast, only 10 papers, or 7%, stated that the KTA cycle framework was integral to the design, delivery, and evaluation of the implementation activities and also included examples to illustrate how the KTA cycle framework had been used as a guide. Interestingly, 80% of these studies were conducted in Canada. The other three categories (informed, adapted/combined, and directed) consisted of 27%, 12%, and 12% of the publications, respectively. Again, these results demonstrate the wide use of the KTA cycle framework with varying levels of completeness.
The study further analyzed the 10 studies that stated the KTA cycle framework was integral to their implementation activities. All of these studies described using components of the Action Cycle of the framework, but only seven described using components of both the Knowledge Creation funnel and the Action Cycle. For the Action Cycle, all 10 studies referred to the first phase, identifying the problem, but the least reported phase was ‘sustain knowledge use’. Important to note is that no studies described using every phase of the KTA cycle framework. Despite the implication that the KTA cycle framework was integral to the research, there were still missing components and variation in use of the framework in all studies.

Overall, the KTA cycle framework was used in a variety of ways from informing study design to full integration within intervention components, showing flexibility in its use and that it can fit local circumstances and needs across a range of disciplines. Flexibility of the use of the phases was intended during design of the framework (Graham et al., 2006). It allows the KTA cycle framework to accommodate different phases being completed by different stakeholders and groups at different points in time. Moreover, flexibility allows for the application of the KTA cycle framework in different settings and disciplines, and with a variety of target audiences. Most studies focused on improving knowledge or awareness, thus supporting what is already known about the majority of professional or education KT strategies within interventions aiming to promote the uptake of evidence. However, closer examination of studies using the KTA cycle framework revealed that usage of the framework varies considerably. Despite the variation in use of the KTA cycle framework, it has been argued that using a theory or framework can improve well-designed and effective interventions. In addition, there is a noticeable gap in nutrition research, which has not been cited to frequently use KTT theories or frameworks, including the KTA cycle framework. Therefore, the KTA cycle framework provides a useful and practical
theoretical basis on which to plan research projects, and to inform the development of a novel intervention with adolescents regarding dairy products.

7.0 CONCLUSION

Currently, adolescent daily dairy intake is inadequate when compared to various national guidelines. Dairy consumption positively impacts adolescent health, and subsequently, other aspects of health throughout an individual’s life. While various dietary interventions have been conducted, the characteristics of effective interventions in adolescents have not yet been investigated systematically. Moreover, it has been shown that many personal, behavioural, and environmental factors impact adolescent dairy consumption, but the specific barriers and facilitators in a Canadian adolescent population remain poorly investigated. These gaps represent knowledge that can be translated and used to inform the development of a nutrition intervention targeting adolescent dairy intake. The use of KT theory, including the KTA cycle framework, may provide a foundation to systematically investigate how to translate nutrition research knowledge into a successful intervention.
Rationale, Objectives, and Hypotheses

Rationale

Despite the benefits of dairy products and the known consequences of their lack of consumption, their intake continues to decline in pre-adolescent and adolescent populations in Canada. The adolescent period is a critical time to instill good nutrition habits due to the substantial bone growth and body composition changes that occur, the increased autonomy over dietary behaviours, and the potential for these habits to continue into adulthood. It is therefore of interest to investigate how we can effectively convey health research regarding dairy products and alternatives as foods for health to pre-adolescents and adolescents.

Previous research has yielded conflicting results regarding why adolescents fail to meet dairy intake requirements and does not present clear techniques that are most effective in creating dietary behaviour change in adolescents. These gaps in knowledge, which are needed to inform proper intervention development, can be appropriately investigated using the KTA cycle framework. Using the framework can provide a foundation to systematically investigate how to translate research knowledge into components necessary for delivering a successful intervention.

Objectives and Hypotheses

The problem addressed at the outset of this thesis was the lack of dairy consumption by pre-adolescents and adolescents, while the knowledge to be mobilized related to the awareness of dairy products as “foods for health” based on decades of scientific research. The overall objective of this thesis is to explore the use of the KTA cycle framework to systematically tailor, plan, and develop a nutrition intervention regarding dairy products and alternatives in adolescents in Southwestern Ontario. This thesis aims to explore how KTT theory can be applied to nutrition research. The overall hypothesis of this thesis is that using the KTA cycle framework
to guide nutrition intervention research will result in effective translation of tailored knowledge, evident by increased knowledge and dairy consumption, to the target population, adolescents. To address the objective and hypothesis of the thesis, three independent, but related, studies were conducted.

**Study 1**

Research Question: What are the characteristics of effective interventions to deliver nutrition knowledge to adolescents?

The specific objectives of Study 1 were to conduct two systematic reviews of the literature, in order to:

1. Characterize the effective components of dairy-specific interventions conducted with adolescents;
2. Characterize the effective components of school-based nutrition interventions in pre-adolescents or adolescents.

Given the objectives of Study 1, it was hypothesized that together, both systematic reviews would reveal:

1. Longer, more focused and intensive interventions with sound theoretical bases would be effective in changing dietary behaviour;
2. Schools would prove to be a suitable place to intervene and modify adolescent eating behaviours.

**Study 2**

Research Questions: What are the barriers and facilitators to consumption of dairy products and alternatives by adolescents, and what are the perceptions and use of sources of health knowledge by this population?
The specific objectives of Study 2 were to:

1. Investigate the barriers and facilitators to dairy product consumption in Grade 7 children as stratified by gender and level of habitual dairy product intake, with the goal of identifying factors that are both common and unique to each group;
2. Investigate the perception and use of sources of health knowledge by young adolescents as stratified by gender.

Given the objectives of Study 2, it was hypothesized that:

1. Male and female adolescents would have different barriers and facilitators to dairy product intake and that these may also differ depending on their habitual level of dairy product intake. Some common factors such as knowledge regarding dairy products and access to convenient dairy products would be similar amongst groups;
2. Adolescents would use parents and teachers as sources of health knowledge, but would prefer to search for the information themselves using the internet.

**Study 3**

Research Questions: What is the effectiveness of a school-based dairy intervention enhanced with a web-based component in modifying adolescents’ knowledge and behaviour, and can positive changes be sustained over the long-term using targeted maintenance strategies?

The specific objectives of Study 3 were to:

1. Determine whether a novel intervention was more effective than a standardized dairy education program at changing: (i) knowledge of dairy products, (ii) intentions to consume dairy products, and (iii) dietary intake of dairy products over the short and long-term;
2. Characterize use of the web-based component of the intervention by students, which was on a voluntary basis;

3. Assess the effectiveness of a parent e-mail campaign as a follow-up strategy to the intervention in impacting website use and student knowledge, behaviour, and intentions.

Given the objectives of Study 3, it was hypothesized that:

1. The novel school-based intervention would be more successful in changing students’ knowledge, behaviour, and intentions to consume dairy products than the control intervention;

2. Students would engage with the intervention website in-between research visits which would further promote knowledge and behaviour changes in the intervention group;

3. The parent email campaign would lead to additional differences in the intervention group, as parent engagement with emails would translate to further improvements in student’s knowledge and behaviour regarding dairy products.

The relation to the KTA cycle framework, methodologies, and results associated with each of these studies are presented in the forthcoming chapters.


CHAPTER 2: KNOWLEDGE SYNTHESIS

2.1 Chapter Introduction

The KTA cycle framework begins with the Knowledge Creation funnel in which knowledge is aggregated and synthesized to be distilled and refined, from primary or first-generation knowledge, into knowledge tools or products that present the knowledge in clear and concise formats.

The knowledge gap to be addressed in this thesis, specifically the lack of consumption of dairy products by adolescents, was already known. Therefore, it was necessary to systematically evaluate the primary literature to learn more about the research that has been conducted to promote dairy product and alternative intake in pre-adolescents and adolescents.

To begin, it was noted that the characteristics of effective dairy-focused interventions had been systematically evaluated in children and pre-adolescents, but not in adolescents. Therefore, the goal of part one of this study was to systematically review published interventions that aimed to increase dairy consumption (either exclusively or in combination with other diet and physical activity modifications) in order to highlight strategies that could be incorporated into future interventions to assist adolescents in meeting their daily dairy intake recommendations.

Moreover, we determined that it was important to learn about nutrition interventions more broadly, specifically those being conducted in schools, which is a setting conducive to research with pre-adolescents and adolescents. Again, it was noted that there was limited information regarding how the unique characteristics of school-based nutrition interventions related to intervention effectiveness, particularly in terms of intervention intensity. Therefore, the goal of part two of this study was to systematically review the intensity of published
interventions aimed to modify the dietary behaviour of preadolescents and adolescents in a school-based setting. The aim of this second review was to further highlight intervention strategies and characteristics for incorporation into future nutrition interventions, specifically those administered in schools.

Together, these systematic reviews can be considered knowledge tools that can inform school-based nutrition intervention development in adolescents.
2.2 Interventions to Increase Dairy Consumption in Adolescents: A Systematic Review

As published:

Olivia Marquez, MSc, Megan Racey, MSc, Michèle Preyde, PhD, Gilly A. Hendrie, PhD, and Genevieve Newton, PhD. Interventions to Increase Dairy Consumption in Adolescents: A Systematic Review. ICAN: Infant, Child, & Adolescent Nutrition, 7(5), pp 242-254. Copyright © [2015] The Authors. Reprinted by permission of SAGE Publications. DOI: 10.1177/1941406415600752
2.2.1 Abstract

Objective: Effective interventions are needed to address the reported inadequacies of dairy product and calcium (Ca) intakes among adolescents. The present review investigated interventions aimed at increasing adolescent dairy and/or Ca intakes, and determined the characteristics associated with successful interventions.

Design: A PRISMA systematic review search identified 17 interventions, described in 16 publications, between 1993-2015 (February). Studies were evaluated for population, delivery, dietary targets and outcome measures, measure of intervention intensity, use of behaviour change techniques, intervention effectiveness, and effect size and quality.

Setting: Interventions targeting an increase in dairy food or Ca intake, either exclusively or in combination with other dietary modifications.

Subjects: Adolescents, aged 12-18 years.

Results: Twelve of the 17 interventions were found to be effective. Effective interventions tended to be higher in overall intensity (mean intensity: negative interventions 12.2, positive interventions 14.25), with the most notable difference in the duration category, such that effective interventions tended to be longer in duration. The number of behaviour change techniques applied did not differentiate effective and ineffective interventions, but prompting the review of behavioural goals and including interviews or brief counseling appeared to be important for effective interventions. Effective interventions tended to have higher methodological quality, while the majority of ineffective interventions were qualitatively assessed as weak.

Conclusions: The current review has identified characteristics of effective interventions that offer insight into promising strategies likely to increase dairy consumption and Ca intakes in
countries where adolescent intake is insufficient. These findings may have important implications for future intervention design.

*Keywords*: Dairy, calcium, adolescents, intervention

2.2.2 Introduction

Dairy products provide a considerable amount of adolescent’s daily intake of vitamins, minerals, and protein (Moore et al., 2008). These foods offer readily available sources of calcium (Ca), which is essential for the strengthening of bones, particularly during the pubertal years when nearly 60% of peak mass is acquired (Hendrie et al., 2013; Moore et al., 2008). It has also been shown that Ca is required for the normal mineralization of bone and cartilage matrix (Heaney, 2009; Loud & Gordon, 2006; Moore et al., 2008). Thus, dairy consumption is beneficial during adolescence, especially since it has been demonstrated that Ca absorption is enhanced during pubertal years (Loud & Gordon, 2006). Moreover, there is also evidence that it reduces the risk of osteoporosis later in life (Kalkwarf et al., 2003; Opotowsky & Bilezikian, 2003). Therefore, it is necessary to ensure adequate adolescent dairy consumption and Ca intake in order to maximize adolescent bone formation and potentially reduce healthcare costs in the future. As children transition into adolescence, milk consumption declines and continues to decline into adulthood (Stewart & Carlson, 2013). Consequently, effective interventions are needed to address the reported inadequacies of dairy consumption among adolescents.

Currently, various dietary interventions aim to increase dairy consumption in adolescents, often in combination with other dietary modification goals. However, the characteristics of effective interventions have not yet been investigated systematically. The goal of this report is to present a systematic review of published interventions that aim to increase dairy consumption, either exclusively or in combination with other diet and physical activity modifications, in order
to determine the strategies needed for future interventions to assist adolescents in meeting their daily dairy and Ca intake recommendations. This review is limited to studies targeting adolescents aged 12-18 years, as this is a crucial period of growth, and a period of dietary self-efficacy development. This analysis will complement the systematic review of dietary interventions to increase dairy consumption among children (aged up to 12 years), by Hendrie et al. (2013). Results of this review will facilitate the development of interventions that target adolescents, with the goals of combating insufficient dairy intake.

2.2.3 Methods

2.2.3.1 Search Method and Inclusion/Exclusion Criteria

The search for literature to be included in this review strictly followed the PRISMA four-phase flow diagram guideline (Moher, Liberati, Tetzlaff, & Altman, 2009). A list of search terms and databases to search was developed in consultation with a learning and curriculum support specialist and was informed by a recent systematic review (Hendrie et al., 2013). The search terms used were comprehensive and inclusive (see Appendix A). They were categorized under the following four headings: Interventions: e.g. clinical trial, outcome study, intervention; Nutrition: e.g. beverage, nutrition, food; Population: e.g. adolescent, teen, youth; and Dairy/Calcium: e.g. milk, cheese, calcium. The search included papers published between 1993 and 2015 (February), published in the following databases: ProQuest (which included 41 databases), Web of Science (which included eight databases, including PubMed), Food & Nutrition Databases, Cochrane Database, Cumulative Index to Nursing and Allied Health Literature, Health and Psychosocial Instruments, Food Agricultural Organization, and CAB
direct. Grey literature and reference lists of identified reviews and articles were searched for additional research type studies.

Studies were limited to those published in English and were included if they evaluated the effectiveness of an intervention designed to modify dietary intake, with or without a control group. Studies were included if any outcome measure included Ca intake, specific dairy foods, or total dairy intake, reported at an individual or group level. Interventions delivered directly to adolescents aged 12 to 18 years, or to adolescents and their parents, through any setting(s) were included. If the age of participants in the study fell outside of the range, the mean age needed to be ≥12 years or ≤18 years for inclusion. Studies that targeted specific clinical populations, such as malnourished or lactose intolerant groups were excluded. Consistent with the PRISMA four-phase flow diagram, 17 interventions, described in 16 publications, were included in the qualitative synthesis. The final PRISMA diagram is shown in Figure 2.1. Following the screening phase, a total of 87 articles were assessed for eligibility using a full text analysis, based on the inclusion and exclusion criteria listed above. From this, 71 articles were excluded for the following reasons: clinical population (n = 6), lack of dietary/dairy intake measure (n = 8), no intervention (n = 24), lacking full text article (n = 10), no English publication available (n = 4), older than 20 years (n = 2), incorrect age range (n = 10), lacking results (n = 5), and duplicates or report of existing study (n = 2). As a result, 16 studies were included in the review. Note that two papers describe one intervention (DeBar et al., 2009; DeBar et al., 2006), and one paper describes two interventions (Gates, Hanning, Gates, McCarthy, & Tsuji, 2013).
Records identified through database searching (n = 5021)

Additional records identified through other sources (n = 141)

Records after duplicates removed (n = 4073)

Records screened (n = 4073) → Records excluded (n = 3986)

Full-text articles assessed for eligibility (n = 87) → Full-text articles excluded, with reasons (n = 71)

Studies included in qualitative synthesis (n = 16*)

Studies included in quantitative synthesis (n = 16*)

Figure 2.1. PRISMA flowchart of search outcomes
2.2.3.2 Intervention Evaluation

Studies were evaluated based on their effectiveness, using the criteria developed by Hendrie et al. (2013). A study was considered effective if at least one dairy and/or Ca intake outcome demonstrated a significant change ($p<0.05$) in a healthy direction, and was measured using an objective method (such as observed intake) or a robust dietary assessment method (such as FFQ, 24hr recall, weighed records). Negative dietary changes, the type of intervention (dairy only or mixed nutrition), and the number of dietary behaviours targeted and modified (expressed as a ratio) were considered and recorded.

Studies were also evaluated based on their intensity, using a modification of the intensity assessment criteria used by Hendrie et al. (2013). A 5-point scale of intensity (1=low, 2=low-medium, 3=medium, 4=medium-high, 5=high) was developed to assess each of the following characteristics, with the exception of ‘reach of the strategies’ that employed a 3-point scale (see below). A subsequent overall intensity score was determined by calculating the sum of the four components of intensity (out of a possible 20). Relative to the studies included in the present review, scores greater than 13 were considered as ‘higher’ intensity, 11-12 as ‘medium’ intensity, and 10 or less as ‘lower’ intensity. Evaluated characteristics included:

1. *Duration of intervention:* Described the length of intervention (scaled relative to interventions included in the review). The longer the intervention, the higher the intensity.

2. *Frequency of contact with intervention:* Described the frequency of contact between the participants and the intervention. If the intervention used multiple frequencies of contact points, the most frequent contact was used. If the frequency of contact was not explicitly stated, then the contact points were divided by the duration in order to obtain an average contact frequency.
3. **Level of personalization/contact**: Described the type of contact or level of contact with the intervention. The more personalized the contact, the higher the intensity.

4. **Reach of the strategies**: Described as the number of settings used to reach the target population. It was also noted if the reach of the strategies included parental involvement. The more settings the intervention took place in, the higher the intensity.

The intensity ranking scale was as follows:

1. **Duration**: 1 = < 6 weeks, 2 = 6-11 weeks, 3 = 12 weeks – 5 months, 4 = 6-12 months, 5 = >12 months

2. **Frequency**: 1 = annually, 2 = bimonthly to quarterly, 3 = monthly, 3.5 = twice a month, 4 = weekly, 5 = daily

3. **Level of Personalization**: 1 = environmental, 2 = group, 3 = environmental + group, 4 = group + individual, 5 = individual OR individual + environmental + group

4. **Reach**: 1 = one setting, 3 = two settings, 5 = three or more settings

In order to determine successful intervention techniques, each intervention was assessed for all behavioural change techniques applied. As in the related review by Hendrie et al. (2013), the definitions from Abraham & Michie’s taxonomy of behaviour change techniques (BCT) were used to define the techniques applied in each of the interventions (Abraham & Michie, 2008). Seven of Abraham & Michie’s BCT (BCT Number: 3, 7, 15, 16, 22, 23, 26) were not used in any of the interventions in this review, and were therefore excluded from the reporting in this paper.

Nine additional categories were added to the original taxonomy to account for commonly recurring techniques unique to the interventions in this review. These additional techniques, along with their definition, are described in the supplementary materials.
The effect size (d) was calculated for each intervention using the data available from the publication, or supplementary data provided from the authors upon request. A 95% confidence interval was used for each calculation. The Quality Assessment Tool for Quantitative Studies by Effective Public Health Practice Project was used to compare across studies, as it has demonstrated the ability to adapt the most current methods of systematic reviews (Thomas, Ciliska, Dobbins, & Micucci, 2004).

All papers were independently reviewed by two researchers for study effectiveness, study intensity and study BCTs, and any discrepancies or disagreements in rankings were thoroughly discussed and resolved by coming to a consensus and agreeing on one of the two opinions. Discrepancies were typically minor in nature and were due to a lack of reporting of intervention specifics in the study papers.

2.2.4 Results & Discussion

The present review identified 17 interventions, described in 16 publications, which focused on increasing adolescent intake of dairy and/or Ca, either exclusively or in combination with other dietary and physical activity modifications. Of the 17 different interventions, 12 (~70%) were classified as effective (Table 2.1). This high proportion of effective studies supports results found from a similar systematic review reporting results of dietary interventions aimed to increase dairy and Ca intake among younger children (5-12 years) (Hendrie et al., 2013). This review presents findings of studies conducted globally, thereby providing an exhaustive summary of interventions taking place in areas with varying baseline dairy and Ca intakes.
Table 2.1. Summary of overall intensity ratings

<table>
<thead>
<tr>
<th>Author</th>
<th>Effective</th>
<th>Dairy or Mixed</th>
<th># Modified Behaviours</th>
<th>Change Primary Outcome</th>
<th>Duration</th>
<th>Frequency</th>
<th>Contact</th>
<th>Reach</th>
<th>Overall Intensity</th>
<th>Intensity Scale</th>
<th>Negative Dietary Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadogan (1996)a</td>
<td>Y</td>
<td>Dairy</td>
<td>3/6</td>
<td>Y</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>16</td>
<td>Higher</td>
<td>N</td>
</tr>
<tr>
<td>Casazza (2007)</td>
<td>Y</td>
<td>Mixed</td>
<td>3/5</td>
<td>Y</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>11</td>
<td>Medium</td>
<td>N</td>
</tr>
<tr>
<td>DeBar (2006)</td>
<td>Y</td>
<td>Mixed</td>
<td>1/4</td>
<td>Y</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>19</td>
<td>Higher</td>
<td>N</td>
</tr>
<tr>
<td>DeBar (2009)</td>
<td>Y</td>
<td>Mixed</td>
<td>1/4</td>
<td>Y</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>19</td>
<td>Higher</td>
<td>N</td>
</tr>
<tr>
<td>Gates (2013a)a</td>
<td>N</td>
<td>Dairy</td>
<td>0/2</td>
<td>N</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>3*</td>
<td>13</td>
<td>Medium</td>
<td>N</td>
</tr>
<tr>
<td>Gates (2013b)a</td>
<td>Y</td>
<td>Dairy</td>
<td>1/2</td>
<td>Y</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>14</td>
<td>Higher</td>
<td>N</td>
</tr>
<tr>
<td>Gates (2013b)a</td>
<td>Y</td>
<td>Mixed</td>
<td>1/2</td>
<td>Y</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>14</td>
<td>Higher</td>
<td>Y</td>
</tr>
<tr>
<td>Lo (2008)</td>
<td>N</td>
<td>Mixed</td>
<td>1/4</td>
<td>N</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>12</td>
<td>Medium</td>
<td>N</td>
</tr>
<tr>
<td>Muth (2007)</td>
<td>N</td>
<td>Mixed</td>
<td>1/13</td>
<td>N</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>11</td>
<td>Medium</td>
<td>N</td>
</tr>
<tr>
<td>Naghashpour (2014)</td>
<td>Y</td>
<td>Calcium</td>
<td>1/7</td>
<td>Y</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>9</td>
<td>Lower</td>
<td>N</td>
</tr>
<tr>
<td>Olson (2008)</td>
<td>Y</td>
<td>Mixed</td>
<td>2/3</td>
<td>Y</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>11</td>
<td>Medium</td>
<td>N</td>
</tr>
<tr>
<td>O’Connell (2005)</td>
<td>N</td>
<td>Mixed</td>
<td>1/3b</td>
<td>N</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>3*</td>
<td>15</td>
<td>Higher</td>
<td>N</td>
</tr>
<tr>
<td>Pobocik (2009)</td>
<td>N</td>
<td>Dairy</td>
<td>0/4</td>
<td>N</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>10</td>
<td>Medium</td>
<td>N</td>
</tr>
<tr>
<td>Singhal (2010)</td>
<td>Y</td>
<td>Mixed</td>
<td>4/13</td>
<td>Y</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>17</td>
<td>Higher</td>
<td>N</td>
</tr>
<tr>
<td>Watson (2009)</td>
<td>Y</td>
<td>Mixed</td>
<td>2/9</td>
<td>Y</td>
<td>3</td>
<td>5</td>
<td>3*</td>
<td>1</td>
<td>12</td>
<td>Medium</td>
<td>N</td>
</tr>
<tr>
<td>Wordell (2012)a</td>
<td>Y</td>
<td>Mixed</td>
<td>3/9</td>
<td>Y</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>14</td>
<td>Higher</td>
<td>N</td>
</tr>
<tr>
<td>Yamaoka (2011)</td>
<td>Y</td>
<td>Mixed</td>
<td>3/5</td>
<td>Y</td>
<td>4</td>
<td>3.5</td>
<td>5</td>
<td>3*</td>
<td>15</td>
<td>Higher</td>
<td>N</td>
</tr>
</tbody>
</table>

*italics*: highlights ineffective studies

a = provided food for intervention (all or some)

* parental reach included; parents were involved in some aspect of the intervention that was either optional or not home-based

b = behaviour change only reported in males

c = may have included an environmental component

The intensity ranking scale was as follows: Duration: 1 = < 6 weeks, 2 = 6-11 weeks, 3 = 12 weeks – 5 months, 4 = 6-12 months, 5 = >12 months

Frequency: 1 = annually, 2 = bimonthly to quarterly, 3 = monthly, 3.5 = twice a month, 4 = weekly, 5 = daily

Level of Personalization: 1 = environmental, 2 = group, 3 = environmental + group, 4 = group + individual, 5 = individual OR individual + environmental + group

Reach: 1 = one setting, 3 = two settings, 5 = three or more settings
The summary of overall intensity ratings and the frequency of intervention characteristics and intensity rating categories associated with intervention effectiveness are presented in Table 2.1 and 2.2 respectively. In the current review, nine (~53%) interventions scored higher intensity, seven (~41%) interventions scored medium intensity, and one scored lower intensity (~6%). The mean overall intensity of the effective interventions was 14.25, compared to 12.2 for the ineffective interventions, demonstrating that effective interventions were of higher intensity. This is similar to interventions targeting dairy consumption in children (Hendrie et al., 2013). Most of the higher intensity interventions scored consistently high across all four measures, and the most notable difference between effective and ineffective studies was in the category of duration (effective interventions mean duration score of 4, ineffective interventions mean duration score of 2). The majority of higher intensity interventions lasted from six months to greater than a year, while all ineffective interventions lasted five months or less. Smaller differences were seen in the categories of frequency (effective interventions mean frequency score 4.6, ineffective interventions mean frequency score 4.13), contact (effective interventions mean contact score 3.8, ineffective interventions mean contact score 4.2), and reach (effective interventions mean reach score 2, ineffective interventions mean reach score 1.8). The only category in which effective interventions were of lower intensity was the contact category, which describes the type or level of contact with the intervention, wherein the more personalized the contact, the higher the intensity. Interestingly, the results in this category suggest that individual contact with adolescents is not necessary for successful modification of dairy intake, and targeting subjects at a group level (such as in school) is sufficient, which has relevant implications for resource allocation.
Table 2.2. Frequency of intervention characteristics and intensity rating categories associated with intervention effectiveness*

<table>
<thead>
<tr>
<th>Target of Intervention</th>
<th>Effective Interventions</th>
<th>Ineffective Interventions</th>
<th>Total</th>
<th>% Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>60.0%</td>
</tr>
<tr>
<td>Mixed</td>
<td>10</td>
<td>2</td>
<td>12</td>
<td>83.3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intervention Intensity</th>
<th>Effective Interventions</th>
<th>Ineffective Interventions</th>
<th>Total</th>
<th>% Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>100.0%</td>
</tr>
<tr>
<td>Medium</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>50.0%</td>
</tr>
<tr>
<td>Higher</td>
<td>8</td>
<td>1</td>
<td>9</td>
<td>88.8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Duration</th>
<th>Effective Interventions</th>
<th>Ineffective Interventions</th>
<th>Total</th>
<th>% Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6 weeks</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>33.3%</td>
</tr>
<tr>
<td>6 – 11 weeks</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>50.0%</td>
</tr>
<tr>
<td>12 weeks – 5 months</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>66.7%</td>
</tr>
<tr>
<td>6 – 12 months</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>100.0%</td>
</tr>
<tr>
<td>&gt; 12 months</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency of Contact</th>
<th>Effective Interventions</th>
<th>Ineffective Interventions</th>
<th>Total</th>
<th>% Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annually</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>100.0%</td>
</tr>
<tr>
<td>Bimonthly to quarterly</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Monthly</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>100.0%</td>
</tr>
<tr>
<td>Biweekly</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>100.0%</td>
</tr>
<tr>
<td>Weekly</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>80.0%</td>
</tr>
<tr>
<td>Daily</td>
<td>6</td>
<td>3</td>
<td>9</td>
<td>66.6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level of Personalization</th>
<th>Effective Interventions</th>
<th>Ineffective Interventions</th>
<th>Total</th>
<th>% Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Environmental + Small Group</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>100.0%</td>
</tr>
<tr>
<td>Group</td>
<td>6</td>
<td>1</td>
<td>7</td>
<td>85.7%</td>
</tr>
<tr>
<td>Group + Environmental</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0.0%</td>
</tr>
<tr>
<td>Individual</td>
<td>6</td>
<td>1</td>
<td>7</td>
<td>85.7%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reach</th>
<th>Effective Interventions</th>
<th>Ineffective Interventions</th>
<th>Total</th>
<th>% Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 setting</td>
<td>9</td>
<td>2</td>
<td>11</td>
<td>81.8%</td>
</tr>
<tr>
<td>2 settings</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>50.0%</td>
</tr>
<tr>
<td>3+ settings</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

*Intervention effectiveness is defined as a statistically significant increase (p< 0.05) in a dairy outcome AND outcomes measured using an objective or robust dietary assessment method.

The intensity ranking scale was as follows:
- Duration: 1 = < 6 weeks, 2 = 6-11 weeks, 3 = 12 weeks – 5 months, 4 = 6-12 months, 5 = >12 months
- Frequency: 1 = annually, 2 = bimonthly to quarterly, 3 = monthly, 3.5 = twice a month, 4 = weekly, 5 = daily
- Level of Personalization: 1 = environmental, 2 = group, 3 = environmental + group, 4 = group + individual, 5 = individual OR individual + environmental + group
- Reach: 1 = one setting, 3 = two settings, 5 = three or more settings

The majority of interventions targeted a mix of dietary and/or physical activity behaviour outcomes, and sought to increase dairy food consumption generally and/or Ca intake within the context of a healthy diet. Contrary to the previous systematic review by Hendrie et al. (2013),

64
which found a clear association between interventions focusing on one discrete dietary behaviour and intervention effectiveness, no similar effect was observed in this review. And, although the number of targeted dietary behaviours varied across studies, there were no notable differences between effective and ineffective studies, and there were no studies that successfully modified all targeted behaviours.

Unlike Hendrie et al. (2013), we did not find that reference of a learning theory in the intervention was a predictor of effectiveness, although it was commonly referred to as influencing intervention design. Moreover, we did not find parental involvement and support to be a strong predictor of effectiveness (see Table 2.3), although current literature suggests that there is a significant association between parental presence, availability of milk at home, and consuming meals as a family, and adolescent dairy consumption (Arcan et al., 2007; Larson et al., 2006; Sharma et al., 2009). When interpreting this result, it is important to consider that in the present study, only six of 17 interventions targeted parents as well as adolescents, which is a small proportion. Given this paucity of studies, the importance of incorporating a degree of parental involvement in future intervention development cannot be dismissed, since this association has also been shown to have long-term effects on dairy consumption that continue into adulthood (Arcan et al., 2007). Despite decreasing parental influence during adolescence, incorporating parental support as facilitators of dietary behaviour change has been shown to facilitate intervention effectiveness, potentially resulting in long-term dietary modifications (Larson et al., 2006; Videon & Manning, 2003).
Table 2.3. Frequency of behaviour change techniques associated with intervention effectiveness*

<table>
<thead>
<tr>
<th>Behaviour Change Techniquea</th>
<th>Effective (n = 12)</th>
<th>Ineffective (n = 5)</th>
<th>Total (n = 17)</th>
<th>% Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Provide general information</td>
<td>7</td>
<td>5</td>
<td>12</td>
<td>58.3%</td>
</tr>
<tr>
<td>2. Provide information on consequences</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>57.1%</td>
</tr>
<tr>
<td>4. Prompt intention formation</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>66.7%</td>
</tr>
<tr>
<td>5. Prompt barrier identification</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>60.0%</td>
</tr>
<tr>
<td>6. Provide general encouragement</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>75.0%</td>
</tr>
<tr>
<td>8. Provide instruction</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>83.3%</td>
</tr>
<tr>
<td>9. Model or demonstrate the behaviour</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>50.0%</td>
</tr>
<tr>
<td>10. Prompt specific goal setting</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>40.0%</td>
</tr>
<tr>
<td>11. Prompt review of behavioural goals</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>100.0%</td>
</tr>
<tr>
<td>12. Prompt self-monitoring behaviour</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>100.0%</td>
</tr>
<tr>
<td>13. Provide feedback on performance</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>100.0%</td>
</tr>
<tr>
<td>14. Provide contingent rewards</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>50.0%</td>
</tr>
<tr>
<td>17. Prompt practice</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>100.0%</td>
</tr>
<tr>
<td>18. Use follow-up prompts</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>100.0%</td>
</tr>
<tr>
<td>19. Provide opportunities for social comparison</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>100.0%</td>
</tr>
<tr>
<td>20. Plan social support/social change</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>75.0%</td>
</tr>
<tr>
<td>21. Prompt identification as role model</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0%</td>
</tr>
<tr>
<td>24. Stress management</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>100.0%</td>
</tr>
<tr>
<td>25. Motivational interviewing</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>100.0%</td>
</tr>
<tr>
<td>30. Use of peer leadersb</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0%</td>
</tr>
<tr>
<td>31. Interviews or brief counselingb</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>100.0%</td>
</tr>
<tr>
<td>32. Prompt parental support/involvementb</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>50.0%</td>
</tr>
<tr>
<td>33. Lessons by nutritionist/dietitianb</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>50.0%</td>
</tr>
<tr>
<td>34. Dairy supplements given/providedb</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>75.0%</td>
</tr>
<tr>
<td>35. Learning theory referencedb</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>28.6%</td>
</tr>
<tr>
<td>36. Taste exposureb</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>33.3%</td>
</tr>
<tr>
<td>37. Environmental restructuringb</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>66.7%</td>
</tr>
<tr>
<td>38. Prescribed dietb</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

* intervention effectiveness is defined as a statistically significant increase (p< 0.05) in a dairy outcome AND outcomes measured using an objective or robust dietary assessment method.

a behaviour change techniques from taxonomy by Abraham and Michie (2008).

b additional BCT added to the original taxonomy to account for commonly recurring techniques unique to the interventions in this review.

Although not explicitly considered as a BCT, the use of technology in interventions deserves attention. Three different interventions in this review utilized a form of technology, all of which were determined to be effective. The intervention described in the two DeBar et al. papers (DeBar et al., 2009; DeBar et al., 2006) included an interactive website component that
incorporated many BCT associated with effective interventions in this review, such as providing general encouragement, prompting review of behavioural goals, providing opportunities for social comparison, and planning for social support/change (Abraham & Michie, 2008; DeBar et al., 2009; DeBar et al., 2006). This result supports the systematic review by Webb, Joseph, Yardley, and Michie (2010), which found that internet based interventions that incorporated more BCTs tended to have larger effects on health-related behaviours. Due to the limited information describing the contents and delivery of the other two interventions utilizing technology, the BCT directly applied could not be determined. Considering the increasing influence of the internet and social media during adolescence, it is of utmost importance to address false beliefs and myths concerning dairy consumption. Although this and other barrier identification techniques prove to be impactful, only five studies in this review employed barrier identification behaviour techniques, of which 60% were effective. Nonetheless, these findings support the evidence that information and communication technologies are effective in supporting intervention to modify adolescent behaviour (Lau, Lau, Wong, & Ransdell, 2011; Mauriello, Sherman, Driskell, & Prochaska, 2007; Webb et al., 2010).

A summary of effect size (d) and quality assessment rating for each study is summarized in Table 2.4. While we intended to conduct a meta-analysis of the effectiveness of interventions, due to insufficient data reporting and inconsistent measurement outcomes, effect size was calculated for only six interventions. And, due to the heterogeneity of outcomes, including calcium, milk and dairy intake, making direct comparisons between the effect sizes of studies is difficult. Of the six studies where sufficient data were available to calculate an effect size, all scored moderate (67%) or strong (33%). In terms of quality assessment, a majority of the interventions scored a moderate rating (n 8), followed by weak (n 5), and strong (n 4). Of the
effective studies, 50% were scored moderate and 33% were scored strong, while only 16% scored weak. In contrast, the majority of the ineffective studies scored weak (60%), followed by moderate (40%), and none scored strongly. It is notable that most effective studies in this review were qualitatively scored as strong or moderate, while ineffective studies were typically scored as moderate or weak, which suggests that stronger study designs and outcome measurements result in interventions that can be shown to be more effective. However, this analysis also demonstrates that more accurate reporting of methodology and results are needed in this area of research.
<table>
<thead>
<tr>
<th>Author</th>
<th>Design</th>
<th>Dietary Assessment Method</th>
<th>Intervention Description</th>
<th>Outcome Measure</th>
<th>Effect Size* (d)</th>
<th>Quality Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadogan (1997)</td>
<td>RCT</td>
<td>7-day weighed intake</td>
<td>I—Adolescent girls were supplied 568 ml (one pint) of whole or reduced fat milk per day and asked to consume as much as possible for 18 months (n 44) C—Continue with habitual diet (n 38)</td>
<td>Milk (g/d)</td>
<td>2.08</td>
<td>Strong</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Calcium (mg/d)</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>Casazza (2007)</td>
<td>CCT</td>
<td>24 hr recall</td>
<td>I—Adolescent students received computer-based or traditional health education for 9 weeks, in 45 minute sessions (n 2565 and 2573, respectively) C—Did not receive intervention (n 1599)</td>
<td>Dairy/d</td>
<td>ND</td>
<td>Moderate</td>
</tr>
<tr>
<td>Dawson (2006)</td>
<td>CCT</td>
<td>Study specific questionnaire</td>
<td>I—Seventh and eighth grade students received five consecutive nutrition education sessions, emphasizing health benefits of dairy (n 45) C—Received no intervention (n 18)</td>
<td>Milk/d</td>
<td>NS</td>
<td>Moderate</td>
</tr>
<tr>
<td>DeBar (2006)</td>
<td>RCT</td>
<td>24 hr recall</td>
<td>I—Adolescent girls enrolled in a 2 year behavioural intervention with bimonthly group meetings, quarterly coaching calls, and weekly self-monitoring with additional website component to improve diet and physical activity (n 101) C—Assigned to an attentional control group (n 108)</td>
<td>Calcium (mg/d)</td>
<td>5.54† 5.99‡</td>
<td>Moderate</td>
</tr>
<tr>
<td>DeBar (2009)</td>
<td>RCT</td>
<td>24 hr recall</td>
<td>I—Adolescent girls enrolled in a 2 year behavioural intervention with bimonthly group meetings, quarterly</td>
<td>Calcium (mg/d)</td>
<td>5.54† 5.99‡</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
coaching calls, and weekly self-monitoring with additional website component to improve diet and physical activity \( (n = 101) \)
C—Assigned to an attentional control group \( (n = 108) \)

<table>
<thead>
<tr>
<th>Study &amp; Cohort</th>
<th>Design</th>
<th>Questionnaire</th>
<th>Description</th>
<th>Comparison</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gates (2013a) Cohort WEB-Q</td>
<td></td>
<td>( I )—Rural school implemented a school nutrition program including policy, education, food provision, and family and community involvement ( (n = 26) )</td>
<td></td>
<td>Milk and milk alternatives ( (\text{servings/d}) )</td>
<td>NS Weak</td>
</tr>
<tr>
<td>Calcium ( (\text{mg/d}) )</td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gates (2013b) Attawapiskat Cohort WEB-Q</td>
<td></td>
<td>( I )—A pilot milk provision program was administered to students in a community school ( (n = 70) )</td>
<td></td>
<td>Milk and milk alternatives ( (\text{servings/d}) )</td>
<td>ND Weak</td>
</tr>
<tr>
<td>Calcium ( (\text{mg/d}) )</td>
<td>ND</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gates (2013b) Kashechwan Cohort WEB-Q</td>
<td></td>
<td>( I )—A pilot snack program was administered to students in a community school with nutrition education guidelines ( (n = 43) )</td>
<td></td>
<td>Milk and milk alternatives ( (\text{servings/d}) )</td>
<td>ND Weak</td>
</tr>
<tr>
<td>Calcium ( (\text{mg/d}) )</td>
<td>ND</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lo (2008) CCT BFQ</td>
<td></td>
<td>( I )—Adolescent 9(^{th}) grade students enrolled in a school-based nutrition education program about beverage intake with peer educators for 6 weeks ( (n = 53) )</td>
<td></td>
<td>Milk ( (\text{servings/week}) )</td>
<td>NS Weak</td>
</tr>
<tr>
<td>Muth (2008) UCT SPAN questionnaire</td>
<td></td>
<td>( I )—High school students were selected to implement a nutrition and physical activity education program to elementary students ( (n = 9) )</td>
<td></td>
<td>Calcium-rich foods ( (\text{d/}) )</td>
<td>NS Weak</td>
</tr>
<tr>
<td>Naghashpour (2014) CCT FFQ</td>
<td></td>
<td>( I )—Female students of junior high school participated in eight 30-minute to one-hour nutrition</td>
<td></td>
<td>Dairy ( (\text{d/}) )</td>
<td>0.17 Strong</td>
</tr>
<tr>
<td>Authors (Year)</td>
<td>Design</td>
<td>Instrument</td>
<td>Intervention Details</td>
<td>Outcome</td>
<td>Effect Size</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------</td>
<td>------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>O’Connell (2005)</td>
<td>CCT</td>
<td>FFQ</td>
<td>Education sessions focusing on calcium intake during a two-month period based on Health Belief Mode (n 95) C—Received no training (n 93)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olson (2008)</td>
<td>CCT</td>
<td>Study specific questionnaire</td>
<td>23-week middle school intervention with nutrition education, school dinners, mailing information, cafeteria changes and awareness to increase fruit, vegetable, and dairy consumption (n 220) C—Received no school intervention (n 269)</td>
<td>Dairy/d</td>
<td>ND</td>
</tr>
<tr>
<td>Singhal (2010)</td>
<td>CCT</td>
<td>Study specific questionnaire</td>
<td>Adolescents enrolled in the study after well-visits and clinicians utilized PDAs to provide information about health, risks, and motivation to change (n 136) C—Usual care well visits (n 148)</td>
<td>Dairy/d</td>
<td>ND</td>
</tr>
<tr>
<td>Watson (2009)</td>
<td>CCT</td>
<td>Study specific questionnaire</td>
<td>High school enrolled in a 6-month multi-component intervention model of nutrition and lifestyle education on behaviour modification (n 99) C—School with no intervention (n 102)</td>
<td>Milk (glasses/d)</td>
<td>ND</td>
</tr>
<tr>
<td>Wordell (2012)</td>
<td>CCT?</td>
<td>Modified FFQ</td>
<td>Three-year intervention in middle schools to alter school food environment and food choices of 7th</td>
<td>Milk (servings/d)</td>
<td>0.70</td>
</tr>
</tbody>
</table>

71
and 8th grade students in and outside of school (n 1406)  
C—No school food environment modifications (n 2707)  

<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Design</th>
<th>Method</th>
<th>Description</th>
<th>Calcium (mg/d)</th>
<th>Effect Size</th>
<th>Quality</th>
</tr>
</thead>
</table>
| Yamaoka (2011)   | RCT    | FFQ    | I—Group-based home-collaborative (HCDE) intervention with 12 sessions and some individual counseling for 6 months to increase energy intake in adolescent girls (n 225)  
C—Received conventional health science education in the classroom (n 234)  | 1.46           | Moderate               |

RCT, randomized controlled trial, NS, not significant, CCT, clinical controlled trial, ND, no data available to calculate effect size, UCT, uncontrolled clinical trial  
* effect size (d) calculated with 95% confidence interval.  
† effect size (d) for year one of intervention (Singhal, Misra, Shah, & Gulati, 2010; Watson et al., 2009).  
‡ effect size (d) for year two of intervention (Singhal et al., 2010; Watson et al., 2009).
Only one study in this review reported a follow-up measure, at three months post-intervention, which was determined to be an ineffective intervention (Lo et al., 2008). It is therefore unclear whether the positive dietary changes in effective studies were maintained after the study completion. Adequate follow-up measures are required to determine which, if any, behaviour modifications are sustained. As mentioned in the previous systematic review by Hendrie et al. (2013), achieving long-term behaviour change requires that the barriers to dairy consumption must be overcome, according to social cognitive theory.

Within this review, there are limitations that must be considered. Studies were published in English, which could have created a small bias to North American studies. As well, this review strictly included dairy and/or Ca modifications, so interventions deemed ineffective in the present review may have been effective with regards to the various other dietary and physical activity targets of the intervention. In addition, the studies determined to be effective must be considered within the context of the study design. For example, the study by Cadogan et al. (1996) was effective in increasing milk consumption among adolescent girls; however, this could potentially solely be a result of the fact that the study design required participants to consume milk for the intervention, with one BCT applied. Moreover, several interventions in this review involved only female adolescents, all of which were determined to be effective (Cadogan et al., 1996; DeBar et al., 2006; Naghashpour, Shakerinejad, Lourizadeh, Hajinajaf, & Jarvandi, 2014). Thus, the relevance of the findings to increasing adolescent boys’ intake should be assessed.

2.2.4 Conclusion

Dietary interventions that aim to increase dairy consumption or Ca intake can potentially assist adolescents in achieving daily Ca intake requirements for healthy development. The current review has identified characteristics of effective interventions that are likely to increase
dairy consumption and Ca intake in countries where adolescent intake is insufficient, including the use of BCT such as prompting review of behavioural goals, self-monitoring behaviour, and practice; and providing feedback, opportunities for social comparison, and interviews or brief counseling. Moreover, intervention intensity was clearly associated with intervention effectiveness, particularly in terms of longer intervention duration, and intervention effectiveness was also linked with stronger study quality. Studies investigating the impact of solely targeting dairy and Ca, along with sufficient data and follow-up results are required. The findings of this review may be used to inform the development of interventions that target adolescents, with the goals of combating insufficient dairy intake.
2.3 Systematic Review of School-Based Interventions to Modify Dietary Behaviour: Does Intervention Intensity Impact Effectiveness?

This is the peer reviewed version of the following article:

Megan Racey, MSc, Charlene O’Brien, BSc, Sabrina Douglas, BSc, Olivia Marquez, MSc, Gilly A. Hendrie, PhD, and Genevieve Newton, PhD. Systematic Review of School-Based Interventions to Modify Dietary Behaviour: Does Intervention Intensity Impact Effectiveness? Journal of School Health, 2016, 86(6), 452-463.

which has been published in final form at DOI: 10.1111/josh.12396. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Self-Archiving.
Abstract

Background: Owing to the associations between diet and health, it is important that effective health promotion strategies establish healthful eating behaviours from an early age. We reviewed the intensity of school-based interventions aimed to modify dietary behaviour in preadolescent and adolescents and related intervention characteristics to effectiveness.

Methods: Our systematic literature search of 8 databases sought to identify interventions measuring dietary intake in school settings to students aged 9 to 18. We evaluated these studies for effectiveness, intensity, intervention category, and follow-up measures.

Results: Of the 105 interventions 81 were found to be effective immediately post-intervention, irrespective of intensity. Studies that were six weeks to five months in duration, targeted students’ environment or group (alone or in combination), and reached students only in schools were more effective. Only one-fifth of interventions conducted a follow-up measure, and a majority showed a loss of effectiveness from post-intervention to follow-up.

Conclusions: We identified characteristics of effective interventions. These findings may inform the development of future interventions targeting dietary behaviour in preadolescents and adolescents in the school-based setting.

Keywords: systematic review; school-based interventions; child and adolescent health; methods and materials of instruction; school health instruction.

Introduction

A healthful diet during preadolescence and adolescence promotes optimal health, growth, and cognitive development. Healthy eating habits are also important for the prevention of chronic diseases, such as cancer, later in life (OMYCS, 2011). Intake of healthy foods, such as fruit and vegetables and low-fat dairy products, can help students perform better in school, have
better digestive health, and maintain a healthy weight (OMYCS, 2011). Owing to the clear associations between diet and health, it is important that effective health promotion strategies are utilized to establish healthful eating behaviours from an early age. Therefore, targeting youth during their preadolescent and adolescent stage of development is crucial for them to reap the numerous reported benefits of eating well during this period, and to translate these healthy eating habits into adult behaviours (Delgado-Noguera, Tort, Martínez-Zapata, & Bonfill, 2011; Powers, Struempler, Guarino, & Parmer, 2005).

The school setting has been deemed a viable location for nutrition education interventions. Schools have the potential to reach children of all ages with diverse ethnic and socioeconomic backgrounds, and research confirms that nutrition behaviours can be both established and altered in this setting (Delgado-Noguera et al., 2011; Powers et al., 2005). Previous reviews of school-based interventions have demonstrated a variety of different intervention approaches, including nutrition education, increased availability of healthy foods, free or subsidized food programs, environmental changes, and parental involvement (Delgado-Noguera et al., 2011; Evans, Christian, Cleghorn, Greenwood, & Cade, 2012; Knai, Pomerleau, Lock, & McKee, 2006). Whereas these have yielded information regarding intervention approaches, delivery, and measurements (particularly in at-risk populations) (Van Cauwenberghe et al., 2010), little is known about the relationship between intervention intensity and effectiveness. Evaluation of intervention intensity considers four scales, including duration, frequency of contact, level of personalization, and the reach of the strategies, and has been used to evaluate the effectiveness of nutrition interventions (Hendrie et al., 2013). This information is particularly relevant given the relationship between resource allocation, both financial and otherwise, and intervention intensity.
Following this, the objective of this paper is to present a systematic review and analysis of the intensity of published interventions aimed to modify the dietary behaviour of preadolescents and adolescents in a school-based setting. Here, we consider the intensity of dietary interventions in totality as well as within subtypes of different dietary categories. Using this method, we will identify the characteristics of effective interventions, which can be used to inform the development of future school-based interventions targeting dietary behaviour in preadolescents and adolescents.

2.3.3 Methods

2.3.3.1 Participants

Interventions delivered directly to adolescents or preadolescents, with preadolescents defined as 9-12 years (Merriam-Webster, 2014) and adolescents described as 13-18 years (NCBI, N.D.), were included. If the ages of participants fell outside of this range, the mean age had to be within this range to warrant inclusion. To make this review relevant to the general population, studies that targeted clinical populations, such as obese, malnourished, or lactose-intolerant groups, were excluded.

2.3.3.2 Instruments

The search for literature strictly followed the PRISMA four-phase flow diagram guidelines (Moher et al., 2009; PRISMA, N.D.). A list of search terms and databases to search was developed in consultation with a learning and curriculum support specialist and was informed by a recent systematic review (Hendrie et al., 2013). The search terms used were comprehensive and inclusive (see Appendix A). They were categorized under the following four headings: Interventions, Nutrition, Population, and Setting. The search included papers published
between 1993 and 2015 (March), published in the following databases: ProQuest (41 databases), Web of Science (eight databases, including PubMed), Food & Nutrition Databases, Cochrane Database, Cumulative Index to Nursing and Allied Health Literature, Health and Psychosocial Instruments, Food Agricultural Organization, and CAB direct. Grey literature and reference lists of identified reviews and articles were also searched. Studies were evaluated based on their effectiveness, using the criteria developed by Hendrie et al. (2013). A study was considered effective if the primary dietary outcome demonstrated a significant change (reported as p<.05) in a healthy direction (eg, a study that aimed to increase fruit and vegetable consumption was deemed effective if the intake of fruit and/or vegetables increased). Studies were also evaluated based on their intensity, using a modification of the intensity assessment criteria used by Hendrie et al. (2013).

2.3.3.3 Procedure

Studies were limited to those published in English and were included if they evaluated the effectiveness of an intervention designed to modify dietary intake, with or without a control group. Studies without a control group were included due to the challenges inherent to public health interventions in replicating a controlled environment and recruiting participating groups. Studies were required to conduct some components of the intervention in a school setting. Interventions were required to include outcomes of modified dietary intake at the group and/or individual level, and dietary intake had to be measured through an objective method (sales data or observed intake) or a robust dietary assessment method (FFQ, 24-hour recall, weighed records).

Immediate intervention effectiveness was determined as well as follow-up effectiveness using the same criteria mentioned above. Follow-up was divided into mid- and long-term follow-
up, with midterm follow-up defined here as three weeks to four months post-intervention, and long-term follow-up defined as six months to two years post-intervention.

A subsequent overall intensity score was determined by calculating the sum of the four components of intensity (out of a possible 20). When required information was not available, an overall intensity score was not calculated. Unfortunately, a lack of reported information resulted in the inability to evaluate fidelity to implementation or dose. Relative to the studies included in the present review, scores greater than 13 were considered as “higher” intensity, 11-12 as “medium” intensity, and 10 or less as “lower” intensity. Evaluated characteristics based on a previous review (Hendrie et al., 2013) included:

1. **Duration of intervention**: described the length of intervention (scaled relative to interventions included in the review).

2. **Frequency of contact with intervention**: described the frequency of contact between the participants and the intervention. If the intervention used multiple frequencies of contact points, the most frequent contact was used. If the frequency of contact was not explicitly stated, then the contact points were divided by the duration in order to obtain an average contact frequency.

3. **Level of personalization/contact**: described the type of contact or level of contact with the intervention.

4. **Reach of the strategies**: described as the number of settings, such as school, home/parents, or community, used to reach the target population.

The intensity ranking scale was as follows:

1. **Duration**: 1 = <6 weeks, 2 = 6-11 weeks, 3 = 12 weeks—5 months, 4 = 6-12 months, 5 = >12 months.
2. **Frequency:** 1=annually, 2=bimonthly to quarterly, 3=monthly, 4=weekly, 5=daily.

3. **Level of Personalization:** 1=environmental, 2=large group, 3=environmental + large group, 4=large group + individual, 5=individual OR individual + environmental + group.

4. **Reach:** 1=one setting, 3=two settings, 5=three or more settings.

The number of modified behaviours for each study was assessed in order to keep track of the dietary behaviours that were measured. Only dietary measurements were taken into consideration, although many studies reported other outcomes such as physical activity measurements, body mass index (BMI), ratios, body measurements, or psychological predictors of behaviour such as knowledge. Dietary behaviours were defined as those that directly related to eating, such as changes in macronutrient or food group intake. Micronutrient measurements were not included as a modified behaviour unless the intervention specifically taught or focused on micronutrient intake (e.g., calcium intake in dairy interventions).

Interventions were categorized based on the primary dietary target or the main dietary message of the intervention. Each intervention fit into a single category only. Interventions were defined by the following four categories:

1. **Fruit and/or vegetable:** a focus on increasing fruit and/or vegetable (FV) intake, the benefits of FV, types of FV, ways to eat more FV, etc.

2. **General healthy eating:** any technique related to general healthy eating in the larger domain of an overall healthy lifestyle such as increasing hydration, decreasing salt intake, increasing FV intake, decreasing fat intake, increasing physical activity, etc. For these interventions, ALL targeted dietary behaviours were considered when evaluating effectiveness of the intervention, focusing mainly on the macronutrient, or food group results.
3. **Single food group focus**: interventions that focused on modifying intake of a single food or food group, such as decreasing sugar-sweetened beverages, or increasing fish or dairy consumption. Studies in this category sought to modify the intake of fish (n = 1), dairy (n = 6), or sugar-sweetened beverages (n = 5).

4. **Single nutrient focus**: a specific dietary focus of modifying the intake of a single nutrient. In this review, all of the studies in this category sought to modify lipid intake (n = 7).

The analysis of intervention effectiveness and intensity was performed for all studies as a whole, and as broken down by intervention category. Two researchers independently reviewed all papers, and any discrepancies were discussed and resolved.

**2.3.3.4 Data Analysis**

Owing to the heterogeneity in assessment methods and outcomes, such as intake of different foods, macro- or micronutrients, or food sales, a meta-analysis was not conducted. Rather, the intensity of interventions was analyzed on the basis of effectiveness. Effective and ineffective studies were compared using two-tailed, unpaired Student’s t-tests. Comparisons were made between each intensity component, including duration, frequency, level of personalization, and reach as well as overall intensity. One-way analysis of variance (ANOVA) was used to compare mean values between each intensity component and overall intensity in effective and ineffective studies in each intervention category, including fruits and vegetables, general healthy eating, single food or food group, and single nutrient. Tukey’s post hoc test was used where indicated by a statistically significant ANOVA. A statistically significant difference was defined as p < .05. All analyses were performed using SPSS version 20.0 (IBM SPSS Statistics, Armonk, NY).
2.3.4 Results

2.3.4.1 Search Outcomes

Consistent with the PRISMA 4-phase flow diagram, 105 interventions, described in 104 publications, were included in the qualitative synthesis. One published manuscript described the intervention given to two distinct populations. These were treated as two different interventions. The final PRISMA diagram is shown in Figure 2.2. Following the screening phase, a total of 248 articles were assessed for eligibility using a full-text analysis, based on the inclusion and exclusion criteria previously described. From this, 144 articles were excluded for the following reasons: clinical populations (n = 11), lack of dietary intake measure (n = 36), no intervention (n = 24), not school-based (n = 10), lacking full article (n = 25), no English publication available (n = 7), older than 20 years (n = 2), incorrect age range (n = 16), lacking results (n = 5) and duplicates or report of existing study (n = 8). As a result, we included 104 studies describing 105 interventions in the review.
Figure 2.2. PRISMA flowchart of search outcomes
2.3.4.2 Intervention Intensity Analysis

*Overall intensity.* Of the 105 interventions included in the present review, 81 were effective and 18 were ineffective, and effectiveness for six interventions could not be determined due to lack of information. Studies were distributed across the levels of intervention intensity, with 19 studies ranked as low, 29 studies ranked as medium, and 36 studies ranked as high, while for 15 studies’ intensity could not be determined due to lack of information (see Appendix B).

Interventions in which effectiveness or intensity could not be determined were still included in this review as they met our inclusion criteria and these interventions still contributed scores and completeness to the evaluated categories. Table 2.5 presents a summary of intensity interventions with known effectiveness, whereas Table 2.6 presents the mean ± SEM intensity values of effective and ineffective interventions, excluding studies for which effectiveness and overall intensity could not be determined. There were no significant differences between the intensity of effective and ineffective interventions either overall or as broken down by intensity component, including intervention duration, frequency of contact, level of personalization, or reach.
Table 2.5. Summary of intensity of interventions with known effectiveness*

<table>
<thead>
<tr>
<th>Intensity*</th>
<th>Effective Interventions</th>
<th>Ineffective Interventions</th>
<th>Total</th>
<th>% Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>16</td>
<td>3</td>
<td>19</td>
<td>84.2</td>
</tr>
<tr>
<td>Medium</td>
<td>24</td>
<td>5</td>
<td>29</td>
<td>82.8</td>
</tr>
<tr>
<td>High</td>
<td>29</td>
<td>7</td>
<td>36</td>
<td>80.5</td>
</tr>
<tr>
<td>Unknown</td>
<td>12</td>
<td>3</td>
<td>15</td>
<td>80.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Duration†</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6 weeks</td>
<td>9</td>
<td>4</td>
<td>13</td>
<td>69.2</td>
</tr>
<tr>
<td>6 – 11 weeks</td>
<td>13</td>
<td>1</td>
<td>14</td>
<td>92.9</td>
</tr>
<tr>
<td>12 weeks – 5 months</td>
<td>16</td>
<td>2</td>
<td>18</td>
<td>88.9</td>
</tr>
<tr>
<td>6 – 12 months</td>
<td>21</td>
<td>6</td>
<td>27</td>
<td>77.8</td>
</tr>
<tr>
<td>&gt; 12 months</td>
<td>18</td>
<td>4</td>
<td>22</td>
<td>81.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency of Contact†</th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Annually</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bimonthly to quarterly</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Monthly</td>
<td>7</td>
<td>1</td>
<td>8</td>
<td>87.5</td>
</tr>
<tr>
<td>Weekly</td>
<td>25</td>
<td>7</td>
<td>32</td>
<td>78.1</td>
</tr>
<tr>
<td>Daily</td>
<td>38</td>
<td>7</td>
<td>45</td>
<td>84.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Personalization†</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>14</td>
<td>3</td>
<td>17</td>
<td>82.3</td>
</tr>
<tr>
<td>Group</td>
<td>20</td>
<td>4</td>
<td>24</td>
<td>83.3</td>
</tr>
<tr>
<td>Environmental + Group</td>
<td>25</td>
<td>4</td>
<td>29</td>
<td>86.2</td>
</tr>
<tr>
<td>Individual + Group</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>50.0</td>
</tr>
<tr>
<td>Environmental + Individual + Group</td>
<td>16</td>
<td>3</td>
<td>19</td>
<td>84.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reach†</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 setting</td>
<td>50</td>
<td>9</td>
<td>59</td>
<td>84.7</td>
</tr>
<tr>
<td>2 settings</td>
<td>29</td>
<td>9</td>
<td>38</td>
<td>76.3</td>
</tr>
<tr>
<td>3+ settings</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*The total number of interventions with known effectiveness is 99 (81 effective, 18 ineffective). The six interventions with unknown effectiveness are not included here.
†Ratings for categories could not always be determined and/or interventions may have more than one delivery method; therefore, total intervention sums are variable.

Table 2.6. Mean (± SEM) intensity values of effective and ineffective interventions

<table>
<thead>
<tr>
<th></th>
<th>Duration</th>
<th>Frequency of Contact</th>
<th>Personalization</th>
<th>Reach</th>
<th>Overall intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective interventions</td>
<td>3.34 (0.15)</td>
<td>4.44 (0.08)</td>
<td>2.84 (0.15)</td>
<td>1.81 (0.12)</td>
<td>12.32 (0.31)</td>
</tr>
<tr>
<td>Ineffective interventions</td>
<td>3.29 (0.37)</td>
<td>4.40 (0.16)</td>
<td>3.00 (0.32)</td>
<td>2.00 (0.24)</td>
<td>12.73 (0.70)</td>
</tr>
</tbody>
</table>

The intensity ranking scale was as follows:
Duration: 1=<6 weeks, 2=6-11 weeks, 3=12 weeks—5 months, 4=6-12 months, 5 = >12 months.
Frequency: 1=annually, 2=bimonthly to quarterly, 3=monthly, 4=weekly, 5=daily.
Level of Personalization: 1=environmental, 2=large group, 3=environmental + large group, 4=large group + individual, 5=individual OR individual + environmental + group.
Reach: 1=one setting, 3=two settings, 5=three or more settings.

Nutrition categories. Table 2.7 presents the intensity evaluation of studies aiming to modify behaviour across different nutrition categories. Interventions in each category were highly
effective (see Appendix B): fruit and vegetable (n = 33; effective n = 27, ineffective n = 4, unknown effectiveness n = 2), general healthy eating (n = 53; effective n = 41, ineffective n = 0, unknown effectiveness n = 2), single food or food group (n = 12; effective n = 8, ineffective n = 3, unknown effectiveness n = 1), and single nutrient (n = 7; effective n = 5, ineffective n = 1, unknown effectiveness n = 1). Comparing the frequency of effective studies in different categories showed that the mean frequency of interventions in the single food or food group category was significantly higher than for the general healthy eating category (ANOVA p=.04, Tukey’s post hoc test p=.03). There were no other significant differences observed between the intensity of effective and ineffective interventions in different categories or as broken down by intensity component, including intervention duration, frequency of contact, level of personalization, or reach.
### Table 2.7. Intensity evaluation of studies in nutrition categories based on effectiveness*

<table>
<thead>
<tr>
<th>Nutrition Category</th>
<th>Duration (/5)</th>
<th>Frequency (/5)</th>
<th>Personalization (/5)</th>
<th>Reach (/5)</th>
<th>Overall (/20)</th>
<th>Intensity Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effective Studies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit and/or vegetable</td>
<td>3.2</td>
<td>~4.5</td>
<td>2.6</td>
<td>1.9</td>
<td>11.4-12.0</td>
<td>Medium</td>
</tr>
<tr>
<td>General healthy eating</td>
<td>3.44</td>
<td>4.2-4.3</td>
<td>3.0-3.2</td>
<td>1.8</td>
<td>12.6-12.7</td>
<td>Medium</td>
</tr>
<tr>
<td>Single food or food group</td>
<td>3.6</td>
<td>5</td>
<td>2.3-2.5</td>
<td>1.5</td>
<td>12.3-12.6</td>
<td>Medium</td>
</tr>
<tr>
<td>Single nutrient (fat)</td>
<td>2.75</td>
<td>4.5</td>
<td>3.8</td>
<td>1.8-2.2</td>
<td>13.5-14</td>
<td>High</td>
</tr>
<tr>
<td><strong>Ineffective Studies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit and/or vegetable</td>
<td>3.3</td>
<td>4.0</td>
<td>3.0</td>
<td>2.0</td>
<td>12.7</td>
<td>Medium</td>
</tr>
<tr>
<td>General healthy eating</td>
<td>3.8</td>
<td>4.3</td>
<td>3.4</td>
<td>2.3</td>
<td>14.0</td>
<td>High</td>
</tr>
<tr>
<td>Single food or food group</td>
<td>1.3</td>
<td>4.7</td>
<td>3</td>
<td>1.7</td>
<td>10.7</td>
<td>Medium</td>
</tr>
<tr>
<td>Single nutrient (fat)</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>11</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Studies with unknown effectiveness</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit and/or vegetable</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>19</td>
<td>High</td>
</tr>
<tr>
<td>General healthy eating</td>
<td>2.5</td>
<td>4.0-4.5</td>
<td>3.5</td>
<td>2</td>
<td>12.0-12.5</td>
<td>Medium</td>
</tr>
<tr>
<td>Single food or food group</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>11</td>
<td>Medium</td>
</tr>
<tr>
<td>Single nutrient (fat)</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Duration: 1=<6 weeks, 2=6-11 weeks, 3=12 weeks-5 months, 4=6-12 months, 5=>12 months.
Frequency: 1=annually, 2=bimonthly to quarterly, 3=monthly, 4=weekly, 5=daily.
Level of Personalization: 1=environmental, 2=large group, 3=environmental + large group, 4=large group + individual, 5=individual OR individual + environmental + group.
Reach: 1=one setting, 3=two settings, 5=3+ settings.
*Mean values for each intensity ranking are presented here.
Follow-up measures. Of the 105 interventions reviewed, 21 or 20% of all interventions, conducted follow-up analysis (Table 2.8). Six conducted a midterm-only analysis, 12 conducted a long-term only analysis, and three conducted both a midterm and long-term analysis. Of the studies that were effective immediately post-intervention for which follow-up measures were available, five maintained effectiveness and six were ineffective at later follow-up. Notably, of the three studies that conducted both mid- and long-term follow-up, two were effective at midterm but not at long-term, and the study that retained a significant measurement of effectiveness at both time points nonetheless showed a decrease from mid- to long-term.
<table>
<thead>
<tr>
<th>Study</th>
<th>Intervention Type</th>
<th>Type of Follow-up</th>
<th>Effective at Immediate Follow-Up (Yes/No)</th>
<th>Effective at Mid-/Long-Term Follow-Up (Yes/No)</th>
<th>Intervention Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ansari et al (2014)</td>
<td>General</td>
<td>Both midterm and long-term</td>
<td>Unknown*</td>
<td>Yes at both time points in group, although decreased mid- to long-term</td>
<td>Low</td>
</tr>
<tr>
<td>Ashfield-Watt et al (2009)</td>
<td>Fruit/vegetable</td>
<td>Midterm</td>
<td>Yes</td>
<td>No</td>
<td>Low</td>
</tr>
<tr>
<td>Bere et al (2006)</td>
<td>Fruit/vegetable</td>
<td>Long-term</td>
<td>No</td>
<td>No</td>
<td>Medium</td>
</tr>
<tr>
<td>Bessem et al (2012)</td>
<td>Fruit/vegetable</td>
<td>Long-term</td>
<td>Yes</td>
<td>Yes</td>
<td>Low</td>
</tr>
<tr>
<td>Dawson (2006)</td>
<td>Single nutrient</td>
<td>Midterm</td>
<td>No</td>
<td>No</td>
<td>Medium</td>
</tr>
<tr>
<td>DeVault et al (2009)</td>
<td>Single nutrient</td>
<td>Midterm</td>
<td>Yes</td>
<td>Yes</td>
<td>Medium</td>
</tr>
<tr>
<td>DeWar et al (2013)</td>
<td>General</td>
<td>Long-term</td>
<td>No</td>
<td>No</td>
<td>Unknown</td>
</tr>
<tr>
<td>Ezendam et al (2012)</td>
<td>General</td>
<td>Long-term</td>
<td>Yes</td>
<td>No</td>
<td>Medium</td>
</tr>
<tr>
<td>Fairclough et al (2013)</td>
<td>General</td>
<td>Midterm</td>
<td>No</td>
<td>No</td>
<td>Medium</td>
</tr>
<tr>
<td>Gates et al (2013)</td>
<td>Single food</td>
<td>Long-term</td>
<td>Yes</td>
<td>No+</td>
<td>High</td>
</tr>
<tr>
<td>Jemmott et al (2011)</td>
<td>Fruit/vegetable</td>
<td>Long-term</td>
<td>Yes</td>
<td>No at both time points</td>
<td>High</td>
</tr>
<tr>
<td>Krolner (2012)</td>
<td>Fruit/vegetable</td>
<td>Long-term</td>
<td>NA (ongoing)</td>
<td>NA (ongoing)</td>
<td>High</td>
</tr>
<tr>
<td>Lo et al (2008)</td>
<td>Single food</td>
<td>Both midterm and long-term</td>
<td>No</td>
<td>Effective at midterm but not long-term follow-up</td>
<td>Medium</td>
</tr>
<tr>
<td>Pbert et al (2013)</td>
<td>General</td>
<td>Long-term</td>
<td>Yes</td>
<td>No</td>
<td>Medium</td>
</tr>
<tr>
<td>Study</td>
<td>Type</td>
<td>Timeframe</td>
<td>Segment</td>
<td>Effectiveness at Midterm</td>
<td>Long-term Effectiveness</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------</td>
<td>------------</td>
<td>---------</td>
<td>--------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Singh et al (2009)</td>
<td>General</td>
<td>Both</td>
<td>Yes</td>
<td>Effective at midterm but not long-term follow-up</td>
<td>Unknown</td>
</tr>
<tr>
<td>Smith and Holloman (2014)</td>
<td>Single food</td>
<td>Midterm</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Te Velde et al (2008)</td>
<td>Fruit/vegetable</td>
<td>Long-term</td>
<td>Yes</td>
<td>No</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

* Study did not perform a measurement immediately post-intervention
+ Study measured the decline in dairy consumption from immediate to long-term follow-up and found a significant decrease
2.3.5 Discussion

Our review describes the findings of studies conducted globally, thereby providing an exhaustive summary of interventions taking place in areas with diverse food practices and school-based settings. We identified 105 interventions, described in 104 publications, which focused on modifying the dietary intake of preadolescents or adolescents in a school-based setting. Effectiveness was determined for 99 of the interventions, of which ∼82% were found to be effective at immediate follow-up (Table 2.5). This high proportion of effective studies supports results found from a similar systematic review of dietary interventions aimed to increase dairy and calcium intake among younger children (5-12 years) (Hendrie et al., 2013), as well as a review of dietary interventions to increase dairy and calcium intake among adolescents (12-18 years) (Marquez, Racey, Preyde, Hendrie, & Newton, 2015). A previous meta-analysis which reviewed school-based interventions also showed high efficacy in reducing obesity rates (Lavelle, Mackay, & Pell, 2012). Our findings are consistent with previous research that shows that schools are a promising setting for impacting dietary change (Bevans, Sanchez, Teneralli, & Forrest, 2011; Katz, 2012; Knai et al., 2006; Mobley et al., 2012; Van Cauwenberghe et al., 2010), although there was a loss of effectiveness across time.

There was variable distribution of interventions across the different levels of intensity, with the majority of interventions being scored as high intensity. A total of 10 points separated the highest and lowest scored intervention intensities, and 15 interventions were not scored because of missing values. Studies that achieved a higher intensity rating scored consistently well across all four measures. Based on previous research (Hendrie et al., 2013; Marquez et al., 2015), we hypothesized that higher intensity interventions would be more effective than interventions with lower intensity; however, the data did not support this idea. As illustrated in
Table 2.5, more than 80% of interventions irrespective of intensity were effective at immediate follow-up, demonstrating a significant positive change in dietary behaviour post-intervention.

Higher intensity studies showed more consistent characteristics than low and medium intensity interventions, including more personalized contact with subjects, longer durations, and more frequent, daily contact with the participants. They also often reached more than just the school environment and involved some home or parental component. Less consistency was observed when looking at medium and lower intensity studies, which were both observed to be very effective, as they scored variably on intensity rankings, except for frequency of contact. Both medium and lower intensity studies were found to have similar frequencies of contact, including both weekly and/or daily intervention visits. They also tended to be conducted in one setting and targeted the students at a lower level of personalization such as environmental or large group. Study duration was one of the main differences between the medium and lower intensity studies, as medium intensity studies tended to be longer in duration than lower intensity studies. Lower intensity studies tended to be less than six weeks in duration. Although clear trends were not evident between the intensity rankings, these results demonstrate that higher intensity studies, with more time and resources invested, can be highly effective, but the investment is not always necessary to achieve intervention effectiveness.

When considering the associations between the components of intervention intensity and intervention effectiveness, study duration showed the most consistent findings. Studies between six weeks and five months in duration appeared to be the most effective, with longer or shorter studies being less likely to result in positive dietary changes. It may be that there is a fine balance between study duration and research visits. Longer studies often had less frequent intervention visits, thus impacting the ability for reinforcement during the study; these interventions may have
been too drawn out with not enough visits, reminders, or follow-ups. Shorter studies, of less than six weeks, had more frequent visits, but often did not allow enough time for students to make significant changes. It therefore appears that it is necessary to find a study length that allows for an appropriate number of visits, whereas also giving time for changes in behaviour to be made.

Another consistent observation related to intervention intensity and effectiveness is that interventions that reached students only in schools were more effective than those with broader reach. Although it is generally accepted that the home, as an additional setting for school-based interventions, is likely to play an important role in the development of habits in children, in the present review, including other reaches such as the home did not necessarily translate to a more effective intervention, possibly due to poor execution of these extended reaches. It is also important to note that while two settings, mainly school and home, was still highly effective, in many cases the second setting was not very active and this varied greatly between studies.

Parental involvement was often passive in the form of newsletters, homework, or small packages that were meant to involve the parents and promote a supportive home environment; however, few studies actively required parents’ involvement. Whereas it is known that parents, as nutritional gatekeepers, can influence healthy food availability, and support and role model favorable behaviours (Downs et al., 2009; Edlefsen et al., 2008; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2001; Fisher et al., 2004; Gillman et al., 2000; Novotny, Han, & Biernacke, 1999; Olson, Chung, Reckase, & Schoemer, 2009; Sharma et al., 2009; Sharma et al., 2010; Vue & Reicks, 2007; Wansink, 2006), it is recommended that when used as part of school-based interventions, parents should be actively involved, rather than voluntary participants, to improve dietary intake in preadolescents and adolescents. Nonetheless, our analytic results show that parental involvement may not improve effectiveness beyond the school setting, perhaps due to
unclear expectations and a lack of participation in optional activities. This is consistent with a previous review that suggested parents must be involved actively in the intervention for the home reach to be effective (Hendrie et al., 2013).

Similar to study duration and reach, the level of intervention personalization appeared to relate to intervention effectiveness. Specifically, interventions that targeted students both as a group and as individuals were less effective than those targeting the environment or group alone or in combination. This was in contrast to our hypothesis, wherein we postulated that more personalized interventions that were tailored to an individual’s specific dietary behaviour would be more effective than impersonal, generalized dietary messages. However, these results should be interpreted with caution. First, there were few studies that targeted students at only the level of the group and individual, making it difficult to draw reliable conclusions regarding effectiveness in this group. Second, several of the studies that targeted only the environment provided food to students, which would greatly increase the likelihood of observing a change in dietary behaviour immediately post-intervention. Unfortunately, most of these studies did not conduct a follow-up after the provision of food was stopped to determine if dietary changes were maintained. Therefore, the relationship between intervention effectiveness and level of personalization is difficult to determine.

It is also difficult to determine the relationship between the frequency of intervention contact and intervention effectiveness. Although monthly contact appears to be the most effective, the small number of studies using this frequency limits this finding. Most interventions had weekly or daily frequency of contact and were largely effective, and our analysis suggests that a minimum of monthly contact with the participants should be used in intervention delivery. For shorter studies, weekly or daily contact may be necessary. No studies in the review used a
frequency of contact less than monthly, therefore the relationship between infrequent contact and effectiveness is unclear.

The majority of the interventions included in this study were in the Fruit and/or Vegetable (FV) or general healthy eating category, with over 90% showing a positive impact on dietary behaviour. Between the FV and general category, the more targeted and direct FV interventions were not more effective than the broad healthy eating interventions, which is in contrast to a previous review of dairy interventions that found that studies focusing on encouraging intake of dairy food or calcium alone were all effective, compared with 55% of studies promoting dairy within the context of a healthy diet (Hendrie et al., 2013). In this review, which focused more broadly on dietary interventions across several categories, there did not appear to be a reduction in effectiveness with dilution of resources across several nutritional targets.

Whereas a high degree of effectiveness was also observed in the single nutrient and single food or food group, these results are limited by the small number of studies, particularly in the ineffective group. However, it can be noted that the single food or food group category was the least effective. This is probably due to the presence of several studies targeting a decrease in consumption of SSBs; because SSBs are proportionally the highest consumed beverage by preadolescents and adolescents (Garriguet, 2008), it may be more difficult to make significant and meaningful dietary behaviour changes.

Although this review found that more than 80% of school-based interventions were successful at modifying dietary behaviour immediately post-intervention, we noted a distinct lack of follow-up for the majority of studies. Only 21 studies reported follow-up measures, either midterm (three weeks to four months post-intervention) or long-term (six months to two years
post-intervention), which represents only one fifth of all studies reviewed. This makes it difficult to assess whether the modified dietary behaviours were maintained after the intervention period, which is a concern if food provision was an integral part of the intervention. From the studies that did conduct follow-up, most reported a failure of participants to maintain the changes seen post-intervention. Interestingly, in the three studies that conducted follow-up at both mid- and long-term, all noticed a loss of effectiveness across time, highlighting the importance of tracking dietary behaviour across an extended period with multiple measures. Future studies should address this gap in intervention retention and follow-up with participants to assess long-term, lasting effects of the intervention, as it appears likely that the high degree of effectiveness of published school-based interventions may be misleading, given the tendency of the majority of researchers to only perform measurements immediately following the intervention.

There are limitations that must be considered. Owing to the absence of uniform reporting or effect size estimates, the definition of effectiveness was based on the significance of results as reported by the study authors. It is acknowledged that statistical significance is related to the assessment method and sample size; however, the approach to determining effectiveness used in this review has been applied elsewhere (Hendrie et al., 2013; Hingle, O'Connor, Dave, & Baranowski, 2010). The method of determining effectiveness of interventions was limited to the quality and specificity of the results. Studies were considered effective if they reported a significant change of the primary dietary outcome which is inherently flawed, especially in mixed message studies (Muth et al., 2007). This review was also limited by the consideration of multiple dietary focuses, leading to difficulty when comparing the effects of these interventions beyond p-values. Most studies were published in English, which could have created a small bias to North American studies. As an attempt to reduce publication bias, grey literature was
searched. Despite these limitations, the methodology of the review is strong and the results show consistency with previous reviews, which is well supported by existing literature.

Overall, interventions that target preadolescents and adolescents in school-based settings to improve dietary habits have been shown to be highly effective, resulting in positive changes in dietary behaviours in the vast majority of studies. However, this review highlights that a significant shortcoming in this body of literature is a lack of follow-up in over 75% of published studies, and demonstrates that positive dietary changes may not be maintained across time. Utilizing an intensity-based scaling of the interventions, the current review found that the school is an effective setting to impact dietary behaviour, and highlights specific intervention characteristics such as intervention duration, reach, frequency of contact, and level of personalization that likely contribute to effectiveness. Therefore, these findings may be used to guide successful development of interventions targeting dietary behaviour in preadolescents and adolescents in the school-based setting.

2.3.6 Implications for School Health

Our findings support the school as a primary target for nutrition interventions and highlight some characteristics of intervention intensity that relate to effectiveness. To maximize effective dietary change in students, interventions should be between six weeks and five months in duration, with a minimum of monthly contact with the participants, and should focus on delivery at the level of the whole class. If interventions aim to include parents in combination with the school-based delivery, then parents should be actively involved in the program, for example, through structured sessions led by a trained facilitator. Increasing the reach of the intervention beyond the school can be effective as community and school partnerships have demonstrated an impact on student nutrition (Wright, Norris, Newman Giger, & Suro, 2012).
Although it does not appear necessary to administer interventions with a high frequency of contact for a prolonged period of time, it should be acknowledged that there is likely to be a loss of positive behaviour change across time, which suggests that maintenance strategies should be explored. A variety of nutritional targets appear to be modifiable in the school environment, allowing messages to be tailored to the specific needs of the student population. Provision of healthy food to students in the school environment is encouraged.
3.1 Chapter Introduction

After producing two useful knowledge syntheses in the first study, the next construct in the KTA cycle framework to be addressed is the Action Cycle. At the outset of the Action Cycle, the problem to be addressed is identified and relevant knowledge is identified, reviewed, and selected. To reiterate, the problem addressed at the outset of this thesis was the lack of dairy consumption by pre-adolescents and adolescents, while the knowledge to be mobilized related to the awareness of dairy products as “foods for health” based on decades of scientific research. In subsequent stages of the KTA cycle framework, knowledge should be adapted to the local context and the barriers to knowledge use should be assessed. These are the constructs of the KTA cycle framework to be addressed in the two phases of the second study.

To begin, we sought to adapt the knowledge of dairy products and alternatives as “foods for health” to the local context where the research would be occurring, specifically in a school-based setting with grade seven adolescents. The objective of this stage of the KTA cycle framework is to facilitate decision making about the value, usefulness, and appropriateness of particular knowledge to a specific setting and circumstances. In the present study, we identified a need to clarify how adolescents perceive and utilize sources of health knowledge, including knowledge about nutrition and health, in order to better understand how the delivery of knowledge in our research setting would be interpreted. The goal of this first phase of the study was to clarify how to tailor the knowledge presented in the forthcoming intervention.

Next, we sought to identify the potential barriers that may limit translation and use of knowledge of dairy products as “foods for health”. At the same time, we also sought to identify
facilitators that encourage dairy product consumption, and which may promote knowledge uptake. Specific to this thesis, it was important to investigate the barriers and facilitators to dairy product consumption in adolescents as previous work revealed contradictory and out-dated information. The goal of this second phase of the research study was to further clarify how to tailor the knowledge presented in the forthcoming intervention.

Together, this research will ensure that the ensuing intervention development is more targeted and appropriate for our population.
3.2 Perceptions and use of sources of health knowledge by young adolescents

As published:

**Megan Racey** MSc, David Machmueller MSc, David Field MSc, Verena Kulak MSc, and Genevieve Newton PhD. Perceptions and use of sources of health knowledge by young adolescents. International Journal of Adolescent Medicine and Health, 2016, AOP. DOI: 10.1515/ijamh-2016-0002
3.2.1 Abstract

*Background:* Understanding how adolescents acquire health knowledge and where they currently seek answers to health-related questions may facilitate the development of interventions that will be both engaging and effective, and may help to improve health over the short and long-term.

*Objective:* The present study sought to investigate the perception and use of sources of health knowledge by young adolescents as stratified by gender.

*Methods:* Thirty 50 minute long focus groups were conducted with 143 participants. Focus group questions were built around the following three main categories: sources of knowledge, including preferred sources, sources accessed for general health, and sources accessed for personal/sensitive health; health information and behaviour change, including characteristics of health knowledge presentation that have influenced behaviour change; and learning preferences to promote behaviour change. Content analysis of focus group transcripts was performed.

*Results:* The use of sources of health knowledge was similar between genders, with some differences noted between sources accessed for general as compared to personal health questions. As well, motivation appeared to be the primary influence for health behaviour change, with knowledge being reported as both as positive and neutral influence, most notably in the areas of diet and exercise. Lastly, adolescents reported several characteristics of health knowledge presentation that they felt would motivate positive behaviour change, including engaging and participatory activities.

*Conclusion:* These results should be considered in the development of interventions to improve health-related behaviour in adolescents, although future research to quantify the use of sources of health knowledge by this population is recommended.

*Keywords:* Young Adolescent, Health Information, Focus Group, Education
3.2.2 Introduction

Adolescents are interested in accessing knowledge about a range of health topics, including diet and exercise (Gray, Klein, Noyce, Sesselberg, & Cantrill, 2005), due to their increased autonomy over health-related behaviour (Currie et al., 2009). They access these health topics through frequently cited resources such as parents, health professionals, health class, teachers, media, and friends (Ott, Rosenberger, McBride, & Woodcox, 2011). However, today’s adolescents are experiencing an increasing number of health problems, including rising rates of obesity (Aten, Siegel, & Roghmann, 1996; Roberts, Shields, de Groh, Aziz, & Gilbert, 2012; Waters et al., 2011) and inadequate levels of physical activity (Colley et al., 2011), which is a concern, as these issues have the potential to translate into diseases later in life such as T2D and heart disease (Deckelbaum & Williams, 2001; O'Dea, 2005). It is known that adolescents have access to many sources of health knowledge to help guide their decision making; however, adolescents’ perceptions of these sources are not well understood.

As previously mentioned, adolescents access a variety of different resources for health knowledge, although their use depends on age and gender of the adolescents as well as the topic of health. Older adolescents (grades 10 to 12) tend to go to their peers for information while younger adolescents (grades five and six) cited mothers and health professionals as their top health resource (Ackard & Neumark-Sztainer, 2001). Regarding gender, female adolescents were more likely to go to their mothers, health professionals or friends for health information while male adolescents noted the internet or media more often as a resource (Ackard & Neumark-Sztainer, 2001). For general health-related questions, adolescents may go to parents or health professionals; however, for more personal questions where there is fear if confidentiality is breached, adolescents go to peers and other adults (Ott et al., 2011). Interventions targeting
adolescent health behaviours frequently focus on improving knowledge using these known sources of health information, such as parents and media, and have been successful in the areas of diet (Powers et al., 2005), substance use (Stanton et al., 2004), and sexual (Stanton et al., 2004) and physical activity (Casazza & Ciccazzo, 2007).

Despite the knowledge regarding where adolescents go for health information and the success of using these sources for creating behaviour change, there remain unanswered questions on their perception and use of these sources. Adolescents’ perceptions of the internet for use of health information has been previously studied (Gray et al., 2005). Research has shown that there is some skepticism regarding the internet as a credible source, but adolescents do know that trustworthy sites exist and can identify them based on their site address (Gray et al., 2005). In contrast, little research exists on perceptions regarding other sources, such as parents, teachers and peers. Understanding how adolescents perceive and utilize sources of health knowledge may have important implications for researchers seeking ways to influence health-related activities in this population (Gray et al., 2005).

The present study sought to investigate the perception and use of sources of health knowledge by young adolescents as stratified by gender. Specifically, this study was conducted in a narrow age range of adolescents as previous qualitative and quantitative studies researched much older or larger age ranges of adolescents. This research is relevant given the important role of knowledge as a mediator of behaviour, and behaviour as a mediator of health. Understanding how adolescents acquire health knowledge and where they currently seek answers to health-related questions may facilitate the development of interventions that will be both engaging and effective, and may help to improve health over the short and long-term.
3.2.3 Methods

3.2.3.1 Participants

Participants were enrolled in eight Grade 7 classes in five elementary schools in Guelph, Ontario. The mean age of study participants was 11.97 years (+/- SEM 0.03). Of the 199 eligible students, 71% consented to participate (n = 142; 68 male, 74 female). The median household income of participating schools was within the middle three quintiles of the Ontario provincial range. Racial/ethnic breakdown of the participants was not determined. Lack of participation was mainly due to failure to return signed consent forms or absenteeism on the study day.

3.2.3.2 Procedures

Students were invited to participate in the study through invitation letters distributed by the classroom teacher. Both parents and adolescents were required to give informed consent. All students participated in the activities, regardless of consent; however, data were only analyzed for consenting participants. This study was approved by the Research Ethics Board at the University of Guelph and by the Upper Grand District School Board. All participants provided informed, written consent.

Thirty 50 minute long focus groups were conducted from October 2014 to January 2015 by professionally trained facilitators. A focus group method was chosen over individual interviews or surveys in order to assess the consensus and diversity of opinion among participants and to encourage responses with depth and complexity (Morgan, 1996). Focus group questions were built around the following three main categories: sources of knowledge, including preferred sources, sources accessed for general health, and sources accessed for personal/sensitive health; health information and behaviour change, including characteristics of
health knowledge presentation that have influenced behaviour change; and learning preferences to promote behaviour change. Questions were based on the Theory of Planned Behaviour and Social Cognitive Theory and targeted subjects’ behavioural capabilities and attitudes; barriers and impediments; social norms and perceived control; environment and observational learning; and self-efficacy and perceived control. A general description of the focus group procedures was described to students and they were informed that the purpose of the discussions was to gather their thoughts about where they go to for health information. They were told there were no right or wrong answers and to respect the privacy of their peers by not sharing the discussion outside of the group. Focus groups of three to eight students were formed based on gender. Two facilitators were assigned to same sex groups (e.g. female facilitator to female group) in order to ensure consistency in facilitation from class to class. Each focus group lasted approximately 50 minutes and consenting groups were audio-recorded.

3.2.3.3 Data Analysis

Recorded data were transcribed by an external company and analyzed using the ATLAS.ti© (ATLAS.ti© Scientific Software Development, Berlin, Germany) qualitative analysis software. Transcripts were checked against the original audio-recordings for accuracy. Then, content analysis of the focus groups transcripts was performed, and the frequency of responses to questions related to sources of information, health information and behaviour change, and learning preferences was determined for both males and females. Two researchers independently analyzed all transcripts and results were compared for accuracy.
3.2.4 Results

3.2.4.1 Sources of Knowledge

Males and females were asked about their preferred sources to access health knowledge (Figure 3.1). The top three sources, parents, internet/media and school/teacher, were similar between genders. Overall, parents appear to be more of an influence in males; however, females emphasized their mothers more specifically as the parent they look to for health information. One female participant stated that “my mom [is my favourite way to get health information] because she’s done so many fitness competitions and [is] healthy”. Another said that her “mom is always saying what’s healthy and what’s not and so like it’s just easier to pick up on it”. In contrast to males, females also mentioned peers, coaches and doctors as sources of information; however, these were all minor influences so their relevance is hard to gauge. Notable to these sources of information is that both peers and non-parent family members were a minor influence in males and females and that students consistently go to older sources for health information.

Figure 3.1. Overall preferred sources to access health knowledge in males and females
Males and females were also asked about the sources that they would access for general health knowledge (Figure 3.2). Parents were identified as the most accessed source by males and females, with doctors also showing importance for both genders. Adolescents stated they trusted doctors because they are “trained”, “they just know [so] you don’t have to worry” and because “[a doctor’s] job is to try to help people stay healthier [and they] wouldn’t lie”. Again, females identified their mother as the primary source for general health knowledge, while males showed no gender preference. Interestingly, internet/media was a highly accessed source of general health knowledge in females but was not identified as important in males. Peers were also identified as a more common source for general health knowledge in males as compared to females, although they were a minor source for both genders. Relative to their preferred sources to access health knowledge, it appears that for direct questions about their own health, adolescents shift towards more trusted authorities, such as doctors and other family members.

**Figure 3.2.** Sources accessed for individual questions related to general health knowledge

Finally, adolescents were asked about the sources that they would access for personal or sensitive health knowledge (Figure 3.3). Again, both males and females reported similar sources,
with parents, other family and friends identified as major sources and doctor, internet/media and school/teacher identified as minor sources. In comparison to sources accessed for general health, for personal health questions doctors were featured less prominently while other family and peers were referenced more frequently. A female participant stated she would go to her family for this information because “they’re the people I mostly trust about my information”. Another participant stated she would choose family over the Internet for questions regarding personal health knowledge because “you could get [information] off the internet and it could be, like, completely different from what you’re thinking it should be”. Peers were frequently mentioned as they were identified as “easier to talk to”. Therefore, it appears that adolescents access knowledge sources with greater personal proximity for personal or sensitive health questions.

For all noted sources of health knowledge, adolescents were asked whether they perceived the sources as being reliable and trustworthy. All sources, including the internet, were reported as being reliable, although there was some caution surrounding its use, with students reporting that they understood the variable reliability between different sites, such as .com versus .gov or .org. Individuals who were accessed as sources of health knowledge were primarily perceived as being reliable due to having experience in related areas.
3.2.4.2 Health Information and Behaviour Change

Participants were asked to identify situations in which health knowledge motivated positive behaviour change. The majority of adolescents reported that they had previously acquired knowledge that motivated behaviour change, with females reporting more frequent positive change than males. Both males and females reported behaviour change in the following areas: diet, exercise and sleep. Diet was the dominant area of change for both genders, while exercise appeared to be more important for males. Adolescents also described the source of health knowledge that motivated positive behaviour change, and the five sources reported by both genders were parents, school, media, doctors, and family. These sources were consistent with the identified sources of information in previous questions.

Participants also identified situations in which health knowledge did not motivate positive behaviour change. Again, the majority of students reported that they had previously
acquired knowledge that did not motivate behaviour change, with no notable differences between males and females. Both genders reported behaviour change in the areas of diet and exercise, with diet featuring most prominently. Reasons cited for a lack in behaviour change included lack of interest or unwillingness to change, unpleasant taste, boring presentation of knowledge, or the change was perceived as too drastic. The sources of health knowledge that failed to motivate positive behaviour change included the previously identified five sources, including parents, school, media, doctors, and family, which was similarly consistent with the previously identified sources of information.

3.2.4.3 Learning Preferences to Promote Behaviour Change

Lastly, adolescents were asked about methods of health knowledge presentation that they felt would motivate them to change their behaviour (Figure 3.4). Both males and females identified that they wanted to see the visual consequences of health knowledge; that the material should be engaging and fun; and that they would prefer to acquire knowledge by playing games. Males more frequently mentioned wanting to learn from role models as compared to females. Rewards were also mentioned by both genders, and females noted a preference for choice in their activities. Participants stressed that they wanted active and hands-on activities using kinesthetic and visual learning techniques with less reading and auditory lessons.
Figure 3.4. Characteristics of health knowledge presentation suggested to promote behaviour change

3.2.5 Discussion and Conclusion

The present study sought to investigate the perception and use of sources of health knowledge by young adolescents as stratified by gender. Overall, the use of sources of health knowledge was similar between genders, with some differences noted between sources accessed for general as compared to personal health questions. As well, motivation appeared to be the primary influence for health behaviour change, with knowledge being reported as both a positive and neutral influence, most notably in the areas of diet and exercise. Lastly, adolescents reported several characteristics of health knowledge presentation that they felt would motivate positive behaviour change, including engaging and participatory activities.

The sources of health knowledge identified by male and female adolescents included parents, school/teacher, internet/media, friends and doctors. Overall, adolescents preferred to access knowledge from older individuals, most notably parents, who were consistently identified
as the dominant and preferred source of health knowledge. This is consistent with previous research (Stanton et al., 2004) that found parents were the primary source of health information (Ackard & Neumark-Sztainer, 2001; Ott et al., 2011) and that parental interventions can significantly influence knowledge and behaviour in areas including general risk, substance abuse, and sexual risk activities. Females frequently mentioned mothers as a source of health knowledge, rather than using the gender neutral term “parents”, which is supported by previous work in a more diverse and larger age group of students (Ackard & Neumark-Sztainer, 2001). Previous intervention studies also support this finding as they have found that the maternal influence on sexual behaviour was stronger for daughters than sons (McNeely et al., 2002), as well a study (Cooley, Toray, Wang, & Valdez, 2008) which demonstrated strong maternal effects on daughter’s eating behaviours and attitudes. Interestingly, although peers have been shown to both positively and negatively influence adolescent health behaviours (Maxwell, 2002), this study found that peers appeared to be a minor resource for health knowledge, although they were identified as being more frequently accessed for personal or sensitive questions about health. It is common for older adolescents to ask their friends or peers first, especially regarding personal or uncomfortable topics (Ackard & Neumark-Sztainer, 2001; Marcell & Halpern-Felsher, 2007); however, the younger age of our population may be why peers were less frequently mentioned overall. It was also noted that although the internet/media was identified as a preferred source to access health knowledge, which is in agreement with previous research (Ackard & Neumark-Sztainer, 2001; Gray et al., 2005), for questions regarding adolescents’ own health, the sources of health knowledge shifted towards individuals, particularly those who were older. Based on the results of the present study, it therefore appears that the accession of sources of health knowledge shows slight variation depending on whether the search for knowledge is
directly related to the individual’s own health, with further variation depending on the nature (sensitive or general) of the question. As well, adolescents appear to shift towards accessing knowledge from trusted authorities and people closer to them, rather than the internet, as questions pertain more to their own health. Again, both these findings from our study, that sources of health information change for different types of information and that adolescents go to more trusted sources for more personal questions, is well supported by previous research (Ackard & Neumark-Sztainer, 2001; Gray et al., 2005; Marcell & Halpern-Felsher, 2007; Ott et al., 2011).

This shift from internet towards individuals may be related to adolescent perception of reliability. While the internet was noted as being mostly reliable, adolescents did express some caution surrounding its general use. They reported that some internet sites are reliable while others are not, and identified websites including those from governments and organizations as being more trustworthy. This caution with the Internet and the ability to identify trusted sources is likely due to the digital literacy curriculum in Canadian schools ("Use, Understand, and Create: A digital framework for Canadian schools," N.D.), which teaches about internet safety, protection of privacy, responsible internet use, authorship and authority of online information. In addition, students are taught to recognize reliable health information online from trustworthy sources. Another study in adolescents aged 11-19 years old also found that adolescents frequently use the internet for health use and were aware of more credible sources (Gray et al., 2005); however, it was noted that many adolescents felt high-quality information existed on the internet but they struggle to find it due to their personal search skills. It should also be noted that the present study did not actually monitor student use of the internet, so their self-reported
behaviour should be interpreted with some caution, as adolescents may be saying what they think they should say based on the curriculum, rather than what they actually do.

Following the discussion of sources of health knowledge, adolescents were asked to identify situations in which knowledge both successfully and unsuccessfully motivated positive behaviour change, most of which were reported as relating to diet and exercise. In both successful and unsuccessful situations, the sources of knowledge were the same, with the differences in outcome appearing to relate to intrinsic motivation and personal preferences. For example, adolescents reported positive change in situations where they wanted to apply the knowledge and change behaviour, and a failure to change when it seemed too drastic to undertake. Similarly, they would modify their diet when the change was consistent with consuming a food they liked, but would not when it did not suite their taste preferences. The scientific literature is replete with evidence of unsuccessful interventions that aimed to modify knowledge and health behaviour in adolescents, with identification of influences including motivation and attitudes affecting outcomes (Dianne Neumark-Sztainer et al., 2003). However, many interventions have also been found to be effective, possibly due to characteristics such as a high level of intensity, including parental involvement (Marquez et al., 2015). Clearly, modifying health behaviour in adolescents is challenging, and while knowledge may be an important influence, its relative impact will depend on other factors.

Finally, adolescents were asked to identify characteristics of health knowledge delivery that would motivate positive behaviour change, and they reported that they wanted to see the visual consequences of health knowledge; that the material should be engaging and fun; that they would prefer to acquire knowledge by playing games; and that they would enjoy learning from role models and earning rewards. These characteristics are strongly supported by the literature.
describing health behaviour interventions in this population. For example, school gardens (Graham & Zidenberg-Cherr, 2005; Lineberger & Zajicek, 2000; Morris & Zidenberg-Cherr, 2002), an engaging and fun activity, and games (Baranowski et al., 2003), have effectively promoted healthful eating habits and improved nutrition knowledge and attitudes towards fruits and vegetables. Similarly, role models were successfully used in a study (Muth et al., 2007) to improve the dietary habits of elementary students, while rewards were used in an intervention (Warren, Henry, Lightowler, Bradshaw, & Perwaiz, 2003) to positively modify diet and physical activity behaviours. Adolescents have previously mentioned that they need social support and supportive relationships from friends, siblings and significant adults such as parents to initiate and maintain healthy behaviours (Marcell & Halpern-Felsher, 2007; Ott et al., 2011). They view health as a shared responsibility between the adolescent and the adults in their lives and differentiated between adults willing to talk with them as opposed to talk “to” them (Ott et al., 2011). The alignment between adolescent suggestions and literature reports is encouraging, and strongly supports the incorporation of these characteristics (preferably in combination) in the design of knowledge based health interventions.

The present study is limited by several factors. Firstly, in focus groups, adolescents may be saying what they think they should rather than providing an honest response, and may not be expressing their own individual view in an attempt to impress their peers or facilitators. To mitigate this issue, focus group facilitators were professionally trained, and same sex facilitators were assigned to each group. As well, teachers were consulted before the focus groups were conducted to get feedback on the social dynamics of participants in each group, and group members were reassigned when conflict was identified. Secondly, this study is limited by the use of participants from a single geographical region, so the demographics of the region should
therefore be noted. While racial or ethnic breakdown was not explicitly measured in this study, recent census data of the city of residence for all research participants found that 84.3% of the total population was white (Statistics Canada, 2013a), so it can therefore be assumed that the ethnic breakdown of subjects was relatively homogeneous and may not be representative of a variety of ethnicities. As well, the city was moderately sized (population approximately 122,000) with close proximity to rural farmland, which may have an impact on health behaviour such as the dietary consumption of milk (Henry et al., 2015; Minaker et al., 2006). And thirdly, although this study explored adolescent perception and use of sources of health knowledge, it may not be a true representation of behaviour, as participants may be influenced by the perception of “right” and “wrong” answers, particularly in the context of the curricular focus on health and sources of health knowledge. Future research should seek to quantitatively explore the use of these sources, although this may be methodologically challenging. Finally, it is important to note that this study did not broadly explore the perception and use of sources of health knowledge across the spectrum of adolescence, which is defined by the Canadian Paediatric Society as roughly corresponding to the ages of 10 and 19 years (Sacks, 2014). The mean age of participants was approximately 12, and all subjects were in grade seven, so this study was limited to the early stages of this period. Therefore, the findings may not generalize across adolescence, particularly the older ages, where greater (and in some cases, complete) autonomy over health (such as meal choices) is achieved.

Given the relationship between knowledge and behaviour, and the importance of behaviour in mediating health, the present study sought to investigate how young adolescent males and females both perceive and access sources of health knowledge. A summary of findings is presented in Table 3.1. Overall, there were very few gender differences noted for
either the perception or use of sources of health knowledge, with both males and females showing a preference for older, trusted sources, especially for more personal questions about their health. Similarly, males and females described both a positive and neutral influence of knowledge on behaviour, mediated by motivation and personal preferences, while the characteristics of health knowledge presentation suggested as positively influencing change were consistent with published literature. These results should be considered in the development of interventions to improve health-related behaviour in adolescents, although future research to quantify the use of sources of health knowledge by this population is recommended.

Table 3.1. Summary of findings: Perceptions and use of sources of health knowledge by young adolescents, and potential strategies for motivating positive behaviour change

- The sources of health knowledge accessed by adolescents are similar between males and females, with some variability depending on the nature of the knowledge being investigated
- Adolescents prefer to learn from older, trusted and experienced sources, mostly notably parents, especially as questions about their health become more personal
- The media and internet are perceived as reliable sources of health knowledge, but with some caution
- Health knowledge can influence behaviour, but change depends on intrinsic motivation and personal preferences
- Adolescents prefer to acquire health knowledge in an engaging and fun way which can include games, role models, rewards, and demonstration of visual consequences
3.3 Barriers and facilitators to intake of dairy products in adolescent males and females with different levels of habitual intake

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3.3.1 Abstract

**Background:** Dairy products and alternatives can contribute to overall good health including positive body composition and decreased adiposity; however, these foods are grossly under-consumed by youth, and worldwide, almost 25% of children are overweight or obese.

**Objective:** The study investigated the barriers and facilitators toward dairy consumption by Grade 7 youth.

**Methods:** Thirty 50-minute, audio-recorded focus groups were conducted with 134 students in eight Grade 7 classes across 5 elementary schools. Focus groups were led by trained facilitators in the elementary schools and participants were separated based on dairy consumption and gender. Recorded data were transcribed and thematically analyzed using qualitative analysis software to identify themes related to barriers and facilitators to dairy product intake by each gender.

**Results:** Factors considered important by males and females across different levels of habitual intake include personal knowledge about dairy products and misconceptions regarding dairy foods and their associated health benefits; food characteristics, including taste; personal behaviours such as habits or routines including dairy products; social environments including parental and peer influence; physical environments factors such as availability and skipping meals; and the convenience of dairy products. Interestingly, only males noted sports as a positive influence for dairy product intake. Also, there were differences in the way males and females perceived dining out as affecting their dairy intake.

**Conclusion:** Results suggest several potential factors that nutrition education interventions aiming to increase dairy consumption could target.

**Keywords:** dairy, children, school age, early lifespan nutrition, focus group, misconceptions
3.3.2 Introduction

Dairy products are implicated as part of a healthy diet, and across various stages of life, have been linked to numerous health benefits such as improving bone and tooth health (Moore et al., 2008); reducing the risk of developing obesity (Lu et al., 2016), high blood pressure (Kris-Etherton, Grieger, Hilpert, & West, 2009), cardiovascular disease (CVD) and type 2 diabetes (T2D) (German et al., 2009); and providing hydration and muscle repair after exercise (Gilson et al., 2010; Karp et al., 2006; Thomas, Morris, & Stevenson, 2009). Canadian national survey data suggest that dairy products are grossly under-consumed in children and adolescents, as 61% of boys and 83% of girls aged 10 to 16 years do not meet the minimum recommended three servings of dairy foods per day (Garriguet, 2007). The same trends are seen in the United States, as only 15% of Americans aged 2 and older meet the recommended servings of dairy products and they consume only 1.9 servings of dairy products per day (Krebs-Smith, Guenther, Subar, Kirkpatrick, & Dodd, 2010). This falls well short of the Dietary Guidelines for Americans’ recommended three servings of dairy products a day for adolescents (Krebs-Smith et al., 2010).

Dairy consumption continues to decline with increasing age (Krebs-Smith et al., 2010). As dairy can be a food to help combat weight gain and obesity (Albala et al., 2008; Bigornia et al., 2014; Dror & Allen, 2014; Kelishadi et al., 2009; Scharf, Demmer, & DeBoer, 2013), this is a concern for younger populations such as children and adolescents who are developing eating habits that will carry into adulthood and whose body composition during childhood are associated with adult adiposity and body mass (Freedman et al., 2005).

With respect to dairy consumption, previous research has identified several barriers and facilitators to intake (Hanson et al., 2005; Larson et al., 2006; Novotny et al., 1999; Nowak, 1998). Studies have identified demographic factors that are associated with low dairy intake
including ethnicity, low socioeconomic status, increased body weight and older age (Larson et al., 2006; Novotny et al., 1999). Both qualitative and quantitative studies among children and adolescents have reported other factors which influence dairy intake (Hanson et al., 2005; Larson et al., 2006; Novotny et al., 1999; Nowak, 1998). Weight-related behaviours or concerns change dairy consumption differently in males and females, as boys want to impress girls and be strong, while girls are more concerned about dairy being a fattening food. Family environment and parental influence can affect dairy consumption both positively or negatively as parents or family dynamics may encourage or discourage dairy product consumption. Making dairy products part of a routine for children and incorporating dairy into meal patterns can encourage dairy consumption. Finally, taste preferences, lactose intolerance, and soft drink intake have been identified as factors influencing dairy intake, all of which vary based on gender (Hanson et al., 2005; Larson et al., 2006; Novotny et al., 1999; Nowak, 1998).

Due to the various facilitators and barriers that may impact dairy intake, results have not been consistent between studies in children and adolescents. Within these factors, gender differences are frequently apparent as boys and girls like to receive information in different ways (Jung et al., 2015). Moreover, there has been limited exploration of the differences between individuals across different levels of dairy product consumption, such as those who meet and those who fail to meet intake requirements. It is expected that those meeting dairy requirements and those not meeting dairy requirements would have different facilitators and barriers impacting their intake. It is therefore predicted that children will have specific factors impacting their dairy intake that will differ depending on gender and consumption levels.

As such, the present study sought to investigate the barriers and facilitators to dairy product consumption in Grade 7 children as stratified by gender and level of habitual dairy
product intake, with the goal of identifying factors that are both common and unique to each group. Grade 7 was chosen due to their age range falling within the specified children/pre-adolescents and their ability to communicate and participate in verbal focus group research. These findings may be relevant as they could be used to guide the development of interventions tailored specifically to different populations, genders or intake levels of dairy.

3.3.3 Methods

3.3.3.1 Study sample

To be eligible, students had to be enrolled in a Grade 7 class in Guelph, Ontario. Of the 199 eligible students aged 10-12 years old, 67% consented to participate (n = 134; 61 male, 73 female). Students were enrolled in eight Grade 7 classes in five elementary schools in Guelph, Ontario. The median household income of participating schools was within the middle three quintiles of the provincial range. Racial/ethnic breakdown of the participants was not determined. Lack of participation was mainly due to failure to return signed consent forms or absenteeism on either study day.

3.3.3.2 Procedures

Students were invited to participate in the study through invitation letters distributed by the classroom teacher. Both parent and children were required to give informed consent. All students participated in the activities, regardless of consent; however, data were only analyzed for consenting participants. Non-recorded focus groups were conducted with non-consenting students in order to allow for inclusion of all students in the activity and limit any feelings of exclusion. This study was approved by the Research Ethics Board at the University of Guelph and by the Upper Grand District School Board.
Prior to conducting the focus groups, a researcher visited the classrooms and facilitated completion of the YAQ, a valid and reliable food frequency questionnaire developed at Harvard University (Rockett et al., 1997). In order to determine the approximate daily intake of dairy products, the dairy section of the YAQ as well as other dairy foods and dairy alternatives found throughout the YAQ, were used to calculate the average daily intake of dairy foods in servings/day (Hanson et al., 2005). Students were then divided into groups based on gender and dairy consumption, resulting in the following five groups: females does not meet dairy requirements (n=6), females meets dairy requirements (n=7), males does not meet dairy requirements (n=6), males meets dairy requirements (n=8), and a mixed gender group for the non-consenting students and students who were absent for the first visit and therefore had no YAQ data. A minimum of two students in each group was needed to keep gender separate in consenting groups. If this condition was not met, the gender division was collapsed (n=3); however, researchers were able to separate the male and female students in the transcript analysis.

Approximately one week following intake analysis and division of students into groups based on intake and gender, focus groups were conducted in the classroom setting. In total, thirty fifty-minute long focus groups were conducted between October 2014 and January 2015. Facilitators were trained in September and October 2014. Focus group questions were developed based on the Theory of Planned Behaviour and Social Cognitive Theory, previous research (Hanson et al., 2005; Larson et al., 2006; Novotny et al., 1999; Nowak, 1998), and final questions were agreed upon by consensus with experts in the field. The questions targeted subjects’ behavioural capabilities and attitudes; barriers and impediments; social norms and perceived control; environment and observational learning; and self-efficacy and perceived
control. Probing was used in the case of close-ended questions. Students were not told how the groups were split in order to minimize bias. Facilitators were assigned to same sex groups and same dairy intake group category at each school (e.g. Female facilitator led a females does not meet requirements group in every school) in order to ensure consistency in facilitation from class to class. Each focus group lasted approximately 50 minutes and consenting groups were audio-recorded.

3.3.3.3 Data analysis

Recorded data were transcribed by an external company and analyzed using the ATLAS.ti© (ATLAS.ti© Scientific Software Development, Berlin, Germany) qualitative analysis software. Transcripts were checked against the original audio-recordings for accuracy. Factors influencing dairy intake in males and females were determined based on the analysis procedures described by Braun and Clarke (2006). Like the focus group questions, factors that influenced dairy product consumption were coded, based on theory, as being associated with an individual’s attitudes/knowledge, perceived control/self-efficacy, environment/reinforcement and social norms/observations. These refined categories related to an individual’s source of information, personal knowledge, food characteristics, personal behaviours, and economic, physical and social environment. The factors influencing dairy product intake were further evaluated to determine whether there were differences related to level of dairy intake in each gender. For this analysis, only factors that were coded for in the transcripts greater than five times were considered in an attempt to focus primarily on factors discussed with greater frequency. The number of times a factor was coded was compared between the two intake groups in each gender and a ratio was determined. Factors were considered predominant for a single group if the ratio was greater than two, while factors were considered as being important
for both groups if the ratio was between 0.8-1.2. Coding was done by three researchers, first individually and then as a group.

3.3.4 Results

3.3.4.1 Participant dairy intake

Participants’ average age was 11.97 years (+/- SEM 0.03). The average daily intake of dairy in the females meets requirements group was 4.64 servings of dairy and alternatives/day (n=33), while in the females doesn’t meet requirements group the average intake was 1.78 servings of dairy and alternatives/day (n=40). The average daily intake of dairy in the males meets requirements group was 4.76 servings of dairy and alternatives/day (n=30), while in the males doesn’t meet requirements group the average intake was 2.10 servings of dairy and alternatives/day (n=31).

3.3.4.2 Factors affecting dairy intake

Overall, we found that barriers and facilitators affecting dairy intake in both males and females were associated with the themes of attitudes and knowledge, perceived control and self-efficacy, environment and reinforcement, and social norms and observational learning, with considerable overlap between these categories. All barriers and facilitators were categorized into these themes, which consisted of over 75 sub-categories, in an attempt to not miss any information stated by participants.

The factors influencing dairy intake in females and males as categorized into attitudes/knowledge, perceived control/self-efficacy, environment/reinforcement and social norms/observations, are illustrated in Figures 3.5 and 3.6, respectively. These figures illustrate ALL of the factors that were identified in the thematic transcript analysis. Following analysis of
the frequency of responses, PREDOMINANT factors influencing dairy product consumption in
groups with different levels of intake for each gender were identified, and are illustrated in
Figure 3.7 for females and Figure 3.8 for males. The lateral portions of these diagrams represent
factors that were unique to groups with different levels of dairy intake, with shared factors
represented in the middle circle.
Figure 3.5. Flow chart illustrating the barriers and facilitators identified from thematic analysis of the females focus group transcriptions.
Figure 3.6. Flow chart illustrating the barriers and facilitators identified from thematic analysis of the males focus group transcriptions
Figure 3.7. Comparison of similarities and differences in females between consumption groups of the facilitators and barriers to dairy consumption in Grade 7 youth. Differences are shown on the right and left regions of each circle while the similarities are indicated by the overlap.
Figure 3.8. Comparison of similarities and differences in males between consumption groups of the facilitators and barriers to dairy consumption in Grade 7 youth. Differences are shown on the right and left regions of each circle while the similarities are indicated by the overlap.
A majority of the factors influencing dairy intake were similar between both females and males, although some gender differences were noted. Sports was a predominant facilitator for dairy product consumption in males only. As well, eating out was a facilitator for all males as they more specifically referenced asking for milk or getting to choose dairy products at restaurants. Females were less likely to discuss availability of dairy products outside of the home and more frequently mentioned not having access to dairy products. Variety of dairy products available was identified as a facilitator in females while it was both a facilitator and barrier in males. Males stated not liking or not willing to try different varieties of dairy products, such as different types of cheese; however, both genders stated liking choice and variety of dairy products such as types of milk, yogurt or ice cream or the versatility of dairy products.

Specifically, one female participant said they “like how you can just eat it with anything and like every time you try it, like a dairy product, even though it’s like the same ingredients, it always tastes different”. Females talked mostly about the lack of convenience of dairy products, while male students noted that dairy products could be both convenient or not convenient. For instance, in regards to transporting or bringing dairy products to school, males felt it was “too much work”. But if dairy products were provided by the school, such as the Elementary School Milk Program, some male students said dairy products would be more convenient in this case.

Both males and females across consumption groups noted similar facilitators affecting dairy product intake. Knowledge of the benefits of dairy products and positive health outcomes were strong facilitators in both male and female meets requirements groups, although all consumption groups showed knowledge of the individual components of dairy products and their influence on health. The students’ daily routine and habits that instilled dairy product consumption, such as cereal and milk at every breakfast, also helped to facilitate dairy product
consumption. Not surprisingly, taste was a major factor which influenced dairy product consumption in both genders. As well, barriers to dairy product intake that were similar between genders and consumption groups included skipping meals that would have normally contained a dairy product or alternative and misconceptions regarding the perceived negative health effects of dairy products. Related to level of habitual intake, home availability between consumptions groups appeared to be reduced in those not meeting dairy requirements. However, in our analysis we were unable to make a clear distinction between availability of dairy products (e.g. Available or not available) and the location in which dairy products are available (e.g. At home, at school, or special occasions). Finally, both peers and parents were important social environment factors that could act as both a facilitator or barrier in both genders, depending on the situation.

To further clarify the above factors, Tables 3.2 and 3.3 present participant quotations that illustrate each predominant factor influencing dairy product consumption in females and males, respectively.
### Table 3.2. Selection of quotations accompanying each predominant factor influencing dairy product consumption in females

<table>
<thead>
<tr>
<th>Females Who Meet Dairy Requirements</th>
<th>Quotation</th>
</tr>
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| Availability – Outside Home        | “Researcher: ‘And, um, where do you consume dairy products?’
Participant: ‘It’s like I mostly drink it at home and eat at home, but I do a large amount at like school.’”  
Positive Outcomes – Associated Benefits | “I like drinking milk because I know it’s going to… [help my] bones.”  
Habits | “Well, I drink milk every morning and night [and] before school starts and before [I go] to sleep.”  
Hunger/Thirst | “[I drink milk because] I’m awake and hungry.”  
| Females Who Do Not Meet Dairy Requirements | Quotation                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Sources of Information – Media     | “Researcher: ‘But speaking of all of the good things and bad things in dairy products, where did [you] all hear that?’
Participant: ‘Dr. Oz.’”  
Sources of Information – Labels | “Researcher: ‘So thinking about some of the unhealthy things… that might not be good for you in dairy products, so where did [you] hear that?’
Participant: ‘Because we read the label.’”  
Peer Influence | Facilitator:
“When I’m with one of my friends, I have this big giant glass of milk sometimes, but I drink way more milk than I usually do.”  
Barrier: | “Researcher: ‘Do you ever think about having dairy products when you're with friends? Like, do you choose cheese and crackers, if that's your favourite? Or are chips and something like that easier, or popcorn or something?’
Participant: ‘No, normally we eat fries.’”  
| Skipping Meals | “Participant: ‘Sometimes if I get up later then I have to have something quickly for breakfast.’
Researcher: ‘Yeah. So what would be quicker than the cereal and milk, what would you choose?’
Participant: ‘My mom makes some toast.’”  
Parental Influence | “My dad, he wants me to drink and eat more [dairy products] but my mom doesn’t because she doesn’t like it.”  
| Availability – Not Available (at home) | “Researcher: ‘If you open up your fridge would you find dairy products in your household?’
Participant: ‘No.’”  

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<tr>
<th>All Female Groups</th>
<th>Quotation</th>
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<tr>
<td>Dietary Components – Associated Benefits</td>
<td>“It makes your bones strong.”</td>
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<tr>
<td>Dietary Components – Associated Harm</td>
<td>“Umm, as much as I like dairy products they also have a lot of sugar for the flavour.”</td>
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<th>Taste</th>
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<td>Facilitator:</td>
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<td>“For me it’s -- it’s like because I like eating it and it’s yummy and it tastes really good.”</td>
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<tr>
<td>Barrier:</td>
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<tr>
<td>“I just really don’t like the taste of milk.”</td>
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<tr>
<th>Parental Influence</th>
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<tr>
<td>“Yeah, every time I go home from school my dad would tell me like did you drink milk?”</td>
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<tr>
<th>Personal Knowledge – Dairy Alternatives</th>
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<tr>
<td>“Researcher: ‘So when I say dairy products, what [comes to mind]?’”</td>
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<tr>
<td>Participant 1: ‘Um, soy milk.’</td>
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<tr>
<td>Researcher: ‘Soy milk, yeah. Any other alternatives [you] know of?’</td>
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<tr>
<td>Participant 2: ‘Almond milk.’</td>
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<td>Participant 3: ‘Goat milk.’</td>
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<tr>
<th>Food Pairing</th>
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<tr>
<td>“I only like milk in my cereal because I don’t like the taste of it like by itself.”</td>
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<th>Convenience</th>
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<td>“Researcher: ‘Do you think you would take dairy products and a snack on the go or is there other things that are easier and more convenient?’”</td>
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<tr>
<td>Participant: ‘I think other things are more convenient because I’m [not] having dairy products in wrappers so you tend not to take them and you take more crackers and that kind of thing ‘cause they’re more portable.’”</td>
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<tr>
<th>Misconceptions</th>
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<tr>
<td>“Like if you eat too much of it, then you’re gonna get fatter.”</td>
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<tr>
<th>Table 3.3. Selection of quotations accompanying each predominant factor influencing dairy product consumption in males</th>
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<td><strong>Males Who Meet Dairy Requirements</strong></td>
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Participant: ‘Nutritional facts.’
Researcher: ‘Nutritional facts. Like what type of facts?’
Participant: ‘The fat, like the sugar, sodium.’” |
| Source of Information – Media | “I watched a short documentary about the history of cheese and other dairy products on TV once.” |
| Source of Information – Family | “I heard it - like my parents kind of tell me…” |
| Parental Influence | Facilitator: “They say why aren’t you drinking any milk, like any – if I forget they always remind me “Did you drink your milk yet?”
Barrier: “Except my dad kind of like - he doesn’t want me drinking a whole bunch [of milk] ‘cause like it’s not good you if you have a whole bunch of it. And also it’s wasting.” |
| **Males Who Do Not Meet Dairy Requirements** | **Quotation** |
| Skipping Meals | “Breakfast on the weekdays I always end up skipping.” |
| Lack of Familiarity | “Like most cheese that I’ve like never had like if I tasted them I probably wouldn’t like it.” |
| Cost | “It’s – it’s like – it’s a bit too much. It’s like 50 cents per milk per day per week.” |
| Temperature | “So like I can’t drink cold things so I -- so I warm [chocolate milk] up for like I don’t know, ten -- 13 seconds and I stir it.” |
| Eating Out | “Researcher: ‘So if you are ever out at restaurants, do you order milk?’
Participant: ‘I usually order pop.’” |
| Availability – At Home | “Researcher: ‘Okay. And how about yourself, when you open your fridge at home what do you normally see?’
Participant 1: ‘Ah, yeah. Like lots of bags of milk. I drink a lot of milk. Uh, maybe some cheese strings, like big bricks of cheese, uh, mozzarella sticks, and cream cheese and some yogurt.’
Participant 2: ‘Two percent milk, yogurt, cheese, butter.’” |
<p>| Hunger/Thirst | “And I like milk cause it quenches thirst, like it beats it up.” |
| Personal Knowledge – Dairy Alternatives | “I like almond milk, I’ll drink but it’s not my favourite. So, yeah, like rice milk is okay, like I’ve kind of like gotten used to it-ish, like when I have to drink it, when we don’t have milk, so, regular milk in my house.” |
| Convenience | Facilitator: “Um, cheese on my sandwiches or like, cause we have milk day [at school] so like we get milk.” |</p>
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<tr>
<th>Category</th>
<th>Quotation</th>
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<tr>
<td>Peer Influence</td>
<td>Facilitator: “I went to this house, he offered me chocolate milk, I said yes”</td>
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<tr>
<td></td>
<td>Barrier: “Yeah, I usually – if I go over to a friend’s house like to drink I’d usually have water, I wouldn’t have like milk or anything”</td>
</tr>
<tr>
<td>All Male Groups</td>
<td>Quotation</td>
</tr>
<tr>
<td>Misconceptions</td>
<td>“Male 1: ‘Uh, if you have, like, too much vitamins in [dairy products].’”</td>
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<td></td>
<td>Male 2: ‘Like, eating too much yogurt can be bad for you because it can make you sick, I guess.’</td>
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<tr>
<td></td>
<td>Male 3: ‘I think … well, I do know if you drink too much milk, um, you can get, like … it can really make you sick because it … I think … like, it’s kind of … poison you because … I don’t know. If you take too much dairy, um, it could really affect your health, not just because of the fat but because of other stuff. I’m not exactly sure what it is.’ ”</td>
</tr>
<tr>
<td>Dietary Components –</td>
<td>“Participant: ‘Well, I like natural milk, just like that. Um, I think in, in some, like, dairy brands they add too much sugar in there.’”</td>
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<tr>
<td>Associated Harm</td>
<td>Researcher: ‘Okay. And, how, how could the sugar be bad for you if you were to, to-? Like, why would too much sugar be a bad thing for you.’</td>
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<tr>
<td></td>
<td>Participant: ‘Because my parents tell me if you take- like, have too much sugar, um, you could end up getting, like, diabetes and it will affect you for the rest of your life.’ ”</td>
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<tr>
<td>Eating Out</td>
<td>“When we’re at a restaurant we would order milk.”</td>
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<tr>
<td>Variety</td>
<td>“Cause I like to – ‘cause you-you can use milk for cereal and drink it and… It’s used for baking quite a lot, so…”</td>
</tr>
<tr>
<td>Dietary Components –</td>
<td>“[Dairy products] hold a lot of protein and stuff. Or not protein. Like minerals and stuff that are healthy. Help fight off diseases.”</td>
</tr>
<tr>
<td>Associated Benefits</td>
<td>“At school you get the chocolate milk.”</td>
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<tr>
<td>Availability – Outside</td>
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<td>of Home</td>
<td>Facilitator – Favourites: “I like chocolate milk. Chocolate milk is my favourite.”</td>
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<tr>
<td>Preferences</td>
<td>Barrier – Least Favourites: “Researcher: ‘why don’t you like yogurt?’”</td>
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<td></td>
<td>Participant: ‘It’s pretty sweet cause it has a lot of sugar.’ ”</td>
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3.3.5 Discussion

This study assessed the barriers and facilitators to dairy product consumption in grade 7 children as stratified by gender and level of habitual dairy product intake, with the goal of identifying factors that were both common and unique to each group. A majority of the factors influencing dairy intake were similar between both females and males, although some gender differences were noted. Similarly, we observed overlap in the barriers and facilitators that influenced both genders across different levels of habitual intake. This information may be used in the development of interventions tailored specifically to different populations.

Many similarities exist between the predominant facilitators affecting dairy product intake in both males and females and across consumption groups, including knowledge, routine habits, peers, and taste, which is consistent with previous research in children and adolescents (Hanson et al., 2005; Larson et al., 2006; Novotny et al., 1999; Nowak, 1998). Higher nutritional knowledge has been associated with consumption of an overall healthier diet (Dickson-Spillmann & Siegrist, 2011) and a lack of knowledge about the association between dairy/calcium and health has also been found to be a barrier to calcium intake (James, 2004).

Habits, or routines, have also been found to affect dairy intake in children populations in previous research (Neumark-Sztainer et al., 1999; Novotny et al., 1999), which is important as it has shown that when food and beverage choices are taught in childhood and further developed in adolescence, they persist into adulthood (Thomas et al., 2009). In addition to knowledge and habits, taste was also a strong facilitator for dairy product consumption in all females and for males meeting requirements. Having a taste preference for dairy products has been noted as one of the greatest influences to dairy product consumption (Larson et al., 2006) and studies have
frequently noted food preferences or taste as a factor influencing food choices (Larson et al., 2006; Lee & Reicks, 2003; Neumark-Sztainer et al., 1999; Novotny et al., 1999).

Males and females also showed similarities in the predominant barriers to dairy product intake. Skipping meals, especially breakfast, was an important barrier in both genders not meeting dairy requirements. Eating breakfast, particularly cereal at breakfast, has been shown to facilitate milk consumption (Albertson et al., 2008). Often, when meals were skipped that would typically have contained a dairy product, students reported grabbing a convenient snack or more transportable meal, such as toast, instead; however, these snacks or meals often did not contain the dairy products or alternatives that would have been consumed regularly. Further, when asked whether the students would make up for this lost dairy serving from breakfast at another point during the day, many reported they would not. Another common barrier influencing dairy intake in both males and females was misconceptions. These misconceptions were typically regarding negative health outcomes that students associated with dairy product consumption. Research has shown that children and adolescents negatively associate the fat in dairy products with obesity, body fat and body composition (Auld et al., 2002; Henry et al., 2015; James, 2004; Novotny et al., 1999) and this was also seen in the current study. In contrast to this false belief, recent systematic reviews have shown no association between dairy and increased body weight or body fat (Abargouei et al., 2012; Dror & Allen, 2014). Research has actually shown that dairy products and alternatives have a positive influence on adiposity, BMI, waist circumference and lean body mass in children and adolescents who reach dairy recommendations (Albala et al., 2008; Bigornia et al., 2014; Dror & Allen, 2014; Kelishadi et al., 2009; Scharf et al., 2013) mainly due to the nutritional components within dairy products as well as the replacement of SSBs and other high calorie foods with dairy products. The findings regarding misconceptions in
children are critical as they suggest that interventions that target these gaps in knowledge, specifically in regards to the potential harm and benefits associated with dairy product consumption, might effectively improve dairy consumption in children (Watson et al., 2009).

In both genders, peers had a strong influence, acting as both a barrier and facilitator in different circumstances, in male and females not meeting requirements. In previous research, peers’ personal food choices and encouragement, or lack thereof, have been reported to have a significant impact on the food choices children and adolescents make (Hanson et al., 2005). Previous research has also noted the importance of peers’ attitudes or choices and its effect on adolescent dietary intake (Auld et al., 2002; Bronner et al., 2006; Lee & Reicks, 2003; Novotny et al., 1999). Therefore, the observation of both a positive and negative influence on dairy intake behaviour in this study is not surprising.

Similar to peers, parental influence was observed to act as both a barrier and a facilitator to dairy product intake. Parents were found to be an important facilitator in the “meets requirements” group of both genders, although males meeting requirements also noted that parents could be a barrier to consumption. In contrast, males not meeting requirements did not discuss parents as influencing dairy intake, while females not meeting requirements noted parents as both a barrier and a facilitator (see Table 3.2 and 3.3). Regardless of these between group differences, parents in general were clearly noted as an important influence, which is not surprising, as Social Cognitive Theory notes the importance of the environment, including having appropriate role models and expectations, to shape behaviour (Bandura, 1989). Previous research in children also supports the important impact parents can have on their children’s food choices (Lee & Reicks, 2003; Neumark-Sztainer et al., 1999; Novotny et al., 1999) and specifically the influence that maternal milk consumption can have on their daughters (Fisher et
These results, along with other research (Hanson et al., 2005), suggest that parents may continue to play a role in determining their child’s consumption of dairy foods during adolescence.

Previous interventions have addressed some of these factors, including parents (DeBar et al., 2009; Gates, Hanning, Gates, Isogai, et al., 2013; O’Connell, 2005; Yamaoka et al., 2011), knowledge of dairy products (Muth et al., 2007; Naghashpour et al., 2014; Singhal et al., 2010; Watson et al., 2009; Yamaoka et al., 2011), taste (Gates, Hanning, Gates, Isogai, et al., 2013), and peers (DeBar et al., 2009; Gates, Hanning, Gates, Isogai, et al., 2013; Singhal et al., 2010) with mixed success (Marquez et al., 2015). The findings of the present study should contribute to the development of future interventions by highlighting several potential targets to address when aiming to change dairy intake in adolescents and the potential difficulties in addressing these factors.

There are several limitations to this study that must be considered. First, although the sample size was moderate, it was limited to a single geographical region. Following this, we did note that in comparison to the previously published national averages (Garriguet, 2007), more of our population appeared to meet the recommended dairy requirements. This may be due to reasons such as the close proximity to rural farm land and the strong agricultural influence on the city, both of which can increase milk consumption (Henry et al., 2015; Minaker et al., 2006). Racial or ethnic breakdown was not measured in this study, so the specific demographics of the subjects are unknown. In general, Guelph is a relatively fast growing, rural-influenced, prosperous city in southern Ontario. Recent census data of the city of Guelph found that 84.3% of the total population was white (Statistics Canada, 2013b), so it can be assumed that the ethnic breakdown of subjects was relatively homogeneous. Focus groups also have limitations as
facilitators may have poor control over what is said, participants may not be expressing their own individual view in an attempt to impress their peers or facilitators, and participants may be uncomfortable discussing personal or sensitive topics, such as body image (Basch, 1987). To mitigate this limitation, researchers were formally trained, and facilitators of the focus groups remained with the same group across each school (e.g. Males who do not meet requirements or females who meet requirements). Overall, however, these limitations are not likely to have had an appreciable impact on the reliability of results, which is supported by the consistency of the present research findings to previously published studies.

3.3.6 Conclusion

Overall, we found that specific factors considered important by males and females across different levels of habitual intake include: personal knowledge about dairy products, misconceptions regarding dairy foods and their associated health benefits, taste, habits or routines, parental and peer influence, availability of dairy products, skipping meals, and the convenience of dairy products. Some gender differences were noted such as sports being a predominant facilitator in choosing to consume dairy in males only and eating out as a facilitator or barrier to dairy product consumption depending on gender. These results suggest several potential targets for interventions that aim to increase dairy consumption, such as increasing knowledge regarding the benefits of dairy consumption, clarifying misconceptions surrounding dairy product consumption and weight gain, making time for breakfast, serving milk or dairy with meals, exposing children to a variety of foods, making dairy tasteful, and suggesting strategies to consume more dairy in the context of peer pressure and eating out. Addressing these barriers and facilitators as part of intervention development, with tailoring to the needs of the target population, is recommended in order to increase effectiveness.
CHAPTER 4: INTERVENTION DELIVERY, EVALUATING OUTCOMES, AND SUSTAINING KNOWLEDGE USE

4.1 Chapter introduction

The previous two studies produced information to inform and tailor nutrition intervention development. Specifically, in the first study, intervention components were based on aspects of successful dairy and school-based interventions identified through the systematic reviews. This included the length of the intervention, reach, and the need to conduct follow-up. In the second study, focus group research revealed that adolescents do trust internet sources and their teachers, further supporting the use of a web-based component in a school-based nutrition intervention. In addition, the second study provided valuable information regarding the barriers and facilitators to adolescent dairy intake. Many of the barriers and facilitators could be targeted in an intervention including: knowledge of dairy products and alternatives, their associated health benefits, and clarifying misconceptions. Following this distillation and tailoring of information, the next phase of the Action Cycle, “select, tailor, and implement interventions” was addressed in the third study.

In this study, a school-based intervention with a web-based component was developed, piloted, and implemented with grade seven adolescents in several schools across Southwestern Ontario. In order to assess effectiveness of the intervention, knowledge use was monitored through post-intervention questionnaires. The intervention continued to follow the KTA cycle framework as it evaluated the outcomes and impact of knowledge to determine if the intervention resulted in behavioural outcomes. And finally, similar to the need for follow-up identified in study one, the Action Cycle also specifies that after intervention implementation and evaluation of outcomes, changes in behaviours must be sustained and followed for resulting improvements.
in the health of individuals and systems. This was accomplished through a follow-up campaign
and assessment of intervention outcomes months after the intervention was completed.

From these results, new knowledge gaps and questions have been identified and
improvements to intervention components have been acknowledged. This sets in motion a
feedback loop that cycles through the KTA cycle framework again.
4.2 The short- and long-term effectiveness of a school- and web-based dairy and alternatives intervention in modifying students’ knowledge of dairy products and alternatives, behaviour of dairy product and alternative consumption, and intentions to consume dairy products and alternatives in grade 7 youth: A randomized controlled trial
4.2.1 Abstract

**Background:** Despite the known health benefits of dairy products, their daily consumption continues to decline in many populations, particularly in pre-adolescents and adolescents. It is therefore of interest to develop effective strategies to increase dairy intake and education in this population. The objective of the cluster randomized controlled trial was to assess whether a school-based intervention enhanced with a web-based component was more effective than a standardized dairy education program at changing: (i) knowledge of dairy products, (ii) intentions to consume dairy products, and (iii) dietary intake of dairy products. As well, the study aimed to characterize use of the intervention website and the effectiveness of a parent e-mail campaign as a follow-up strategy to the intervention.

**Methods:** Grade 7 students (n=175) in 10 Southwestern Ontario schools were randomized by school, into intervention or control. Intervention schools received the WhyDairy intervention with a website component for six to eight weeks while control schools received a DFO education program which spanned four weeks. Intervention schools were further randomized to receive follow-up contact, through monthly emails, or no follow-up contact, across the 5-month follow-up period. A questionnaire, consisting of three surveys (knowledge, FFQ, and intention), was delivered at baseline, post-intervention, and follow-up. Website use was collected using Google Analytics and the email campaign was tracked using MailChimp.

**Results:** All groups significantly increased their knowledge post-intervention but only intervention schools with follow-up email contact maintained this positive change in knowledge. No groups saw significant changes in dietary behaviour. While there was moderate engagement with the website during the intervention period, there was poor engagement during the follow-up
period. Finally, the email campaign was successful in reaching parents, but did not result in high engagement or changes in student outcomes.

Conclusions: The results of this study demonstrate the effectiveness of a school-based intervention enhanced with a web-based component in changing student knowledge regarding dairy products and the engagement of the website during the intervention period. Future work should consider longer durations to see changes in dietary behaviour and more targeted approaches during follow-up periods.

4.2.2 Introduction

Dairy products are a convenient source of vitamins, minerals, and protein necessary in the diets or pre-adolescents and adolescents (Moore et al., 2008; Park et al., 2008). These nutrients include calcium, a mineral essential for strengthening of bones, which is particularly important during the pubertal years when nearly 60% of PBM is acquired (Heaney, 2009; Loud & Gordon, 2006). Additionally, consumption of recommended levels of dairy products have been shown to contribute to a reduced risk of chronic disease development, including T2D (Rice, Quann, & Miller, 2013), cardiovascular disease (Rice et al., 2013), and osteoporosis (Kalkwarf et al., 2003; Opotowsky & Bilezikian, 2003).

Despite the known health benefits of dairy products, their daily consumption continues to decline in many populations, particularly in pre-adolescents and adolescents. Canadian national survey data suggest that dairy products are grossly under-consumed in this age group, as 61% of boys and 83% of girls aged 10 to 16 years old do not meet the minimum recommended three servings of dairy and/or alternatives per day (Garriguet, 2007). The same trends are seen in the United States, as only 15% of Americans aged two and older meet the recommended servings of dairy products, and they consume only 1.9 servings of dairy products per day (Krebs-Smith et
This falls well short of the Dietary Guidelines for Americans’ recommended three servings of dairy products and alternatives a day for adolescents (Krebs-Smith et al., 2010). As youth age, consumption continues to decline and individuals continue to fail to meet recommendations, despite the fact that recommendations for intake decrease (Garriguet, 2007). As dairy products can be a food used to address dietary inadequacies, promote health, and prevent disease later in life, their low consumption is a concern for children and adolescents who are developing eating habits that will carry into adulthood. In addition, knowledge can be used to mediate behaviour as increased knowledge regarding healthy choices has been shown to increase consumption of these foods (Wardle, Parmenter, & Waller, 2000; Worsley, 2002). Therefore, it is of interest to investigate effective interventions and strategies to increase the knowledge and consequently consumption of dairy products among pre-adolescents and adolescents.

Previous research has highlighted components and characteristics of nutrition interventions, including dairy, that are likely to be effective (Hendrie et al., 2013; Marquez et al., 2015; Racey, O'Brien, et al., 2016). Schools are recognized as an appropriate setting and location to implement dietary interventions as they provide a place in which consistent and reliable information is delivered to students (Brown & Summerbell, 2009). In particular, the school setting has the potential to deliver this information to and reach youth of all ages with diverse ethnic and socioeconomic backgrounds (Brown & Summerbell, 2009; Delgado-Noguera et al., 2011; Peterson & Fox, 2007; Powers et al., 2005). Schools also provide the opportunity to foster healthful food and activity choices (Brown & Summerbell, 2009), and previous research has shown that nutrition behaviours can be both established and altered in this setting (Brown & Summerbell, 2009; Delgado-Noguera et al., 2011; Peterson & Fox, 2007; Powers et al., 2005).
These changes in nutrition behaviours have resulted in successful changes of body composition and improved eating habits (Neumark-Sztainer et al., 2003).

School-based interventions may be enhanced through the use of strategies that reach beyond the classroom, such as specialized web-based programs (DeBar et al., 2009; Haerens, De Bourdeaudhuij, Maes, Cardon, & Deforche, 2007). Nutrition sessions can be taught to all students in the classroom, and then students can be directed to web-based programs that they can access from home or other locations. These programs could be designed to supplement the material taught in class, using content that appeals to youth including games and other engagement strategies (Racey, Machmueller, Field, Kulak, & Newton, 2016). Web-based programs may be especially appropriate for use in interventions targeting youth, as 93% of adolescents use the internet (Lenhart, Madden, Macgill, & Smith, 2007). It has also been widely reported that adolescents are more comfortable with technologies like the internet and perceive them as more helpful than do adults (Macgill, 2007). Supplementing a school-based nutrition intervention with a web-based program allows students to access the information at any time, and therefore increases potential exposure to the intervention content, which may facilitate changes in behaviour.

Follow-up is often overlooked as a component of school-based nutrition interventions. A 2016 review found that over 75% of studies conducted no follow-up at all post-intervention, and of the studies that did conduct follow-up, most reported a failure of participants to maintain changes seen post-intervention (Racey, O'Brien, et al., 2016). Measuring outcomes beyond the immediate post-intervention period is necessary to determine whether effects persist across time. As well, it is possible to incorporate follow-up strategies into this period to determine whether techniques such as persistent contact with participants and their environment can be used to
maintain, or even augment, positive outcomes. For nutrition interventions targeting youth, follow-up strategies often include parents. Dietary changes can be more pronounced in interventions that include active parental involvement component (Meiklejohn, Ryan, & Palermo, 2016), and parental involvement is most successful when communications and interactions are directly targeted to parents (Hendrie et al., 2013).

To address the issue of low consumption of dairy products by youth, we developed a school-based intervention enhanced with a web-based component that targeted Grade 7 adolescents. The first objective of the study was to determine whether the novel intervention was more effective than a standardized dairy education program at changing: (i) knowledge of dairy products, (ii) intentions to consume dairy products, and (iii) dietary intake of dairy products. Effects were measured over the short and long-term. The second objective of the study was to describe use of the web-based component of the intervention by students, which was on a voluntary basis. Finally, the third objective of the study was to assess the effectiveness of a parent e-mail campaign as a follow-up strategy to the intervention in impacting website use and student knowledge, behaviour, and intentions. We hypothesized that the novel school-based intervention would result in consistent use of the website and be more successful in changing students’ knowledge, behaviour, and intentions to consume dairy products. We also hypothesized that the parent email campaign would lead to additional differences in the intervention group as parent engagement with emails would translate to further improvements in student’s knowledge and behaviour regarding dairy products.
4.2.3 Methods

4.2.3.1 Participants

Participants were recruited from 12 grade seven classrooms at 10 schools in Southwestern Ontario who agreed to be a part of the study (including Guelph, Kitchener/Waterloo, Burlington). All students in each class were invited to participate. Of the 311 eligible students aged 10-12 years old, 193 consented to participate (62%); however, 175 students who consented were present at the first intervention visit and completed the intervention. All seventh grade students received the intervention, which was consistent with the Ontario elementary school curriculum ("Health and Physical Education, Grades 1-8," 2010). Racial/ethnic breakdown of the participants was not determined. Lack of participation was mainly due to failure to return signed consent forms or absenteeism on study days involving survey completion.

Students were invited to participate in the study through invitation letters distributed by the classroom teacher. Both parent and child were required to give informed consent. While all students completed each activity, only data for consenting students were analyzed and non-consenting student data was only shredded upon completion of the final intervention visit (in October) to allow for rolling admission of students into the study. The study was approved by the Research Ethics Board at the University of Guelph (REB # 14NV037), as well as by the Wellington Catholic District School Board (WCDSB) and individual Christian school principals/directors.
4.2.3.2 Sample Size Calculation

A sample size calculation was performed to estimate an appropriate sample size to aim for when recruiting participants for this study. Using the endpoint of changes in dairy intake and/or milk intake, the variables used an alpha level of 0.05, a power level of 80%, a minimal detectable difference (effect size) of 0.43 servings (which represents the average effect size of dairy-specific studies from a previous dairy review by Marquez et al. (2015)), and a standard deviation of 1.5 (which is reflective of the variability in dairy or milk intake in similar intervention studies from the Marquez et al. (2015) review). It was established that in order to detect statistically significant changes, if they are present, a minimum of 384 participants would be required to complete the study.

4.2.3.3 Study Design Cluster

This study was a school-based cluster randomized controlled trial (RCT). The intervention was first piloted in a local private school to assess feasibility of intervention delivery and success of planned activities. Because no changes were made between piloting the intervention and full-scale implementation, the pilot school was included in the pre-post analysis. For the RCT schools, nine elementary schools in Southern Ontario were block randomized (using blinded envelopes) based on school board (Private or Catholic) into intervention with no follow-up email contact (INT n=3), intervention schools with follow-up email contact from June to October (INT+FU n=3), or control (CON n=3) treatment by the lead researcher. Control schools received no email contact. Following randomization, schools were told their assignment as this dictated the number of visits and time required. Distance and geographical location of the schools made intervention treatment contamination unlikely. Researchers delivered the
intervention and were therefore not blinded to allocation of the schools; however, students were unaware of their allocation or the purpose of the study.

4.2.3.4 Intervention and Control Treatments

The control schools received the Dairy Farmers of Ontario (DFO) education program. This program is a free service to teachers and provides interactive, curriculum-connected in-class workshops for elementary schools in Ontario, Canada. The program was taught by a DFO educator (a retired school teacher trained by the DFO), with supervision by the lead researcher, after baseline evaluation and at a second research visit (Figure 4.1). All research visits were approximately two weeks apart, therefore, control school visits spanned approximately four weeks.

The intervention schools received the WhyDairy intervention, which was developed by the lead researcher. Development of the WhyDairy intervention was informed by behaviour change theories (Social Cognitive Theory (Bandura, 1989) and the Theory of Planned Behaviour (Ajzen, 1991)). Intervention visits addressed a variety of constructs including behavioural capability, attitude/knowledge, perceived control, reinforcement/observational learning, self-efficacy, outcome expectation, goal setting, and self-regulation. The WhyDairy intervention was also based on previous research that investigated pre-adolescents’ perceptions of learning about health information (Racey, Machmueller, et al., 2016) and the barriers and facilitators to intake of dairy products and alternatives (Racey et al., 2017). This research identified factors that could be targeted in an intervention, including: knowledge and misconceptions of dairy products; health benefits of dairy products and alternatives; parental and peer influences; fun and engaging lessons that incorporate games; and demonstration of visual consequences of health mediated outcomes. As well, alternatives, such as soy milk and soy yogurt, were included in the
intervention material, as opposed to solely dairy-specific foods, in order to meet curriculum guidelines and be consistent with Canada’s Food Guide ("Health and Physical Education, Grades 1-8," 2010; "What is a Food Guide Serving of Milk and Alternatives," 2008). WhyDairy was developed as a web-based program, and the intervention included both school-based visits (delivered in class to all students and which used the web program as a teaching tool), as well as additional web-based material that students could access voluntarily on their own.

Figure 4.1. Randomization and participant flow through intervention

The intervention material was taught over three 20 to 40-minute school visits (Figure 4.1). The total intervention period spanned approximately six to eight weeks. During these visits, the researchers used the WhyDairy program to teach students about several topics, including: (i) what constitutes dairy products and alternatives and appropriate serving sizes, (ii) what nutrients are present in dairy products and alternatives, and (iii) what health benefits are associated with
consumption of dairy products (Table 4.1). At the end of each visit, students were asked to
develop a positive S.M.A.R.T. (Specific, Measurable, Achievable, Realistic, Time-sensitive)
behavioural goal regarding dairy product and alternatives. Visits were both didactic and
interactive and researchers followed a script to ensure consistency across schools (see Appendix
C). Researchers navigated the website content (including games) during intervention visits and
students were encouraged to voluntarily access the website outside of class time and at home.
Sections of the website within the “Student Corner” (Table 4.1) were opened as researchers
completed the visit for that school to encourage the students to explore new material on the
website after visits and to control the access of information by students. Use of a web-based
format for WhyDairy was designed to make the information taught during the school–based
sessions interactive, fun, easy-to-use, and accessible to the students after visits were complete
(see Appendix D). The goal was to create prolonged contact with the intervention information
beyond the in-class visits and to extend the intervention reach to the parents and home
environment.
<table>
<thead>
<tr>
<th>Visit #</th>
<th>Visit Theme and Timing</th>
<th>Visit Details</th>
<th>Website Sections (Content and Pages)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Baseline Survey (20 min)</td>
<td>- Introduction to researchers</td>
<td>Home Page</td>
</tr>
</tbody>
</table>
|        | What Are Dairy Products and Alternatives? (20 min) | - Definition of a dairy product and/or alternative  
- Interactive game with sample dairy products and alternatives, common misconceptions  
- Serving sizes of dairy products and alternatives  
- “Guess the Serving Size” Gameshow | Student Corner → What are Dairy & Alternatives |
|        |                       | - “Build your own meal” interactive game to build meals containing different dairy products and alternatives  
- “S.M.A.R.T” goal setting | Student Corner → Build Your Own Meal |
| 2      | What is in Dairy Products and Alternatives? (40 min) | - Small group “think, pair, share” activity comparing nutrition facts table (NFT) of various dairy products, alternatives and other food choices  
- Comparison of NFT was accompanied by more interactive versions on the webpage  
- Activity was used to lead discussions on carbohydrates, protein, fats, cholesterol, vitamins and minerals  
- “S.M.A.R.T” goal setting | Student Corner → What is in Dairy & Alternatives |
|        |                       | - Discussion of how the nutrients in dairy products and alternatives can positively impact different health effects  
- Bone health, body weight and composition, and sports performance and recovery were discussed  
- “S.M.A.R.T” goal setting | Student Corner → Why Dairy & Alternatives |
| 3      | Why Dairy and Alternatives? (40 min) | | Student Corner → Explore the Human Body |
The website also contained sections not directly related to the intervention visits including a Parent Corner, Kitchen Corner, and Contact Us page.

- **Parent Corner**: Contained information related to the researcher team, the intervention message and goal, quick tips on incorporating dairy and alternatives into meals, serving sizes of dairy products and alternatives, common misconceptions with scientifically supported answers, and frequently asked questions.

- **Kitchen Corner**: Contained family-friendly recipes for breakfast, lunch, dinner and snacks with a link to further recipes.

- **Contact Us**: Lead researcher contact information

Throughout the website, “Fun Facts” were placed as a hover-over pop-up box for students to find and explore while navigating through the website pages.

Intervention and control treatments occurred simultaneously across a four- to eight-week timeframe.

The follow-up email campaign consisted of five emails (see Appendix E) sent once a month to parents during the months between post-intervention measurements and the final follow-up measurement visit. The emails contained general information about the intervention and had themes such as “Calcium and Bone Health” and “Protein in Dairy and Alternatives”. The emails directed parents to different parts of the intervention website in an effort to involve parents as well as the students during the months researchers were not directly interacting with them.

**4.2.3.5 Primary Outcomes Assessment**

Assessment occurred in the students’ classroom at baseline, post-intervention, and at a follow-up visit. Students completed a survey under the direction of the lead researcher who led
the class through the questions. The survey, which included multiple-choice and Likert scale options, assessed demographic characteristics of participants, such as age and gender, and consisted of three components: knowledge of dairy products and alternatives, behaviour or intake of dairy products and alternatives, and intention to consume dairy products and alternatives (see Appendix F).

Knowledge of dairy products and alternatives

Knowledge was assessed using a researcher-developed knowledge test consisting of 11 True/False or Yes/No questions as no valid or reliable dairy knowledge tool existed. The option to select “not sure” was also included in an attempt to deter students from simply guessing the correct answer, although these responses were also graded as incorrect. After discussion with experts in the field and accommodations for time constraints, six categories were selected to test all aspects of dairy knowledge. These categories were selected due to their importance to dairy nutrition and relevance to school curriculum. The six categories were; what are dairy products and alternatives, intake recommendations and serving size, overcoming barriers to dairy intake, nutrients in dairy products and alternatives, misconceptions about dairy products and health benefits of dairy products and alternatives.

To establish content validity of our tool, a panel of experts was called upon to assess representativeness, clarity, and factor representativeness (Rubio, Berg-Weger, Tebb, Lee, & Rauch, 2003). Following the expert panel review of the tool and the resulting reliability values were deemed appropriate, final edits were made to the questionnaire prior to conducting reliability testing. To establish reliability in the tool, a local elementary school was recruited to which consent forms were sent home and returned after they had been signed by a parent or legal guardian as well as the student. The questionnaire was administered by two researchers to a total
of 32 students in Grade 7 and 8, and one week later the same questionnaire was re-administered to the same students. The test-retest reliability produced a Pearson correlation of 0.82 and the internal consistency resulted in a Cronbach’s alpha of 0.7. Therefore, the knowledge tool is both valid and reliable (Parmenter & Wardle, 2000; Rubio et al., 2003).

**Intake of dairy products and alternatives**

Intake of dairy products and alternatives was assessed using a modified version of the original YAQ (Rockett et al., 1997). Modifications were performed by the lead researcher to select only dairy products or foods containing dairy products, and a question about consumption of alternatives was added.

**Intention to consume dairy products and alternatives**

Finally, the intention to consume dairy products and alternatives was measured using 17 Likert-type questions on a scale of one to seven and was developed based on the theory of planned behaviour (Ajzen, 2006) and a TPB survey development manual (Francis et al., 2004). The tool measured beliefs about the behaviour, social norms, perceived behavioural control, and intention to consume dairy products or alternatives. Question topics were selected based on previous research regarding barriers and motivators to dairy product consumption (Racey et al., 2017). The survey was designed to be completed in 20 minutes.

**4.2.3.6 Data Collection and Analysis**

**Survey**

Each question of the three questionnaires comprising the survey were inputted and checked for accuracy by two independent researchers. Responses for the FFQ were converted into dairy servings per day (Racey et al., 2017). If students indicated more than one answer, the average of the two was inputted. Any answers left blank were accounted as no servings of that
food. The knowledge questionnaire consisted of 11 right or wrong questions with a total possible score of 26. Responses of “not sure” were recorded, but were treated as an incorrect response. If a student left a question blank or circled multiple answers, the question was marked as wrong.

Finally, the Likert scale numbers circled on the intentions survey were inputted accordingly. If a student circled more than one answer, the average of the two was inputted. Due to the nature of this survey and the fact that two questions accounted for the entire theory construct, if the student left the answer blank at the baseline survey, a four was inputted to indicate a neutral response (half-way between one and seven on the scale). Alternatively, if they left the answer blank at the post-intervention or follow-up visit, the last observation was carried forward, therefore assuming no change.

*Website use during intervention and follow-up period*

Voluntary use of the website, whydairy.com, outside of classroom visits, was tracked using multiple components of Google Analytics software. Each school was assigned a unique acronym that needed to be included in the web address to gain access to the website. This allowed Google Analytics to distinguish each school’s activity via the specific web address. Data were tracked from the first school visit and concluded with the last follow-up assessment visit. This spanned the six to eight-week intervention period as well as the five-month follow-up period. The “Audience” tool was used to track the number of website sessions and the specific date on which they occurred as well as to distinguish new users versus returning users. The “Acquisition” tool provided data on how students accessed the website; examples of sources include social media and direct web address input. The “Behaviour” tool showed statistics specific to each page, allowed for tracking of content use, and tracked the order that pages were visited during each session (behaviour flow).
In order to facilitate data analysis, each website page was assigned to a specific category to describe its content. “Knowledge” pages contained mostly textual information about the importance of dairy and alternatives and their nutritive components. “Interactive” pages contained activities and games to facilitate learning about dairy and alternatives. For example, the “Plate” page permitted users to select breakfast, lunch or dinner, and build their meal while being encouraged to include the proper number of servings of dairy and alternatives. Finally, the “Kitchen & Recipe” category included website pages that provided students with recipes for breakfast, lunch, dinner, dessert and snacks that highlighted dairy ingredients.

Follow-up email campaign

The follow-up email campaign sent to parents of students in three of the intervention schools was tracked using Mailchimp. MailChimp is an online tool that tracks multiple aspects of an email campaign, such as, managing subscriber lists, user interaction with emails, opening of the email, clicking on links with the email, and other analytical tools to monitor success of an email campaign. Specifically, this project tracked subscribers across the five months, number of emails opened by each parent, and number of clicks within each email. Each parent was assigned a “Parent Engagement Score” to quantify their interaction with the five emails. One point was awarded for each email opened (parent opening an email in their inbox) and one point was awarded for each link within an email the parent clicked on. This resulted in a total possible engagement score of ten. As mentioned above, website use during this follow-up email campaign period continued to be tracked in order to assess website interactions originating from email engagement.
4.2.3.7 Statistical Analysis

Students needed to be present at both baseline and post-intervention visits in order for their data to be analyzed. If students were absent at the follow-up visit, and therefore had no score for the final survey, the mean of their treatment group was used in order to keep flow of participants to the end of the intervention and limit those lost to follow-up due to absenteeism.

All data were corrected for any scan or input errors and then checked for normalcy using the Shapiro-Wilk test of normality prior to statistical analysis. Testing for outliers was conducted by visual boxplot analysis. All outliers were left in analysis, unless otherwise stated, as visual inspection of their values did not reveal them to be extreme. Only one student who consented was purposefully removed from the data analysis due to deliberately poor completion of the survey (e.g. selecting multiple answers per question throughout knowledge test and FFQ) and an intention to not follow survey instructions. Transformation of data was attempted if data were not normally distributed; however, this was rarely effective in computing normal data. Therefore, non-parametric statistical tests were used unless otherwise stated. Participants were analysed based on intention to treat. All statistical analyses were performed using IBM SPSS Statistics, Version 24 for Windows (Property of IBM Corp). The p-value was set at ≤0.05. The Friedman test (or repeated measures one-way ANOVA for normal data) was performed to determine within-group effects across all three time points for knowledge, behaviour, and intention. The Kruskal-Wallis test (or one-way ANOVA if data were normal) was used to determine the between-group effect. To assess any correlations between intention questionnaire variables, a bivariate correlation matrix was generated using Spearman’s correlation.

Parent email could be linked to the child’s ID code and thus allowed researchers to track parent interaction with the emails and correspond this with their child’s behaviour, knowledge,
and intentions. Therefore, students were separated into three groups based on their parent’s email interaction: no follow-up emails received, follow-up emails received and engagement score of zero (follow-up, engagement-), or follow-up emails received and engagement score greater than zero (follow-up, engagement+). A one-way ANOVA was conducted to determine if the changes in students’ knowledge scores from post-intervention to follow-up were different based on their treatment condition regarding parent interaction with the follow-up email campaign. Spearman’s rank coefficient was used to determine the strength of association between a parent’s email engagement score and their child’s change in knowledge test score from post-intervention to follow-up.

4.2.4 Results

4.2.4.1 Study Population

Of the 193 students who consented to participate in the study, 175 completed the survey at baseline. The study population consisted of 83 males and 92 females (Table 4.2). Mean age ± standard deviation was 12.32 ± 0.47 years. Descriptive statistics for baseline information of the treatment groups for sex, age, total dairy intake, or knowledge score is shown in Table 4.2. There were no significant differences in baseline knowledge scores or dairy consumption between any groups. There were differences between treatment groups with regards to schools implementing the Elementary School Milk Program (ESMP) and prior exposure to DFO educational visits. In control schools, two of three schools (or 87% of students) had regular visits by a DFO educator for three or more years, compared to only one school in the INT group. This variable was not considered prior to randomization, but an ANCOVA did not reveal differences at baseline between groups based on prior exposure to a DFO program. Overall, approximately half our
population was meeting dairy requirements as defined by Canada’s Food Guide with an average intake of $3.36 \pm 1.66$ servings of dairy per day.

### Table 4.2. Descriptive of study population at baseline

<table>
<thead>
<tr>
<th></th>
<th>TOTAL (n=175)</th>
<th>INT (n=115)</th>
<th>CON (n=60)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong>&lt;sup&gt;1&lt;/sup&gt;</td>
<td>12.32 ± 0.47</td>
<td>12.32 ± 0.47</td>
<td>12.32 ± 0.47</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>53%</td>
<td>52%</td>
<td>53%</td>
</tr>
<tr>
<td>Male</td>
<td>47%</td>
<td>48%</td>
<td>47%</td>
</tr>
<tr>
<td><strong>ESMP</strong></td>
<td>8/10 schools</td>
<td>6/7 schools</td>
<td>2/3 schools</td>
</tr>
<tr>
<td></td>
<td>82% students</td>
<td>84% students</td>
<td>78% students</td>
</tr>
<tr>
<td><strong>DFO prior</strong></td>
<td>3/10 schools</td>
<td>1/7 schools</td>
<td>2/3 schools</td>
</tr>
<tr>
<td></td>
<td>41% students</td>
<td>17% students</td>
<td>87% students</td>
</tr>
<tr>
<td><strong>Dairy Requirements</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meet or exceed</td>
<td>51%</td>
<td>55%</td>
<td>47%</td>
</tr>
<tr>
<td>Does not meet</td>
<td>49%</td>
<td>45%</td>
<td>53%</td>
</tr>
<tr>
<td><strong>Dairy Intake</strong>&lt;sup&gt;1,3&lt;/sup&gt;</td>
<td>3.36 ± 1.66</td>
<td>3.37 ± 1.56</td>
<td>3.34 ± 1.86</td>
</tr>
<tr>
<td>Female</td>
<td>3.27 ± 1.74</td>
<td>3.28 ± 1.56</td>
<td>3.25 ± 2.06</td>
</tr>
<tr>
<td>Male</td>
<td>3.47 ± 1.58</td>
<td>3.48 ± 1.56</td>
<td>3.45 ± 1.64</td>
</tr>
<tr>
<td><strong>Knowledge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score (/26)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>15.39 ± 3.40</td>
<td>15.67 ± 3.53</td>
<td>14.87 ± 3.09</td>
</tr>
<tr>
<td>Percent&lt;sup&gt;1&lt;/sup&gt;</td>
<td>59.21% ± 13.07</td>
<td>60.27% ± 13.57</td>
<td>57.17% ± 11.90</td>
</tr>
</tbody>
</table>

ESMP = School has the Ontario Elementary School Milk Program in effect
DFO Prior = Class was exposed to or received the Dairy Farmers of Ontario educational sessions consistently for 3-5 years prior to entering Grade 7.
Dairy Requirements = Canadian Food Guide recommended 3-4 servings/day or dairy and/or alternatives

Note: INT treatment includes pilot school students
1. Values in mean ± standard deviation
2. Based on Canada’s Food Guide recommended 3-4 servings of dairy and alternatives per day for children aged 9-18 years old.
3. In servings of dairy per day

#### 4.2.4.2 Short- and Long-term Changes in Knowledge, Behaviour, and Intentions

A Kruskal-Wallis H test revealed no statistically significant differences in knowledge scores between groups at any time point. However, Friedman tests revealed significant differences in knowledge scores (as a percent) at different time points during the intervention period for all treatment groups. Pairwise comparisons were performed with a Bonferroni correction for multiple comparisons. Overall, all treatment groups significantly improved their knowledge scores from pre-intervention to post-intervention ($p<0.05$); however, differences were
seen among treatment groups when comparing pre-intervention to follow-up and post-intervention to follow-up (Figure 4.2). In INT + FU schools, post hoc analysis revealed statistically significant differences in knowledge scores from pre-intervention (61.5%) to follow-up (65.4%) (p<0.05) and no significant decay in knowledge between post-intervention and follow-up. In INT schools, there was a significant decrease in knowledge from post-intervention (73.1%) to follow-up (65.4%) (p<0.05). In CON group, post hoc analysis revealed statistically significant improvements in knowledge scores from pre-intervention (57.7%) to follow-up (65.4%) (p<0.05), but a significant decrease from post-intervention (73.1%) to follow-up (65.4%) (p<0.05).

![Figure 4.2. Mean knowledge scores with 95% confidence interval for each treatment group across all three time points](image)

* = significant increase in knowledge p<0.05  
** = significant decrease in knowledge p<0.05  
INT+FU: Baseline 57.7% (13.88), Post-intervention 68.4% (13.0), Follow-up 65.5% (11.3)  
INT: Baseline 59.8% (12.9), Post-intervention 69.7% (14.5), Follow-up 64.9% (12.6)  
CON: Baseline 56.9% (11.8), Post-intervention 72.7% (12.0), Follow-up 66.8% (11.6)
With regards to dairy consumption, there were no significant changes in dairy intake within or between any group at any time point during the intervention period (Figure 4.3), as assessed by a Friedman test or Kruskal-Wallis H test, respectively. Mean dairy intake for females at follow-up fell below recommendations for CON and INT schools, but not for INT+FU schools (data not shown). As well, INT+FU schools saw a high percentage of students meeting or exceeding dairy requirements (64%) at the follow-up visit compared to INT (51%) or CON (58%) schools (data not shown).

![Dairy Servings per Day](image)

**Figure 4.3.** Mean dairy and alternatives intake per day with 95% confidence interval for each treatment group across all three time points

Dairy servings per day as mean (SD) = INT+FU: Baseline 3.3 (1.7), 3.2 (1.9), 3.2 (1.6); INT: Baseline 3.2 (1.3), 2.8 (1.3), 3.0 (1.3); CON: Baseline 3.4 (1.9), 3.3 (1.6), 3.5 (2.0)

The simple association between theory constructs was examined using Spearman correlation coefficients (Table 4.3). Total dairy intake at follow-up was weakly, but significantly, correlated with perceived behavioural control, self-assessment of control, and intention, for all three treatment groups. Intention to consume dairy products was moderately or strongly correlated with two variables, perceived behavioural control and self-assessment of control, for
all treatment groups. There were no significant differences between treatment groups and mean ratings of any theory constructs at the three time points (data not shown).

Table 4.3. Theory of Planned Behaviour Correlation among theory constructs at follow-up

<table>
<thead>
<tr>
<th>Theory Constructs</th>
<th>Social Norms</th>
<th>Perceived Behavioural Control (PBC)</th>
<th>Self-Assessment of Control</th>
<th>Intention</th>
<th>Total Dairy Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attitudes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT</td>
<td>0.513**</td>
<td><strong>0.723</strong></td>
<td>0.502**</td>
<td>0.503**</td>
<td>0.109</td>
</tr>
<tr>
<td>INT+FU</td>
<td>0.324*</td>
<td>0.006</td>
<td>0.173</td>
<td>0.270</td>
<td>-0.213</td>
</tr>
<tr>
<td>CON</td>
<td>-0.075</td>
<td><strong>0.524</strong></td>
<td>0.582**</td>
<td>0.454**</td>
<td>0.375**</td>
</tr>
<tr>
<td><strong>Social Norms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT</td>
<td></td>
<td></td>
<td>0.362**</td>
<td>0.268</td>
<td>0.149</td>
</tr>
<tr>
<td>INT+FU</td>
<td></td>
<td></td>
<td>0.084</td>
<td>-0.152</td>
<td>-0.101</td>
</tr>
<tr>
<td>CON</td>
<td></td>
<td></td>
<td>-0.027</td>
<td>0.069</td>
<td>0.070</td>
</tr>
<tr>
<td><strong>PBC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT</td>
<td></td>
<td></td>
<td><strong>0.714</strong></td>
<td>0.661**</td>
<td>0.353**</td>
</tr>
<tr>
<td>INT+FU</td>
<td></td>
<td></td>
<td><strong>0.519</strong></td>
<td>0.404**</td>
<td>0.419**</td>
</tr>
<tr>
<td>CON</td>
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<td>0.560**</td>
<td>0.627**</td>
<td>0.372**</td>
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<tr>
<td><strong>Self-Assessment of Control</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>INT</td>
<td></td>
<td></td>
<td><strong>0.788</strong></td>
<td>0.487**</td>
<td></td>
</tr>
<tr>
<td>INT+FU</td>
<td></td>
<td></td>
<td><strong>0.522</strong></td>
<td>0.422**</td>
<td></td>
</tr>
<tr>
<td>CON</td>
<td></td>
<td></td>
<td>0.677**</td>
<td>0.355**</td>
<td></td>
</tr>
<tr>
<td><strong>Intention</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT</td>
<td></td>
<td></td>
<td></td>
<td>0.526**</td>
<td></td>
</tr>
<tr>
<td>INT+FU</td>
<td></td>
<td></td>
<td></td>
<td>0.452**</td>
<td></td>
</tr>
<tr>
<td>CON</td>
<td></td>
<td></td>
<td></td>
<td>0.374**</td>
<td></td>
</tr>
</tbody>
</table>

* = correlation is significant at the 0.05 level (2-tailed)
** = correlation is significant at the 0.01 level (2-tailed)
bold = strong spearman correlation coefficient of >0.70
italic = moderate spearman correlation coefficient of >0.50

4.2.4.3 Website Use During the Intervention Period

Website data during the six to eight-week intervention period were tracked for all schools who received the intervention (Table 4.4). Overall, the WhyDairy website was used by 37.3% (n=43) of students participating in the intervention (n=115) for a total of 79 sessions. Google Analytics showed that of the 79 sessions, 49% (n=39) were initiated by returning students who had already visited the website at least once.
Table 4.4. Summary table of all website sessions conducted by students during the WhyDairy intervention period

<table>
<thead>
<tr>
<th>Total Sessions</th>
<th>Total Users</th>
<th>Total Pageviews</th>
<th>Avg pages per session</th>
<th>Avg Session Duration (mm:ss)</th>
<th>Avg Bounce Rate</th>
<th>Avg % New Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total all intervention schools</td>
<td>79</td>
<td>43</td>
<td>492</td>
<td>6.32</td>
<td>0:06:56</td>
<td>19.17%</td>
</tr>
</tbody>
</table>

Sessions = a group of website interactions that takes place within a 30min time frame by a single user
Users = individual viewing website
Pageviews = each view of any page on the website
Pages per session = number of pages viewed during a single session
Average session duration = length of time user interacted with website
Bounce rate = percentage of single-page sessions (ie. Sessions in which the person left site from the entrance page without interacting with the page or website)
% New Sessions = percentage of first time viewers

As can be seen in Table 4.5, the Kitchen/Recipe section of the website recorded the highest amount of views per page (11), but the shortest average time per page (19s). However, these pages also had the lowest average of website exits, meaning the last page viewed before exiting the website (8.02%). The Interactive pages had the second highest count of page views per page and the most time was spent on these pages, with an average time of 0:01:47. The least popular section was pages containing Knowledge content, which attracted 8.62 page views per page with an average viewing time of 34s per page. This section had the second lowest average website exits (10.26%).
Table 4.5. Interaction with WhyDairy website pages, with all webpages categorized into Knowledge, Interactive or Kitchen & Recipe categories, by students during the intervention period

<table>
<thead>
<tr>
<th>Category</th>
<th>Sample Content</th>
<th>Total page views</th>
<th>Views per page</th>
<th>Average time on page (mm:ss)</th>
<th>Average % Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>What are dairy &amp; alternatives and why are they important</td>
<td>112</td>
<td>8.62</td>
<td>00:34</td>
<td>10.26%</td>
</tr>
<tr>
<td>Interactive</td>
<td>Games including; Explore the human body, build your own plate</td>
<td>96</td>
<td>8.73</td>
<td>01:47</td>
<td>18.84%</td>
</tr>
<tr>
<td>Kitchen/Recipes</td>
<td>Breakfast, lunch, dinner, dessert &amp; snack recipes</td>
<td>55</td>
<td>11.00</td>
<td>00:19</td>
<td>8.02%</td>
</tr>
</tbody>
</table>

Figure 4.4 provides an overview of how study participants navigated through the WhyDairy website with pages categorized as Knowledge, Interactive, or Kitchen/Recipe. This analysis was conducted on 47 website sessions out of a total of the 79 sessions that took place throughout the intervention. To be included in this analysis, sessions must have originated from the student homepage to most accurately evaluate a typical traversal path.

From the school home page, 40% (n=19) visited a Knowledge page for their first interaction, 13% (n=6) visited an Interactive and 23% (n=11) visited a Kitchen/Recipe page. The remaining 24% of students exited the website from the home page without any further interactions. Of the 17 students that initially visited a Knowledge page, six exited while two proceeded to a Kitchen/Recipe page. The remaining 11 students proceeded to an Interactive page, five of which visited another Knowledge page before exiting. Alternatively, of the five students that visited an Interactive page for their first interaction, 50% (n=3) exited the website from this page category, while the remaining three students engaged in further interactions. After initially visiting a Kitchen/Recipe page, five of the 11 students visited a page in at least one other category before exiting the website, and six students exited directly from a Kitchen/Recipe page.
Figure 4.4 highlights the exploration of all three categories of the website, as 58% (n=21) of students in this sample who did not leave the website directly from the home page proceed to visit website pages in more than one category of content.
Figure 4.4. Traversal paths through the whydairy.com website, taken by a sample of students during the intervention period that began at the home page for their school
Figure 4.5 captures the date of access of whydairy.com in relation to the date of intervention education visits one, two, and three, which is when the students were encouraged to visit the website. Although there were four classroom visits in total during the intervention period, the fourth visit was strictly for post-intervention survey completion and therefore did not include promotion of website content. Thus, it was not included in this evaluation. As well, “other” denotes a website visit not within two days following a classroom visit. On average, across the seven schools who received the Why Dairy and Alternatives intervention, 67.5% of website sessions occurred within the two days following classroom visits one to three. Approximately one-quarter (25.6%) of the sessions occurred within two days following Visit 1, while 16% of the sessions occurred within two days following Visit 2, and 25.9% of the sessions occurred within two days following Visit 3.

![Pie chart showing website session percentages]

**Figure 4.5.** Average percent of website sessions on whydairy.com that occurred within the follow two days of a classroom visit for the intervention schools (n=7)
4.2.4.4 Follow-up Email Campaign

In regards to the parent follow-up email campaign, out of a total 52 consenters, 50 parents provided correct email addresses; however, the total number of subscribers declined across the five months (Table 4.6). The average percentage of email opens was 43%, with the highest percentage of opens recorded from Email 1 (50%) and the lowest from Email 4 (33%). Despite the modest percentage of opened emails, only five clicks in total were recorded throughout the entire email campaign coming from Email 1 or 3. Emails 2, 4, and 5 did not generate any clicks. During the follow-up period, there was low activity on the WhyDairy website. In schools that were part of the parental email campaign, eight website sessions were initiated during the five-month follow-up period and these sessions all originated from email clicks. In comparison, the INT schools engaged in only five website sessions across the follow-up period.

Table 4.6. Parent email campaign subscribers, email opens and email clicks across the five-month email campaign

<table>
<thead>
<tr>
<th>Follow-up Email #</th>
<th>Subscribers</th>
<th>Opens (% of subscribers)</th>
<th>Clicks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>50%</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>44%</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>48</td>
<td>44%</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>46</td>
<td>33%</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>46</td>
<td>43%</td>
<td>-</td>
</tr>
</tbody>
</table>

Subscribers = parents who remained subscribed to receive emails
Opens = emails opened from inbox
Clicks = engagement with the email through clicking one of the WhyDairy links provided in the email

A one-way ANOVA was conducted to determine if the changes in students’ knowledge scores from post-intervention to follow-up were different based on their parent’s interaction or engagement with the follow-up email campaign. The mean change in knowledge scores (Figure 4.6) became increasingly positive from no follow-up (mean -1.3 ± 3.7 SD), to follow-up with

174
engagement (mean -1.1 ± 2.4 SD), to follow-up no engagement (mean -0.95 ± 2.0 SD), but the differences between these treatment groups was not statistically significant (p=0.875).

Furthermore, a Spearmen’s rank coefficient was calculated to determine the strength of the association between a parent’s email engagement score and their child’s change in knowledge test score from post-intervention to follow-up. The coefficient was calculated to be 0.169 and this association was not statistically significant (p=0.381).

Figure 4.6. Mean change in student knowledge score from post-intervention to follow-up
No Follow-up: Parents did not receive emails between the end of the intervention and follow-up visit.
Follow-up Engagement+: Parents received emails during the follow-up period and opened and clicked on at least 1 email.
Follow-up, Engagement-: Parents received emails during the follow-up period but did not open or click on any emails.

4.2.5 Discussion

The objective of the study was to assess whether a school-based intervention enhanced with a web-based component was more effective than a standardized dairy education program at changing: (i) knowledge of dairy products, (ii) intentions to consume dairy products, and (iii) dietary intake of dairy products. As well, the study aimed to characterize use of the intervention website and the effectiveness of a parent e-mail campaign as a follow-up strategy to the
intervention. Overall, all participants demonstrated improvements in knowledge regarding dairy products and alternatives with voluntary use of the website during a two-day period following intervention education visits and general success of the parent email campaign in maintaining subscribers throughout the campaign period. However, no treatment groups saw changes in dietary behaviour and while there was moderate engagement with the website during the intervention period, there was poor engagement with the website during the follow-up period. The results of this study demonstrate the effectiveness of a school-based intervention enhanced with a web-based component in changing student knowledge regarding dairy products and the engagement of the website during the intervention period. Future work should consider longer durations to see changes in dietary behaviour and more targeted approaches during follow-up periods.

4.2.5.1 Post-intervention Changes in Knowledge, Behaviour, and Intention

Contrary to our hypotheses, we found no differences in knowledge about dairy products and alternatives or intake of dairy products and alternatives between our treatment groups post-intervention. There are a few potential reasons for the lack of differences between the intervention and control groups. After the intervention was complete, it was discovered that some schools were repeatedly exposed to the DFO education program for a prolonged period of time prior to the intervention beginning (87% of CON school students), while other schools had no contact (17% of intervention school students). The interaction and relationship building with the same educator for many years prior to the intervention was therefore severely imbalanced across treatment groups. While the WhyDairy intervention was intended to be focused primarily on dairy products and alternatives, since previous research has suggested that targeted dietary messages lead to more successful interventions (Marquez et al., 2015), the intervention was
broader in scope than the DFO program. The control program from the DFO focused entirely on dairy products, reinforcing these simple messages repeatedly. In comparison, the WhyDary intervention spoke to dairy products, but also included alternatives, as components of an overall healthy diet. Addressing diet more broadly may have inadvertently diffused the intended focus and message of the intervention, thus resulting in less targeted knowledge acquired by the students. The lack of difference between the treatment groups may also be due to the fact that the control schools received a shorter program (two to four weeks shorter than the WhyDairy intervention), which allowed students to retain information over the short-term and recall this information sooner than the intervention students, thus reducing the natural decay of knowledge across time (Custers, 2010). Those in the intervention schools learnt about what constitutes a dairy product or alternative about six to eight weeks prior to being asked questions on the post-intervention survey, compared to the control school students who only had to retain the information for two to four weeks. Finally, while this study was intended to be a randomized control trial with a control group, the DFO education program that acted as our control was not a true “treatment as usual”. The educator was inconsistent with their teaching between schools and directly referenced the baseline and post-intervention survey questions. All of these factors may have resulted in the lack of differences seen between treatment groups.

While there were no differences in knowledge about dairy products and alternatives between control or intervention groups, all three treatment groups saw significant increases in knowledge post-intervention. This is consistent with previous literature that educational interventions in schools can modify and improve knowledge regarding food and food groups in adolescents (Fahlman, Dake, McCaughtry, & Martin, 2008; Long & Stevens, 2004; Powers et al., 2005; Watson et al., 2009). Nutrition interventions must be sufficiently long to result in
changes in knowledge in adolescents (Hoelscher, Evans, Parcel, & Kelder, 2002). It has been suggested that 10-15 hours of education (Shariff et al., 2008) through interventions spanning between five to 13 weeks (Contento, Randell, & Basch, 2002; Powers et al., 2005; Yoon, Yang, & Her, 2000) are needed to improve adolescents’ health and nutrition knowledge. While the WhyDairy intervention spanned a period of six to eight weeks, our intervention was able to elicit changes in knowledge with only one hour and 40 minutes of total instructional time. In addition, the control program was also able to improve students’ knowledge with only one hour of instructional time. This suggests that with content and teaching strategies that are appropriate and targeted to the age group, nutrition knowledge can be changed in a short amount of time.

Despite the change in knowledge across all treatment groups, there were no changes in behaviour as measured by dairy and alternative intake. This result is in contrast to literature that suggests nutrition knowledge can be at least a partial mediator of food intake (Wardle et al., 2000; Worsley, 2002), although it is clear that knowledge is only one of many influential factors over food behaviour (Worsley, 2002). Other important factors include: perceived consequences of the behaviour; attitudes and beliefs about the behaviour; skills and confidence; social and physical environments; and barriers and facilitators to dairy product consumption, such as knowledge about dairy products, misconceptions regarding dairy products, taste preference, habits, availability of dairy products, and their convenience (Racey et al., 2017). Many of these factors are common constructs of behaviour change theories, including the Theory of Planned Behaviour (Ajzen, 1991) in which the WhyDairy intervention was modeled upon. Although we attempted to target barriers and facilitators to dairy product intake (such as by clarifying their benefits and common misconceptions, teaching ways to incorporate dairy and alternatives into everyday meals, and promoting experimenting and trying a new dairy product), there were
several that we were unable to reach, such as availability (due mainly to getting research ethics board approval to bring food into schools) and cost. Moreover, we were unable to fully extend the reach of the intervention to include direct parental and home contact, although we attempted to do so by sending materials home with students. We attempted to measure these factors and constructs within our survey and did see some correlations between perceived control and self-assessment of control, as well as self-assessment of control and intention to consume dairy products. However, despite these correlations, our intervention (at only six to eight weeks) may not have been long enough to result in behaviour change, as previous work has indicated that interventions are more likely to be successful if they are between six weeks to one year in length (Contento et al., 2002; Marquez et al., 2015; Powers, Struempler, Guarino, & Parmer, 2005; Racey, O'Brien, et al., 2016; Yoon et al., 2000). In addition, it has been suggested that a minimum of 50 hours of instructional time is needed to produce behavioural changes in adolescents (Contento et al., 2002; Powers et al., 2005; Yoon et al., 2000). This is very difficult to achieve in a school-based setting unless the intervention is directly integrated into the academic curriculum, as it must be delivered consistently on a long-term basis. Our intervention was also limited by sample size, and we did not reach the number of participants needed as determined by our power calculation. Recruitment of schools was limited by their ability to dedicate class time to the intervention, which again highlights the need for interventions to be directly integrated into the curriculum. In addition, our population consumed high levels of dairy at baseline, with over half of the participants meeting dietary recommendations, which may be due to the close proximity to rural farm land and the strong agricultural influence on the area, both of which can increase milk consumption (Henry et al., 2015; Minaker et al., 2006).

Consequently, there was a limited need for behaviour change since the majority of the population
was already meeting their dietary targets, and our intervention encouraged them to meet, but not exceed, these recommendations. Additional data analysis segmenting students into five quintiles of dairy intake (data not shown) did not reveal any significant differences; however, this breakdown of student would further reduce our population size far below our power calculation target. So, while increasing nutrition knowledge may be an important initial step to modifying behaviour, ensuring this translation will likely require a more intensive intervention and greater control over variables such as parental involvement and participant baseline characteristics (Campbell et al., 2007).

4.2.5.2 Website Use During the Intervention Period

The amount of time spent on a website has also been shown to be a significant indicator of behaviour change outcomes in health interventions (Couper et al., 2010). One-third of our intervention study population voluntarily used the website during the eight-week intervention period, but activity almost exclusively occurred within two-days following a research visit. This may suggest that repeated between visit prompts or personalized sections of the website, such as recommended by DeBar et al. (2009), are warranted to encourage sustained use of a supplementary web-based component of a school-based nutrition intervention. Of those who viewed the website, almost half were returning users which could indicate that these students found the website to be satisfactory and therefore chose to revisit. We were unable to elicit the exact reasons as Google Analytics provided us with anonymous usage of the website. Therefore, future research is needed to determine the characteristics of the returning users compared to those who did not return, their motivations to return to the webpage, and the specific website components that were satisfactory.
Using the WhyDairy website as a supplementary, technological component to the school-based intervention had the added benefit that website content could be specifically matched to the content of the research visits. As well, the website was updated with new content prior to each research visit. Previous research has demonstrated that users preferred having new, updated content throughout an intervention period and this encourages return visits to see the new content (Papadaki & Scott, 2006). The influence of face-to-face encouragement of using the website and the release of new content may have been related to high number of visits within two days following a classroom visit and the relatively high number of returning users. However, we only successfully motivated one-third of students to visit the website, which meant the majority of students did not access the website on their own and may suggest that face-to-face encouragement is not a sufficient engagement strategy.

In addition to visual appeal, the content and layout of a website can greatly influence which pages are visited. The high number of page views in the Interactive content category is concurrent with previous research that children and adolescents enjoy games and interactive components of health and nutrition websites (Ahn & Kim, 2007; Franck & Noble, 2007). While the Kitchen/Recipe category had the second highest views, we are limited in not knowing if a student printed or recorded the recipe, and therefore, did not re-visit the page. The layout of the website may also promote page views for specific content categories. For example, one interactive feature involves exploration of the human body to learn how dairy and alternatives affect various body parts and bodily functions. Users were able to click on different parts for further information. Therefore, this feature promoted additional page views of the Interactive category as users explored many body parts. In contrast, most knowledge pages contained only information presented in text without links to additional knowledge pages. This is a caveat to
consider when relying on categorical page view data to conclude about popular content and further support the need for qualitative research.

In an attempt to gather a more holistic view of how students navigated through the site, researchers utilized the Behaviour Flow tool of Google Analytics. This tool provided valuable insight towards how students navigated through the website, specifically the order by which they viewed different types of content and the pages from which they exited the website. This analysis is an example of combining the quantitative data collected by Google Analytics with objective interpretation to gain a more in depth understanding of user behaviours. Our observations support the progression towards higher order learning during a website session. Bloom’s taxonomy outlines progression in thinking where a foundation of understanding developed in lower-order thinking is necessary to progress to higher order thinking (Bloom, Krathwohl, & Masia, 1984). Levels of thinking progress in the following order: Remembering, Understanding, Applying, Analysing, Evaluating and Creating (Bloom et al., 1984). When comparing the three content categories of the WhyDairy website to Bloom’s Taxonomy levels, pages in the Knowledge category would fall under “Understanding”, Interactive pages would fall under “Applying” and Kitchen/Recipe pages would fall under “Creating”. Analysis of the traversal paths support the idea that users progressed in a pattern corresponding to Bloom’s Taxonomy levels, by building a foundation at the “Understanding” level before progressing to “Applying” or “Creating” levels. Researchers developing websites to assist in their intervention efforts may consider developing the pages to flow in the same order as Bloom’s Taxonomy in order to capitalize on student’s natural progression through the site and development of knowledge.
4.2.5.3 Follow-up Email Campaign and Student Changes in Knowledge

A significant issue with school-based nutrition interventions has been previously identified as a lack of follow-up (Racey, O'Brien, et al., 2016). As well, it has been suggested that interventions aimed at improving adolescents’ consumption of dairy products may be enhanced by including a parental component (Hanson et al., 2005; Racey, O'Brien, et al., 2016). The WhyDairy intervention attempted to address these issues by including a parental email campaign and a follow-up data collection visit five-months post-intervention. Interestingly, the INT+FU schools were the only group to maintain their knowledge at the follow-up visit and demonstrate a significant increase in knowledge from baseline to the follow-up visit almost five months later, with no significant decrease in knowledge at any time point. The other two treatment groups, CON and INT, both experienced a decay of knowledge across time with a significant decrease in knowledge at follow-up as compared to post-intervention. It has been widely suggested, and should be a focus of future interventions, that without reinforcement of knowledge and newly learned concepts, decay in knowledge can occur (Custers, 2010).

The retention of knowledge in the INT+FU group may be due to the success of the parental email campaign during the follow-up period. Almost all parents (92%) remained on the email list and just under half of parents (43% average) opened the emails. While there was poor engagement with the emails, as measured by clicking the links provided, this is only one method of quantifying the success of the email campaign. The body of the emails contained basic information and reminders regarding the health benefits of dairy products and alternatives and ways to incorporate them into every day meals. By opening and potentially reading the emails, this may have been enough for parents to prompt and reinforce what the students learned during the intervention period and translate into improved knowledge outcomes at follow-up. As well,
parents may have researched information on other websites, which would not have been accounted for by only tracking our intervention website visits. Providing parents of adolescents with knowledge and skills to enhance the home food environment can have a direct impact on adolescent eating behaviours (Arcan et al., 2007; Hanson et al., 2005). In our intervention, we failed to see the translation of parental engagement with student changes in behaviour. As well, parental engagement with the emails did not correlate with a positive change in their child’s knowledge. This may be due to the low engagement with the emails, the decrease in website visits during the follow-up period, the passive nature of the email campaign, and the timing of emailing parents over summer holidays. Therefore, future research that incorporates parents as a target of their intervention should focus on actively engaging the parents, changing the home food environment, and utilizing parents to model healthy behaviours at a more convenient time (Arcan et al., 2007; Hanson et al., 2005; Racey, O'Brien, et al., 2016).

4.2.5.4 Limitations

Due to the nature of this study, a number of limitations exist. Firstly, our study may have been underpowered to detect significant differences. While our initial recruitment of schools and students would have led to a study that was almost sufficiently powered, student absences and lack of consent led to a smaller study population than anticipated. This also speaks to the issues with recruitment due to restrictions placed by the school board and the schools. In total, 23 schools were contacted across Southwestern Ontario and 13 declined to be a part of the study. Secondly, the intervention program and time with the students was limited due to school board and individual school restrictions. Researchers were often required to conform to their schedules which altered the precise plan of implementing an intervention in exactly the same way across multiple locations. This also limited the length, depth, and intensity of the intervention, which
have been suggested as important components for the success of changing adolescent behaviour (Marquez et al., 2015; Racey, O'Brien, et al., 2016). In regards to the outcome measurements, they were derived from a survey with three questionnaires based solely on self-report. While adolescents are capable of completing these types of surveys (Hess et al., 1998; Leeuw & Otter, 1995), social bias, recall bias, and lack of clear understanding may have influenced the accuracy of their reporting (Brener, Billy, & Grady, 2003). As well, students gained knowledge during the intervention about correct serving sizes and therefore may have more appropriately reported their dairy intake at post-intervention and follow-up. Although it is unclear whether this would lead to an over- or under-estimation of intake at baseline. Finally, Google Analytics was configured to distinguish each school’s activity via this specific web address; however, it did not allow us to identify specific website users and it is possible that the website may have been accessed by third-party users via Google search or ad buttons. In order to mitigate this, any Google Analytics data that appeared to originate from these third-party users were excluded from data analysis. We acknowledge the fact that those voluntarily accessing the intervention website represent a subset of the entire population and were likely more engaged students.

4.2.6 Conclusion

Overall, the results of this study (Table 4.7) provide supportive evidence that knowledge regarding dairy products and alternatives can be changed through a school-based intervention with supportive web-based components and that the increase in knowledge can be sustained over five months with follow-up strategies. However, the change in knowledge did not translate into a change in behaviour, potentially due to the high baseline dairy consumption of our population or the relatively short length of time spent interacting with students. With regards to the website component, students were more actively engaged in the website during the intervention period
and especially in the days following a research visit. This engagement did not continue to
through the follow-up period which consisted of summer break and a potential change in routine
or access to internet. Finally, parents were receptive to receiving emails as an effective follow-up
strategy, and almost half engaged in opening the emails. Despite this, the vast majority of parents
did not engage with the email by clicking on any links or resources provided within the email
text. Future research should consider the school environment as an effective location to educate
students about foods for health and could supplement the lessons with web-based components. In
addition, researchers should investigate motivations for using websites and how to encourage
prolonged website use when developing these supportive intervention components. Parents can
be an effective supplement to school-based interventions and more targeted approaches that
actively engage parents could result in changes amongst students in future research.

Table 4.7. Summary of findings: Effectiveness of the WhyDairy intervention and the associated
website and parent email components

- A school-based dairy intervention with a website component is effective in creating
  short-term changes in knowledge
- Changes in knowledge can be maintained up to five-months post-intervention with
  parent involvement through a targeted email campaign
- Longer, more intense interventions may be necessary to see changes in dietary
  behaviour
- One-third of students voluntarily accessed the WhyDairy website and timing of these
  visits corresponded closely with school visits
- Interactive game pages were the most popular pages, followed by Kitchen/Recipe and
  Knowledge pages
- Future research should consider developing targeted interventions with web
  components to enhance student engagement and more active strategies to reach the
  home environment, including parents
CHAPTER 5: INTEGRATIVE DISCUSSION

5.1 Overview

The work in this thesis aimed to address the gap of using the KTA cycle framework in practice to inform nutrition intervention research. The overall objective of this thesis was to explore the use of the KTA cycle framework to systematically tailor, plan, develop, implement, and evaluate a nutrition intervention targeting dairy product and alternative consumption by adolescents in Southwestern Ontario. As such, this thesis aimed to produce a comprehensive illustration of how the components of a KTT theory can be used in nutrition research. The objectives were accomplished by: tailoring and synthesizing existing knowledge to identify and extract relevant information (Chapter 2); adapting the knowledge to the local context and investigating the barriers and facilitators to the behaviour (Chapter 3); and using this knowledge to inform the development and delivery of a novel nutrition intervention, which included sustaining knowledge use and evaluating outcomes (Chapter 4). The following is a discussion of the major findings of this thesis, along with the strengths and limitations of the work, and suggestions for future research directions.

5.2 Study Summaries Related to the KTA Cycle Framework

To review, the KTA cycle framework begins with the Knowledge Creation funnel, in which knowledge is aggregated and synthesized into tools or products that present the knowledge in clear and concise formats, such as a systematic review. In order to address the identified problem of a lack of dairy product consumption by adolescents, the first study evaluated primary literature to investigate the breadth of research conducted to promote dairy product and alternative intake in pre-adolescents and adolescents, as well as to investigate school-based nutrition interventions more broadly.
Study one identified several characteristics that may be related to intervention success. Both systematic reviews found that the majority of interventions were categorized as high or medium intensity (62% of school-based interventions and 94% of dairy-focused interventions), and suggested that targeting adolescents at a group level, such as in their classroom and within schools, was feasible. While the school-based review did not find differences between intervention intensity categories or dietary targets in regards to specific intervention components (reach, duration, personalization, contact), the dairy-focused systematic review did highlight some important differences. Duration of the intervention appeared to be strongly related to intervention effectiveness, as those that lasted six months to one year were more effective than those less than five months. This is in contrast to the school-based review, which found that interventions five weeks to six months in duration tended to be more effective than those that were longer or shorter. These results suggest that there may be benefits to interventions that are not too short or too long in duration.

Both systematic reviews also found similarities with regards to follow-up and parental involvement in the intervention. There was limited follow-up noted by interventions in both the dairy and school-based review (6% and 20% respectively), and almost all of the effective interventions that conducted follow-up were no longer effective or were less effective when participants were monitored across time. Both reviews also found that parental involvement was not reflective of intervention success; however, this could be due to the relative passive nature of many parental components as well as the small number of studies in the reviews that involved parents. This highlights that there is a gap in follow-up measurements in nutrition intervention research with pre-adolescents and adolescents which may skew the literature to appear highly
effective, but only while the intervention is occurring. As well, there is also a gap regarding parental involvement in nutrition interventions, at least as far as active engagement.

Lastly, while the dairy systematic review did not find that a behaviour change theory was predictive of intervention effectiveness, it did suggest that the use of technology was associated with effectiveness. Interactive technology or website components are not a BCT themselves, but some interventions used these techniques to incorporate behaviour change theory constructs (or BCTs) that were associated with effective interventions. Adolescents are avid users of technology and often use the internet and technologies to access health knowledge. These findings support the evidence that information and communication technologies are effective in supporting intervention to modify adolescent behaviour.

After producing useful knowledge tools and identifying intervention characteristics that were associated with effectiveness, we moved onto the Action Cycle of the KTA cycle framework. The first phase of the second study addressed the beginning of the Action Cycle, adapting knowledge to the local context, while the second phase assessed the barriers to knowledge use. Both phases of the second study were conducted using a similar population (in terms of age, grade, and location) that would be the target of the subsequent intervention. Specifically, the first phase of the second study sought to investigate adolescents’ perceptions and use of various sources of health knowledge in order to further tailor the resources used in the forthcoming intervention, while the second phase of the second study sought to assess the barriers and facilitators to dairy product consumption.

Focus groups were conducted in the second study to explore where students go for reliable health knowledge as well as how knowledge can be presented to create behaviour change. With regards to how adolescents described preferring to learn about health, the favoured
sources were not surprising. Adolescents reported that they sought general health-related information from parents, school/teacher, internet/media, friends, or doctor. However, when their health questions were more personal and specific, they tended to go to trusted and older persons with whom they had a close relationship. When asked about how health knowledge that has changed their behaviour was presented to them, adolescents said that regardless of the mode of delivery, what mattered most for behaviour change was their own personal motivation and preferences towards the behaviour. Following this, adolescents were asked how they would prefer health knowledge was presented to them to encourage them to change their behaviour. Not surprisingly, students wanted the information to be presented in a way that would be engaging and fun, including through playing games. They also mentioned role models, earning rewards, and seeing the visual consequences of engaging in healthy behaviours (such as ‘before and after’ photos). These insights and suggestions from adolescents provided useful knowledge that could be used in the development of future intervention research with similar populations.

Focus groups were also conducted in the second study to investigate the specific barriers and facilitators to dairy product consumption. Through this work, we confirmed our hypotheses based on previous work regarding factors that affect dietary behaviours. Knowledge regarding the health benefits of consuming dairy products, misconceptions that dairy products have adverse effects on health, routines and habits, peers and parents, and taste preferences were all identified as barriers and/or facilitators common between both genders and different levels of habitual dairy intake. So, while knowledge can be a factor related to dietary behaviour, this work confirms that a combination of social, environmental, and personal factors also strongly affect dietary behaviour and can be targets when attempting to change behaviour (Worsley, 2002).
The research conducted in the first two studies yielded important knowledge that could be used to develop an intervention that was targeted and appropriate for a grade seven population. To recap, we learnt from the first study that in order to create an effective intervention, targeting adolescents in the schools at a group (classroom) level is adequate, that parents need to be more actively engaged, that a study duration of six weeks to five months should be sufficient, that technology could be a useful tool to help deliver the material, and that maintaining behaviour changes as measured at follow-up is a severe gap in current literature. In the second study, we confirmed that teachers could deliver general health knowledge in the school setting, such as knowledge regarding dairy products. The second study also gave direction to format the education sessions as engaging and fun, including the use of games, and to incorporate visual demonstrations of health effects. Furthermore, the second study highlighted a number of barriers and facilitators to address during the intervention. Specifically, knowledge regarding dairy products and clarifying misconceptions were important factors to address related to adolescents’ dairy product intake. Social factors such as parents are again mentioned as significant targets for adolescent interventions. Taken together, the first and second studies highlighted many directions for the nutrition intervention development undertaken in the third study.

In the third study, the remaining components of the Action Cycle of the KTA cycle framework were the research focus. To begin, the component of “select[ing], tailor[ing], and implement[ing] interventions” was addressed. As no existing intervention was available that incorporated all of the knowledge generated in the first two studies, a novel school-based intervention with a web-based component was developed, piloted, and implemented with adolescents across Southwestern Ontario. Next, the “monitor[ing] knowledge use” component of
the cycle was addressed through post-intervention questionnaires. The intervention continued to follow the KTA cycle framework as it evaluated the outcomes and impact of knowledge to determine if the intervention made a difference in behavioural outcomes. And finally, similar to the identified need for follow-up, the Action Cycle also specifies that after intervention implementation and evaluation of outcomes, knowledge use must be sustained. This was accomplished through a follow-up campaign and assessment of intervention outcomes months after the intervention was completed.

The third study was a cluster randomized controlled trial that provided valuable insight with respect to intervention development and implementation. Firstly, the intervention (both school and web-based components) effectively increased knowledge in the treatment group, as demonstrated through knowledge test scores improvements. Secondly, the follow-up email campaign effectively engaged parents, as illustrated by the fact that the majority of parents opened the emails and remained on the listserv, and that students whose parents received the emails maintained their increase in knowledge regarding dairy products and alternatives at the follow-up visit. Thirdly, the web-based component of the intervention successfully complemented the school-based sessions, as illustrated by the high percentage of website use following the intervention visits. Overall, it appears that the comprehensive intervention, including school, web, and parent email components, was effective, although we did not observe a change in dietary intake of dairy products or alternatives at any point in the measurement of outcomes.

It is important to note that all relevant findings from the first and second studies could not be addressed through our novel intervention. There are several reasons for this. To begin, there were severe constraints associated with doing school-based research, most notably in terms of
student accessibility. At the level of the school board, it was difficult to gain approval to conduct research in schools, while at the level of the classroom, there were limitations in terms of the number of classes that could be dedicated to research. As such, in the development of the intervention, we selected factors that were easier for adolescents to control (for example, their own knowledge rather than access to dairy products which may be regulated by parents) and factors that were not limited by ethics or cost (for example, the ethics board had concerns regarding provision of food to adolescents by researchers). While the third study was not successful in changing behaviour or intentions in any group, and while there were no differences between treatment and control groups, the intervention was appropriately supported by previous research and demonstrated the use of the KTA cycle framework in nutrition research.

From these results, new knowledge gaps and questions have been identified and improvements to intervention components have been acknowledged. This sets in motion a feedback loop that cycles through the KTA cycle framework again. Such gaps and questions will be discussed further in the next sections.

5.3 Generalizability and Limitations of KTT Work

The three studies presented in this thesis have some general limitations that are worth noting. In the first study, the majority of nutrition interventions targeting dairy, calcium, or milk intake, or those targeting other food behaviours specifically conducted in a school setting, were successful (70% and 82% respectively), highlighting the overwhelming success of interventions in terms of modifying the dietary behaviours of pre-adolescents and adolescent populations. However, so many successful interventions in the short term can make it difficult to effectively identify characteristics that are associated with success. Intervention effectiveness was based on specific criteria of modifying a dietary behaviour in a healthy direction. Interventions that were
deemed ineffective using this criterion may have been effective at changing other relevant outcomes such as dietary knowledge or physical activity. Particularly in the school-based systematic review, there were numerous dietary behaviours that were considered which resulted in a small number of studies in some categories and limited the conclusions that could be made. This diversity in nutrition research, as well as investigators failing to report the necessary data to compute effect sizes, made it difficult to conduct a meta-analysis for either systematic review. A meta-analysis would have further helped make conclusions regarding intervention effectiveness and the intervention components that were related to successful outcomes. Notably, this could have resulted in relevant intervention characteristics being missed, and consequently being omitted from the novel intervention development in study three.

Some studies in the interventions included in the systematic reviews provided food, including dairy products such as milk. While it was noted which interventions included this component, supplying adolescents with food greatly impacts intervention effectiveness when measuring that dietary behaviour. It reduces barriers such as accessibility or cost of the food and directly increases the consumption of the food, thus resulting in improved dietary behaviours. Unfortunately, our intervention was not able to provide food to students due to cost and liability, and therefore, we had to develop other ways to address these barriers, if possible. Moreover, when the intervention is no longer in progress and providing food, it is not known if adolescents would continue these behaviours and choose to consume these foods on their own. Researchers should investigate the success of the intervention after the provision of food ends, or compare to interventions that use other techniques to target the barriers of cost or accessibility regarding the food or food group of interest.
Using focus groups is a qualitative research method that has some inherent limitations. Specifically, adolescents may be saying what they think researchers would like to hear, and may be trying to give the “right” answer, specifically when asked about health behaviours. Adolescents may also be trying to impress peers in the same group with their responses. This makes it difficult to control what is being said during the focus groups and ultimately, what results can be gleaned from the information provided by the adolescents. As the intervention was informed by the results of the focus group, inaccurate responses from students could impact intervention development. Researchers could be planning an intervention that targets all the right concepts, but doesn’t truly get at the issues affecting the adolescents. To mitigate issues with focus group control and encourage truthful responses, researchers in the second study were formally trained and groups were reviewed and approved by teachers prior to conducting the focus groups in an attempt to limit peer influence.

There are a few likely reasons why the intervention was not successful in meeting all objectives. The study was limited by the regulations and restrictions of the school board regarding total time of visits, number of visits, time between visits, and approval of individual schools. These factors restricted the tight control that is preferred in a randomized controlled trial and also resulted in an underpowered study. Meeting the needs of both the Research Ethics Board and the school board limited the intensiveness of the intervention and involvement with the students, therefore further limiting our ability to address some important barriers previously identified such as taste preferences, cost, convenience, or peer influence. Targeting these barriers more effectively may have resulted in better dietary behavioural outcomes.

The focus groups in the second study provided useful insight regarding who could potentially deliver health information and how this information could be communicated.
Teachers were recognized as a trusted source of health knowledge, but due to time constraints teachers could not be formally trained to deliver the intervention components. This resulted in researchers leading the intervention who may not have been viewed as trusted sources of information. Learning through games that are fun and engaging led to the development of educational games on the website. The games were developed by our research team and due to lack of funding and time, we were unable to test the concepts or conduct focus groups with the students to see if our assumptions on what would be a fun way to learn were also perceived the same way by adolescents. Although the intervention was piloted as a whole unit, the individual components were not evaluated, which could have led to ineffective components being included in the final intervention. With adequate time and resources, these components could be evaluated more thoroughly in future research.

Separate from the limitations of the research methods and intervention development, there are limitations and challenges with community-based work and the field of KTT. KT interventions are generally complex to design and evaluate as they occur in real-world settings (Curran et al., 2011). Behaviour change theories have been suggested to guide and optimize the development of interventions as well as the evaluation of interventions (Curran et al., 2011). The WhyDairy intervention did use theory in its design, but both health and KT interventions have been criticized for falling short in maximizing the use of theory when designing KT strategies (Curran et al., 2011). Weak designs, poor reporting, and haphazard application of KT frameworks in research results in limited insight into the rationale and specification of the intervention, true effect, and the likely confounders (Curran et al., 2011). Future researchers need to carefully design interventions and provide more comprehensive information about the process of designing, implementing, and developing interventions.
Integral to the KTA cycle framework is addressing barriers to knowledge use. The importance of these factors and the ability to influence them is well recognised (Field et al., 2014). It has been suggested that when the target audience is consulted, they identify those barriers that they feel able to influence, such as knowledge or awareness, rather than organisational barriers, which could be perceived as more problematic or more distant (Field et al., 2014). While the age of our target audience made it unlikely that they would recognize these types of barriers, or the differences between them, the analysis of the barriers and facilitators within a KT project could be categorized as such. In order to target these barriers, multifaceted KT strategies are likely to be more effective than a single strategy (Field et al., 2014). So, while interventions may need to be targeted to one dietary focus (such as dairy products) (Hendrie et al., 2013), rather than targeting a healthy diet more broadly (such as in WhyDairy), there is the need to use many KT strategies to target multiple barriers at once. Real-world KT intervention research occurs in complex settings which necessitates the need for complex, multifaceted interventions that address different barriers at the same time (Curran et al., 2011). However, it has been noted that there is limited literature regarding how to effectively promote and facilitate these strategies (LaRocca, Yost, Dobbins, Ciliska, & Butt, 2012).

5.4 Recommendations for Future Work

With regards to the nutrition intervention field, there are numerous suggestions for future work that can be extrapolated from this thesis. As the first study identified poor reporting of intervention components and a lack of follow-up in the vast majority of studies, future studies should seek to rectify these issues. Interventions could provide supplemental information for more details of intervention components. As well, researchers could measure long-term
behaviour to investigate if changes can be maintained across time, as well as explore techniques that can be used to maintain behaviour changes.

In the second study, many of the major barriers and facilitators to dairy product consumption in adolescents that were identified were confirmatory of previous research in similar populations (Hanson et al., 2005; Larson et al., 2006; Novotny et al., 1999; Nowak, 1998); however, our results did not identify cost, competition with other foods/beverages, or demographic factors to be major influences on dairy intake. There is likely a need to explore barriers and facilitators to dairy intake in populations that are more highly stratified. Habitual dairy intake, and different demographic factors such as ethnicity, socioeconomic status, and gender are known factors influencing dairy intake (Hanson et al., 2005; Larson et al., 2006; Novotny et al., 1999; Nowak, 1998) that did not present as major barriers or facilitators in our work. Our research investigating adolescent use and perception of sources of health knowledge is, to our knowledge, the first of its kind. Future work should look to confirm these findings and further investigate the use of technology, internet, and media as strategies to communicate health information to adolescents.

Finally, in the third study, our intervention provided support for the use of school-based nutrition interventions to modify student knowledge, and confirmed that classroom sessions can be supplemented with web-based components. However, the change in knowledge was not sufficient to change dietary behaviour, which is in contrast to previous literature (Wardle et al., 2000; Worsley, 2002). This finding further supports the complex nature and multiple factors involved in creating dietary habits that needs to be investigated. Future work should look to better investigate the link between knowledge and behaviour, explore motivations for using
websites, and ways to encourage prolonged website use when developing these supportive intervention components.

In terms of the KTT field, again, there are recommendations for future work based on this thesis. Important considerations in KTT are the “who” and the “how”. This relates to who should deliver the KTT strategies and how should the knowledge be translated, or what KTT strategies should be used. Our work highlighted the struggle with these considerations. Researchers may not be the best people to deliver health knowledge to students. Despite the expertise in their field and knowledge they would like to translate, they are likely not experts at communicating with their target audience. There can be, and was, negative feedback with regards to academics being in the classroom, mostly from the students. As well, our study had an additional “who” which related to our funding source (Dairy Farmers of Ontario). This concerned some parents and schools who feared that there may be bias in the KTT efforts and communication of information. With regards to how knowledge should be translated for behaviour change to occur, interventions based in theory and previous work can be more successful than those that are not planned in such a way (Curran et al., 2011). However, it is also important to test the intervention and its components prior to conducting a full trial. Focus groups with the target audience to gather insight on the intervention components to be used could ensure the KT strategies are further tailored and adapted to the local context and audience. In the case of school-based research, teachers would also be a valuable resource for input on teaching techniques and methods ensuring that these components are age-appropriate, especially if it is intended that teachers take over delivering the intervention after the research phase is complete. Teachers may be aware of unforeseen barriers to implementing an intervention, which would allow researchers to further tailor their work for sustained knowledge use. These considerations of who should
deliver KTT and how it can be delivered are vital for the success of KT strategies.

Academics and universities play a critical role in creating knowledge and conducting research using a variety of approaches. It is important for researchers to work with communities and stakeholders in developing research questions and methods, and to conduct research to ensure it will be useful and applicable by the end users. These techniques and considerations will help to close the gap in getting research into action. However, there may be a role for knowledge brokers or KTT experts, rather than researchers themselves, in communicating the research to stakeholders in more effective ways and investigating which KT strategies may be best.

5.5 Conclusion

There is much still to be learned regarding the application of the KTA cycle framework in nutrition intervention research, particularly with adolescents. The work in this thesis highlights the importance of considering and consulting with the target audience throughout the research process. As well, there are identified gaps or steps where more contact and work with stakeholders could have further improved the intervention development and potentially resulted in the desired change in dairy intake. While school-based and dairy-focused interventions are widely supportive of creating behaviour change in pre-adolescents and adolescents, there are a range of reasons and barriers that may explain why adolescents are failing to meet their dairy requirements that should be targeted in future interventions. Taken together, the results from this thesis highlights the need for KTT work in the nutrition field, but also the challenges that future research needs to address to create sustained and lasting dietary changes.
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O'Connell, K. M. (2005). Impact of the HEROS (Healthy Eating to Reduce Obesity through Schools) study on healthy food choices and obesity among middle school students in Guilford County (NC) schools.


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APPENDICES

Appendix A – Search terms and Added Behaviour Change Techniques for Chapter 2

Search Terms for Dairy Systematic Review (Chapter 2.1)

1. Interventions
"clinical trial" [tw] OR "clinical trial" [pt] OR "latin square" [tw] OR "time series" [tw] OR ((before and after) OR (study or studies or trial* or design*)) OR ((single* OR doubl* OR trebl* OR triple) [tw] AND (blind* OR mask)) [tw] OR placebo* [tw] OR random* [tw] OR (matched communities OR matched schools OR matched populations) [tw] OR control* [tw] OR (comparison group* OR control group*) [tw] OR matched pairs [tw] OR (outcome study OR outcome studies) [tw] OR (quasiexperimental OR quasi experimental OR pseudo experimental) [tw] OR (nonrandomi* OR non randomi* OR pseudo randomi* OR quasi randomi*) [tw] OR prospective*[tw] OR volunteer* [tw] OR experimental [tw] OR intervention* [tw] OR model [tw] OR models [tw]

2. Nutrition – Food and Nutrient Intake
"High fat" OR "low fat" OR "fatty food*" OR diet* OR "low calorie" OR "calorie control*" OR "healthy eating" OR 'snack food*' OR "fat intake" OR "portion size*" OR "meal pattern*" OR meal* OR lunchbox* OR "lunch box*" OR "energy intake*" OR "fat intake*" OR "weight status" OR obes* OR overeat* OR "over eat*" OR overweight OR "over weight" OR overweight OR "overfeed*" OR "over feed*" OR "weight gain*" OR "weight loss" OR "weight chang*" OR bmi OR "body mass index" OR nutrition OR food

3. Population
adolescent* OR teenage* OR “young people” OR “young person” OR “young adult”

4. Dairy/calcium
dairy OR milk OR cheese OR yoghurt OR yogurt OR calcium OR "cow’s milk" OR "calcium-rich foods" OR "dairy products" OR "dairy foods" OR "dietary calcium" OR "milk intake"

Added Behaviour Change Theories

<table>
<thead>
<tr>
<th>30. Use of peer leaders</th>
<th>Use of peer mentors or leaders working with the person</th>
</tr>
</thead>
<tbody>
<tr>
<td>31. Interviews or brief counseling</td>
<td>Interviews or brief counseling was conducted on the person before or during the intervention</td>
</tr>
<tr>
<td>32. Prompt parental support/involvement</td>
<td>Parental support or involvement was recommended or required for component(s) of the intervention</td>
</tr>
<tr>
<td>33. Lessons by nutritionist/dietitian</td>
<td>And education component or part of the intervention was led or taught by a nutritionist or dietician</td>
</tr>
<tr>
<td>34. Dairy supplements given/provided</td>
<td>Dairy supplements or products were given or provided at a regular basis as a part of the intervention</td>
</tr>
<tr>
<td>35. Learning theory referenced</td>
<td>A learning theory was referenced in the development and execution of the intervention</td>
</tr>
<tr>
<td>36. Taste exposure</td>
<td>The person was exposed to various dairy products</td>
</tr>
</tbody>
</table>
37. Environmental restructuring

Some aspect of the environment the person frequents is restructured to facilitate a behavioural change aspect of the intervention

38. Prescribed diet

A diet has been developed/prescribed for the person

**Search Terms for School-based Systematic Review (Chapter 2.2)**

1. **Interventions**

"clinical trial" [tw] OR "clinical trial" [pt] OR "latin square" [tw] OR "time series" [tw] OR ((before and after OR (study or studies or trial* or design*)) OR ((single* OR doubl* OR trebl* OR triple) [tw] AND (blind* OR mask)) [tw] OR placebo* [tw] OR random* [tw] OR (matched communities OR matched schools OR matched populations) [tw] OR control* [tw] OR (comparison group* OR control group*) [tw] OR matched pairs [tw] OR (outcome study OR outcome studies) [tw] OR (quasiexperimental OR quasi experimental OR pseudo experimental) [tw] OR (nonrandomi* OR non randomi* OR pseudo randomi* OR quasi randomi*) [tw] OR prospective*[tw] OR volunteer* [tw] OR experimental [tw] OR intervention* [tw] OR model [tw] OR models [tw]

2. **Nutrition – Food and Nutrient Intake**

"High fat" OR "low fat" OR "fatty food*" OR diet* OR "low calorie" OR "calorie control*" OR "healthy eating" OR "snack food*" OR "fat intake" OR "portion size*" OR "meal pattern*" OR meal* OR lunchbox* OR "lunch box*" OR "energy intake*" OR "fat intake*" OR sugar* OR beverage* OR "weight status" OR obes* OR overeat* OR "over eat*" OR overweight OR "over weight" OR overfeed* OR "over feed*" OR "weight gain*" OR "weight loss" OR "weight chang*" OR bmi OR "body mass index" OR nutrition OR food OR dairy OR milk OR cheese OR yoghurt OR yogurt OR calcium OR "cow’s milk" OR "calcium-rich foods" OR "dairy products" OR "dairy foods" OR "dietary calcium" OR "milk intake"

3. **Population**

"pre adolescent*" OR "pre-adolescent" OR adolescent* OR teen* OR "young people" OR "young person*" OR "young adult*" OR schoolchildren OR "school children" OR paediatr* OR boys OR girls OR youth*

4. **Setting**

School* OR school-based OR "school based" OR "middle school" OR "elementary school" OR "high school" OR "primary school"
### Appendix B – Summary of overall intensity ratings sorted by intervention category

<table>
<thead>
<tr>
<th>Author</th>
<th>Category</th>
<th>Effective (Yes/No)</th>
<th># Modified Behavior</th>
<th>Sig Change in Primary Outcome</th>
<th>Duration (out of 5)</th>
<th>Frequency (out of 5)</th>
<th>Level of Personalization (out of 5)</th>
<th>Reach (out of 5)</th>
<th>Overall Intensity (out of 20)</th>
<th>Any Negative Dietary Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adamo (2013)</td>
<td>F/V</td>
<td>N</td>
<td>0/3</td>
<td>N</td>
<td>4</td>
<td>X</td>
<td>2</td>
<td>1</td>
<td>X</td>
<td>N</td>
</tr>
<tr>
<td>Ashfield-Watt (2009) a</td>
<td>F</td>
<td>Y</td>
<td>1/1</td>
<td>Y</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>N</td>
</tr>
<tr>
<td>Bakshi (2012)</td>
<td>F/V</td>
<td>Y</td>
<td>4/4</td>
<td>Y</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>7</td>
<td>N</td>
</tr>
<tr>
<td>Baranowski (2003)</td>
<td>F/V</td>
<td>Y</td>
<td>4/6</td>
<td>Y</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>11</td>
<td>N</td>
</tr>
<tr>
<td>Baranowski (2000)</td>
<td>F/V</td>
<td>Y</td>
<td>2/3</td>
<td>Y</td>
<td>3</td>
<td>X</td>
<td>5</td>
<td>3</td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Bere (2006)</td>
<td>F/V</td>
<td>N</td>
<td>0/2</td>
<td>N</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3*</td>
<td>14</td>
<td>N</td>
</tr>
<tr>
<td>Bere (2005) a</td>
<td>F/V</td>
<td>Y</td>
<td>2/3</td>
<td>Y</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>11</td>
<td>N</td>
</tr>
<tr>
<td>Bessems (2012)</td>
<td>F</td>
<td>Y</td>
<td>4/11</td>
<td>Y</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td>N</td>
</tr>
<tr>
<td>Birnbaum (2002) †</td>
<td>F/V</td>
<td>Y</td>
<td>X</td>
<td>Y</td>
<td>4</td>
<td>5</td>
<td>1, 3, or 5</td>
<td>3*</td>
<td>11, 13 or 15</td>
<td>X</td>
</tr>
<tr>
<td>Davis (2009)</td>
<td>F/V</td>
<td>Y</td>
<td>1/4</td>
<td>Y</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>11</td>
<td>N</td>
</tr>
<tr>
<td>No Author (2006)</td>
<td>F/V</td>
<td>Y</td>
<td>2/4</td>
<td>Y</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>13</td>
<td>N</td>
</tr>
<tr>
<td>Evans (2012)</td>
<td>F/V</td>
<td>Y</td>
<td>1/1</td>
<td>Y</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>11</td>
<td>N</td>
</tr>
<tr>
<td>Feoerster (1998) †</td>
<td>F/V</td>
<td>Y</td>
<td>1/1</td>
<td>Y</td>
<td>2</td>
<td>4</td>
<td>2 or 3</td>
<td>5</td>
<td>13 or 14</td>
<td>N</td>
</tr>
<tr>
<td>Hassapidou (1997)</td>
<td>F/V</td>
<td>Y</td>
<td>0/7</td>
<td>N</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>3*</td>
<td>11</td>
<td>Y</td>
</tr>
<tr>
<td>He (2009) a†</td>
<td>F/V</td>
<td>Y</td>
<td>1/3</td>
<td>Y</td>
<td>3</td>
<td>4</td>
<td>1 or 3</td>
<td>1</td>
<td>9 or 11</td>
<td>N</td>
</tr>
<tr>
<td>Jamelske (2008) a</td>
<td>F/V</td>
<td>Y</td>
<td>2/6</td>
<td>Y</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>12</td>
<td>N</td>
</tr>
<tr>
<td>Jemmott (2011)</td>
<td>F/V</td>
<td>Y</td>
<td>3/3</td>
<td>Y</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>3*</td>
<td>13</td>
<td>N</td>
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<tr>
<td>Jones (2014)</td>
<td>F/V</td>
<td>Y</td>
<td>2/8</td>
<td>Y</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>14</td>
<td>N</td>
</tr>
<tr>
<td>Krolner (2012)</td>
<td>F/V</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>19</td>
<td>N</td>
</tr>
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Duration: 1 = < 6 weeks, 2 = 6-11 weeks, 3 = 12 weeks – 5 months, 4 = 6-12 months, 5 = >12 months
Frequency: 1 = annually, 2 = bimonthly to quarterly, 3 = monthly, 4 = weekly, 5 = daily
Level of Personalization: 1 = environmental, 2 = large group, 3 = environmental + large group, 4 = large group + individual, 5 = individual OR individual + environmental + group
Reach: 1 = one setting, 3 = two settings, 5 = 3+ settings
X = Could not be determined
a = Aspects of intervention included the provision of food
* Parental reach included; parents were involved in some aspect of the intervention that was either optional or not home-based
† Multiple interventions analyzed in study
‡ Effectiveness in boys reported; intervention was more effective in boys than in girls
§ Girls only; not effective in boys
¶ Significant changes were persistent in at least one second/long-term follow-up
¶‡ Significant changes were not persistent into second/long-term follow-up
µ Significant changes were seen in all countries at first follow-up, but only in Norway at second follow-up

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Intervention effectiveness defined as a statistically significant increase (p<0.05) in primary dietary outcome AND outcome measured using an objective method or robust dietary assessment method.
° Intervention is ongoing
Appendix C – Intervention manual/script for Chapter 4

VISIT 1 – WHAT ARE DAIRY PRODUCTS AND ALTERNATIVES?

1.0 INTRODUCTION
- short introduction of who we are, where we come from and reminder of the study and right to withdraw

1.1 TALK:
“Hi my name is Megan and this is Andrew. We are both studying at the University of Guelph. Your teacher sent home forms a few weeks ago about a nutrition project and you were to bring back your forms with your parents’ signature if you wanted your data to be a part of the study. If you still want to be a part of my project and haven’t brought your form back, that’s okay – you still can! If, at any point, you feel uncomfortable or don’t want to be a part of the study, that’s okay too and you can withdraw.”

2.0 QUESTIONNAIRE/SURVEY (20 min)

2.1 TALK:
We are going to start with a little survey for you to fill out. I will read through the instructions and each question with you. So don’t start until I tell you. A few other things about the survey;
- only 20 minutes to complete questionnaire
- no right or wrong answers
- remain quiet – this is an individual survey
- if you have a question, raise your hand

2.2 ACTION:
- distribute questionnaire package

2.3 TALK/DESCRIBE:
1. First names on top of page
2. Read through instructions with students
3. Read each question one at a time with students. YAQ approx. 10 min, knowledge and intention approx. 5 min each – STAY ON TIME AND BE QUICK
**Question 7 = dairy products in fast food restaurants needs to be explained thoroughly
**Intention questionnaire = be thorough, good explanation
**RELATE SERVING SIZES TO HAND!!

2.4 ACTION:
- ensure students have filled out all questions – DOUBLE CHECK YOUR PACKAGE!
- collect questionnaires
- ensure all questionnaires are collected by 20 minutes
3.0 VISIT 1 ACTIVITY: Knowledge about What are Dairy Products and Alternatives (20 min total)

A. WEBSITE: Why Dairy Home page
WEBSITE: Student Corner landing page

3.1 ACTION:
*Introduce students to the website, link, url, school page and how to navigate to student corner
- show students the website URL specific to their school – WRITE ON BOARD?
- show home page and how to get to Student Corner
- quick description of how to navigate student corner with side bar and visit 1

B. WEBSITE: Student Corner → What are dairy products and alternatives (5 MINUTES)

3.2 ASK: Could you define what a dairy product is? *give time for answers*
ANSWER: It is any product produced from the MILK of mammal, like cows or goats.

3.3 ASK: Could you define a dairy product alternative? *give time for answers*
ANSWER: Alternatives are typically plant based (soy or nuts) and are made to be similar to the nutritional quality of dairy products. This means many dairy alternatives have the SAME nutrients as dairy products do.

3.4 ASK: Ask students for some examples of dairy products and alternatives

3.5 ASK: Ask students, one picture at a time, if the examples of the website are dairy products, an alternative, or not a dairy product

WEBSITE GAME: Pictures of different dairy products and alternatives as well as some “tricks/non-dairy products” → hover over and checkmark or X will appear
ANSWER: Some examples are; Milk, cheese, yogurt, soy milk, lactose-free milk, cottage cheese, ricotta cheese, yogurt drinks, goat cheese, goat milk, sheep milk, milk-based puddings, cream cheese*, ice cream*, whipped cream*, frozen yogurt*, sour cream* 
*higher in fat and sugar so consumption should be limited and don’t really count as a dairy product serving

C. WEBSITE: Student Corner → Gameshow Serving Sizes (5-7 MINUTES)
WEBSITE: Parent Corner → Serving sizes **separate tab for example

3.6 ASK: Does anyone know how many servings of dairy and alternatives you should be getting in a day?
ANSWER: Males and females aged 9-18 should be getting 3-4 servings of dairy products and alternatives a day!

3.7 TELL: Now, we are going to play a game! It can be tricky to know how much milk or yogurt is ONE serving of dairy products or alternatives. If you don’t know what a serving is, how are you going to know if you’ve met your 3-4 servings of dairy and alternatives a day?? Pretty
tough, right?

WEBSITE GAME:
- go through one example of each; beverage, cheese, yogurt, trick/dessert
3.8 ASK:
- In this game, we are trying to guess how many servings of dairy products or alternatives are in this picture. I will show you the picture and then raise your hand to give me an answer.
- INPUT answer (correct or incorrect w/ link to Health Canada website)
- link to picture of hand/fist/palm/finger (Parent Corner → Serving Sizes) **HAVE TAB OPEN
3.9 TELL: Hmm… not as easy as we thought and it can be confusing! That’s why there are over 20 more examples that you can try at home yourself!

D. WEBSITE: Student Corner → Build your own meal (5-7 MINUTES)
Fitting Dairy & Alternatives into your diet

3.11 TELL: Now that we know how many servings of dairy products and alternatives we should get in one day, and what the serving sizes are, we are now going to discover what these servings may look like in typical meals that we eat every day.
WEBSITE GAME: Show students “plate” page with drop-down menu of food options.

3.12 TELL: So Andrew and I have picked one of our favourite meals and we are going to put that into the website and it will calculate how many servings of dairy and alternatives are in this meal!
1. First, we must select which meal of the day it is – BREAKFAST
2. Then, we select our main dish, side and drink – FRENCH TOAST, FRUIT SALAD AND JUICE
Hmmm, this meal has NO servings of dairy or alternatives in it! Can someone give me one suggestion to add more servings of dairy or alternatives to my meal?
3. Recalculate meal and make adjustments/suggestions based on feedback from students
- if time permits, can try other meal combinations and talk about substitutions
- try to show all three options;
  - add 2 dairy servings to get option 2 (ie add cheese sticks and milk)
  - add 3 dairy servings to get option 3 (ie yogurt, cheese, milk)

3.13 TELL: So as you guys can all see, there are many combinations you can play with to see how many servings of dairy or alternatives your favourite foods contain. You can choose breakfast, lunch or dinner and many different types of foods. Remember that balance is KEY! You don’t want to get ALL you servings of dairy in ONE meal. Also, the food options here are typically one serving of dairy, like one glass of milk. So if you normally drink one LARGE glass of milk with your meal, than you may be consuming MORE servings of dairy then the website is saying.

4.0 BEHAVIOURAL GOAL (3 MIN)
4.1 ASK: To finish off today, I want you all to think about a realistic goal you can set for yourself that involves dairy products and alternatives. Goal needs to be S.M.A.R.T = Specific, Measurable, Attainable, Relevant, Time-bound.
So an example of one could be:
- increasing serving of dairy/alternatives by half a serving per day
- choosing alternatives to replace a serving of dairy
- adding a new alternative to meals
- trying a new dairy product or alternative once a week

Write down your goal. If you have an Agenda, write it in there and share it with your parents! We will talk about these goals next time we visit your class.

5.0 THANK YOU/FUN FACTS: So, thanks so much for your attention today! Don’t forget to play around on the website and explore the games for yourself. We will open more parts of the website as we visit your class, so stay tuned!
**time permitting: discuss/explore fun facts on website

VISIT 2 – WHAT IS IN DAIRY PRODUCTS AND ALTERNATIVES?

1.0 INTRODUCTION/GROUP WORK (5 MIN)
- ASK about website use over the last few weeks

1.1 TELL/DESCRIBE:
For today’s visit, we are going to do a “Think, Pair, Share” activity;
- you will get 6 worksheets that you will think about with your partner and share your answers
- we will discuss the answers one worksheet at a time as a class
- you will only have a few minutes to complete the worksheets
- work on ONE worksheet, take up/discuss questions, work on next worksheet, etc.

1.2 ACTION:
- get the students into pairs
- give them worksheets – 6 sheets PER pair
- Groups are as follows;
  - White milk and Unfortified OJ = Sheet 1
  - Chocolate milk and Unfortified OJ = Sheet 2
  - White milk and Soy Milk = Sheet 3
  - Regular Unsweetened Yogurt and Regular Sweetened Yogurt = Sheet 4
  - Ice cream and Frozen yogurt = Sheet 5
  - Cheese and Egg = Sheet 6

A. WEBSITE: Student corner → Playing with Food
TELL:
- how to use the game, bring up foods, compare foods
**note the table below the NFTs that students can use to compare foods themselves
- show them how many foods there are to compare!
- serving size on the NFTs are typically ONE serving of dairy, so this is especially important for yogurt, cheese and frozen desserts
2.0 Carbohydrates, Vitamins and Mineral Discussion (15 MIN TOTAL)
- bring up product comparisons from worksheet onto website
- discuss questions on the worksheet and nutrients (see below)
- discuss “pop-up” points

Worksheet 1: WHITE MILK AND UNFORTIFIED OJ (2 MIN)
WEBSITE: Select Product A: White milk and Product B: Unfortified OJ
WEBSITE HOVER SELECTIONS: Milk = sugar, protein, vitamins and minerals
       OJ = sugar, vitamins and minerals

ACTION:  
- give students 2min to complete questions on worksheet 1

ASK/DICUSS: (3 MIN)

1. Compare the TOTAL carbohydrates in these foods. Do they have different or similar levels?  
   - DIFFERENT levels of carbs

2. Which food has more sugar in it? What can carbs and sugar be used for in the body? B.  
   WEBSITE: Student corner ➔ Carbohydrates  
   - OJ has more sugar – twice as much!  
   - And the sugar in OJ is different than the sugar in milk and dairy products  
   - sugar in fruit juices and pop is different than the natural sugar, lactose, that is in dairy products.  
     The sugar in fruit juices is normally fructose or glucose.  
   - Carbohydrates or sugars are mainly used for energy throughout our body, including our brain  
   - Carbs are sugars, starches and fibers found in fruit, grains, vegetables and dairy products!  
   - they are mostly used for energy for our bodies and especially our brains!  

There are two main types of carbs  
   1. Simple carbs like sugar that break down quickly for energy  
   2. Complex carbs like potatoes, lentils and whole grain breads—these carbs are better for you because they contain more nutrients!  

- Watch out for simple carbs (like pop, sugar and candy) that don’t provide any nutritional benefits  
- Dairy products may have some sugar in them, CALLED LACTOSE, but since dairy products contain so many other nutrients, it is very good for you.  
  - one glass of milk has 13g of NATURAL sugar in it, known as lactose  
  - that means a glass of WHITE milk has 10% of the carbs you need in a day

- try to LIMIT added sugar (ie chocolate milk added sugar, some alternatives have added sugar, candies, pop, sweets)  
- Only about 60 calories in chocolate milk are from added sugars, which is small relative to the powerhouse of nutrients it provides.

DISCUSSION POINT: sugar content is different and OJ can have more added sugar than milk
Worksheet 2: CHOCOLATE MILK AND UNFORTIFIED OJ (2 MIN)
WEBSITE: Select Product A: Chocolate milk and Product B: Unfortified OJ
WEBSITE HOVER SELECTIONS: Chocolate milk = sugar, vitamins and minerals
OJ = sugar, vitamins and minerals

ACTION:
- give students 2min to complete questions on worksheet 2

ASK/DICUSS: (3 MIN)

1. Circle which food has more the following vitamins:
   - Vitamin A: Chocolate milk
   - Vitamin B: Chocolate milk
   - Vitamin D: Chocolate milk

2. What are these vitamins used for in the body? C. WEBSITE: Student Corner ➔ Vitamins & Minerals
   - Vitamin A
     - vitamin A is a fat soluble vitamin that is FORTIFIED in almost all dairy products and some alternatives
     - What does fortified mean? This means it is an important nutrient that is ADDED to a food
     - it helps maintain normal vision and keeps your skin and eyes and immune system healthy
     - also promotes normal growth and development
   - Vitamin B
     - there are many forms of B vitamins – water-soluble vitamin
     - they are important for making red blood cells, help form DNA, keep your nervous system healthy, and help your body use energy from food
   - Vitamin D
     - vitamin D is a fat soluble vitamin that is also fortified or ADDED to dairy products and some alternatives
     - helps your body absorb and use calcium and phosphorous for strong bones and teeth
     - also helps your immune system healthy and protect you from infections and diseases

DISCUSSION POINT: Can buy fortified OJ with Calcium and Vitamin D ADDED. This gives OJ similar levels of Calcium and Vitamin D to milk. BUT, milk has more of the other bone building minerals.

Worksheet 3: WHITE MILK AND SWEETENED SOY MILK (2 MIN)
WEBSITE: Select Product A: White milk and Product B: Sweetened soy milk
WEBSITE HOVER SELECTIONS: White milk = sugar, protein, vitamins and minerals
Sweetened soy milk = sugar, vitamins and minerals

ACTION:
- give students 2min to complete questions on worksheet 3

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ASK/DICUSS: (3 MIN)
1. Compare the calcium in these foods. Do they have different or similar levels?
- SIMILAR levels of calcium

2. Which food has more of the following minerals:
- phosphorous: White milk
- magnesium: sweetened soy milk

3. What are these minerals used for in the body? D. WEBSITE: Student Corner ➔
Vitamins & Minerals
- Calcium
  - a macro-mineral that helps you build and maintain strong bones and teeth
  - also helps muscles contract and helps your heart beat
  - macro mineral means we need a lot of it, where micro mineral means we need less of it
- Phosphorous
  - it is a mineral that is part of every cell in your body and can be found in large amounts
    in your bones and teeth
  - helps supports growth, and is involved with storage and use of energy
  - critical for ENERGY!
- Magnesium
  - helps you take energy from food and make new proteins
  - an important part of your bones and helps keep your muscles and nerves healthy

DISCUSSION POINT: Nutrients between milk and soy milk are very similar, but most of the
nutrients are found natural in milk while soy milk is fortified to meet the levels of milk. Soy milk
can be bought in an UNSWEETENED version, which has all the same levels buts MUCH less
sugar (5g total CHO, only 1g sugar). These two foods have very similar levels of sugars or
carbohydrates, but in milk, the sugar is natural. In sweetened soy milk, the sugar is added for
flavour.

E. WEBSITE: Student corner ➔ Playing with Food

3.0 Protein, Fats and Cholesterol Discussion (15 MIN TOTAL)
- bring up product comparisons from worksheet onto website
- discuss questions on the worksheet (see below)
- discuss “pop-up” points
- discuss nutrients in more detail

Worksheet 4: REGULAR UNSWEETENED YOGURT AND REGULAR SWEETENED
YOGURT — NO FAT (2 MIN)
WEBSITE: Select Product A: Plain Fat Free Yogurt and Product B: Fruit Fat Free Yogurt
WEBSITE HOVER SELECTIONS: Plain yogurt = sugar, vitamins and minerals
              Fruit yogurt = fat, sugar

ACTION:
- give students 2min to complete questions on worksheet 4
ASK/DICUSS: (3 MIN)

1. **Compare the protein in these foods. Do they have different or similar levels?**
   - these foods have similar levels of protein

2. **What can protein be used for in the body?** F. WEBSITE: Student corner ➔ Protein
   - protein can be used for building muscles AND enzyme activity, bone structure, skin, hair and nail health and the healthy maintenance of important cartilage
   - Protein is a macronutrient- where “macro” means big. Other macronutrients include fats and carbohydrates, and we need all three of these for survival and for our bodies to function properly
   - protein is made up of amino acids – amino acids join together to form protein molecule which forms things like our muscles – acts like a construction worker building your muscles (and performs other body functions!)
   - Protein does not equal to meat! Although, this may be a common misconception. Rather it is a macronutrient commonly found in meat, but also can be found in other rich animal and plant sources such as milk, cheese, Greek yogurt and soy milk
   *POP-UP/DICUSSION POINT: Greek yogurt is MUCH higher in protein than any variety of regular yogurt (sweet, not sweet, fat or non fat). There is also yogurt with or without fat. Fat is okay in moderation (1% or 2%) but want to be careful of yogurts that are high in fat. Yogurts with NO fat can sometimes be higher in sugar to make it taste better and be creamier. Choose one you like that is higher in protein and lower in sugar and play with ways to make it taste better (ie add fruit or granola)!
   Also, the SUGAR is higher in the fruit yogurt to add flavour and because fruit has sugar in it. But, sometimes, fruit flavoured yogurt has NO fruit in it at all and actually is just loaded with sugar flavouring. You could make plain yogurt taste better with added honey, whole fruit, healthy granola.

Worksheet 5: ICE CREAM AND FROZEN YOGURT (2 MIN)
WEBSITE: Select Product A: Ice cream and Product B: Frozen yogurt
WEBSITE HOVER SELECTIONS: Ice cream = sugar
                                 Frozen yogurt = fat

ACTION:
- give students 2min to complete questions on worksheet 5
ASK/DICUSS: (3 MIN)

1. **Compare the levels of fat in these foods. Do they have different or similar levels?**
   - these foods have different levels of fat

2. **What can fat be used for in the body?** G. WEBSITE: Student Corner ➔ Fats
   - Fat is essential for a healthy diet!
   - Your body needs fat for lots of different things and there are different kinds of fat
   - Your body stores from fat from an EXCESS of calories – these calories can be from protein, carbohydrates, or fat – really from ANY food
   - Fat in food does not always mean fat on your body and some fats are good for you
     - Like mono and polyunsaturated fatty acids in fish, avocados and nuts
   - it may be best to choose lower fat options of dairy products when you can, but most fat is
important in your overall healthy lifestyle!
3. Which food has higher calories? Why might this be?
- ICE CREAM has more calories because it has more fat
DISCUSSION POINT: a serving of dairy dessert is SMALL – only ½ cup

Worksheet 6: CHEESE AND EGG (2 MIN)
WEBSITE: Select Product A: Cheddar Cheese and Product B: Egg
WEBSITE HOVER SELECTIONS: Cheddar cheese = fat, protein, vitamins and minerals
    Egg = sugar, vitamins and minerals

ACTION:
- give students 2min to complete questions on worksheet 6

ASK/DICUSS: (3 MIN)

1. Compare the levels of cholesterol in these foods. Do they have different or similar levels?
   - they have DIFFERENT levels of cholesterol
   - an egg has more cholesterol in one serving

2. What can cholesterol be used for in the body? H. WEBSITE: Student corner ➔ Cholesterol
   - Much of the cholesterol we need is already in our bodies
   - Only 20% needs to come from our diet in the foods we eat
   - we NEED cholesterol for keeping our cell membranes intact and for creating hormones
   - Common misconceptions are that all cholesterol is bad for you- but this is NOT true!
     - Remember this: H stands for helpful and L stands for lousy! HDL is what we want more of in our diet
     - High amounts of LDL (lousy type) in the blood can lead to the clogging of arteries which can be dangerous
     - But the helpful kind, HDL helps carry the cholesterol back to your liver where it is removed from your body

3. One food is higher in FAT. Which one? If you choose to eat this food, what might it mean for HOW MUCH you choose to eat?
   - cheddar cheese is much higher in fat so you have to pay attention to serving size
DISCUSSION POINT: eggs are NOT dairy products, even though they have similar nutrients and often are pictured with dairy products

4.0 BEHAVIOURAL GOAL (5 MIN)
4.1 ASK: To finish off today, I want you to think back to goal you set last visit. How did everyone do trying to meet the goal they set last time we visited? Can anyone remember their goal and tell me what it was? How did you try to reach your goal? **lots of positive encouragement regardless of responses

Can you set a NEW OR MODIFIED behavioural goal for the next two weeks that involves dairy products and alternatives. Is it a S.M.A.R.T. goal? Some examples are;
- increasing serving of dairy/alternatives by one a day
- choosing alternatives to replace dairy
- choosing dairy or alternatives when eating out
- adding dairy or alternatives to one meal a day
- trying a new dairy product or alternative once a week
- asking parents for dairy and alternatives at home and in lunches
- try a new recipe that involves dairy products or alternatives

Write down your goal. If you have an Agenda, write it in there and share it with your parents! We will talk about these goals next time we visit your class.

5.0 FUN FACTS/THANK YOU: So, thanks so much for your attention today! Don’t forget to play around on the website and explore the games for yourself. We will open more parts of the website as we visit your class, so stay tuned!

**Time permitting: explore fun facts on website

VISIT 3 – WHY DAIRY PRODUCTS AND ALTERNATIVES?

1.0 INTRODUCTION/REVIEW (5 MIN)
- ASK about website use over the last few weeks

1.2 TELL/DESCRIBE:
A. WEBSITE: Student Corner → What is in Dairy and Alternatives (landing page visit 2!)
I want to remind you all about our previous visit and all the nutrients, vitamins and minerals in dairy products and alternatives that we talked about and what their roles in our bodies are

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>FUNCTION</th>
</tr>
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<tr>
<td>Carbohydrates</td>
<td>Energy, fuel for body and brain</td>
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<tr>
<td>Vitamins</td>
<td></td>
</tr>
<tr>
<td>Vitamin A</td>
<td>Vision, skin, immune system</td>
</tr>
<tr>
<td>Vitamin B</td>
<td>Make red blood cells, nervous system, energy</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Bones and teeth, immune system</td>
</tr>
<tr>
<td>Minerals</td>
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<td>Calcium</td>
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<td>Protein</td>
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<td>Fats</td>
<td>Energy, brain</td>
</tr>
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<td>Cholesterol</td>
<td>Cell membranes and hormones</td>
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**ASK LOTS OF QUESTIONS RELATED BACK TO VISIT 2

2.0 HEALTH EFFECTS OF DAIRY & ALTERNATIVES (30 MIN TOTAL)

A. WEBSITE: Student Corner → Explore the Human Body
TELL:
So today we are going to explore the human body and discover how all the things in dairy products and alternatives can benefit our body from head to toe.
- HOW TO NAVIGATE THIS GAME

2.1 BONE/HEIGHT (8 MIN TOTAL)
INTRODUCTION/ACTIVITY (3-4 min)
ACTION:
- get students to talk with their neighbours
- we’ll ask you a few questions and we’d like you to brainstorm with your neighbours and classmates about possible answers
ASK/TELL:
1. based on what you know about calcium and what is does in the body, what could happen if you don’t have enough? What happens when you HAVE enough?
2. think specifically about bones – what could the consequences be?
3. brainstorm three ways that dairy and alternatives might have a positive impact on bone
- ASK students for some ideas and write on board

DISCUSS: (3-4 min)

B. WEBSITE: Student Corner ➔ Human Body ➔ CLICK ON BONE
- The health of your bones is particularly important when you are growing during pre-adolescence and adolescence (ages 9-18). This age is when you are DEVELOPING bone and see the largest GROWTH of bone. Growth of bone occurs until 20-30 years old, maintenance period up to 50 years old.
- It is actually very difficult to get a bone healthy diet without dairy products and alternatives as they have calcium, vitamin D, phosphorous, magnesium and protein. All of these nutrients are crucial for developing strong bones.
- May not see the immediate effects of meeting dairy requirements NOW, but it does prevent future weak bones (osteoporosis) and bone fractures (bone mineral density)
- If you meet your dairy product and alternative recommendations of 3-4 servings a day, you could see decreased fractures and an increase in your height of 0.5cm a day.

D. WEBSITE: Student Corner ➔ Explore the Human Body

2.2 BODY WEIGHT/COMPOSITION (8 MIN TOTAL)
INTRODUCTION/ACTIVITY (3-4 min)
ACTION:
- same pairs as before
- we’ll ask you a few questions and we’d like you to brainstorm with your neighbours and classmates about possible answers
ASK/TELL:
- a variety of nutrients in dairy and alternatives that contribute to an overall healthy body
1. Do you think dairy products and alternatives can help you maintain a healthy body weight?
2. Brainstorm TWO ways dairy products and alternatives may help your overall body weight and
composition (replacing bad foods, nutrient dense foods, healthy foods)
- ASK students for some ideas and write on board

DISCUSS: (5 min)

E. WEBSITE: Student Corner  Human Body  CLICK ON ABDOMEN FAT
- An overall healthy diet is crucial for a healthy body weight and dairy can be a part of that diet!
- Consuming dairy products and alternatives can help you feel fuller for longer and this may mean you eat a little less food during the day.
- children who have a higher dairy intake tend to have lower body weight and better body composition in adolescence. This is because dairy products and alternatives are often replacing bad foods like Sugar sweetened beverages. Body composition = proportion of fat, muscles, bone and water in your body
- The protein content of dairy products and some alternative support building muscle mass on your body and promote losing body weight in the form of fat.
- The calcium in dairy products and alternatives can also increase the fat you lose and decrease the fat you put onto your body.
- you do WANT to increase your weight as you grow, but want to do it in a healthy way
- You should aim to meet the recommendations of 3-4 servings a day and also meet your calcium recommendations of 1300 mg a day to potentially improve your body weight and body composition.

G. WEBSITE: Student Corner  Explore the Human Body

2.3 SPORTS AND HEALTH PERFORMANCE (8 MIN TOTAL)
INTRODUCTION/ACTIVITY (3-4 min)
ACTION:
- same pairs as before
- we’ll ask you a few questions and we’d like you to brainstorm with your neighbours and classmates about possible answers
ASK/TELL:
- variety of nutrients in dairy and alternatives that contribute to an overall healthy body
  1. can you think of ONE way dairy and alternatives may help your muscle?
  2. how could this relate to sports performance or recovery after sports?
  3. Do you think dairy products and alternatives could help with hydration?
- ASK students for some ideas and write on board

DISCUSS: (5 min)

H. WEBSITE: Student Corner  Human Body  CLICK MUSCLE
- It is recommended that people your age exercise 60 minutes every day.
- Milk and some dairy alternatives can help you recover faster and feel better while doing this exercise, including playing sports.
- during exercise, your body and muscles are stressed and break down a little so they can re-build themselves stronger
- you also lose water through skin from sweating
- Milk, specifically chocolate milk, has the best ratio of carbohydrates to protein, has a high water content and also contains key electrolytes. All of these things make it an ideal post-exercise beverage to replenish the lost nutrients and help re-hydrate you.
- Many sports drinks don’t have any protein in them and this can be bad for your muscles that need to repair after exercise.
- You don’t need dairy, milk or alternatives to perform well in sports but they do help you recover faster!

3.0 WRAP-UP (3 MIN)
- So the body parts we discussed today are well-researched health effects of dairy products and alternatives and their nutrients
- there are more to discover on the website such as; eye health, brain, digestive health, blood pressure
- so click around and explore the human body yourself!

4.0 BEHAVIOURAL GOAL (5 MIN)
4.1 ASK: To finish off today, I want you to think back to goal you set last visit. How did everyone do trying to meet the goal they set last time we visited? Can anyone remember their goal and tell me what it was? How did you try to reach your goal? **lots of positive encouragement regardless of responses. Can you set a NEW OR MODIFIED behavioural goal for the next little while that involves dairy products and alternatives. Some examples are;
  - counting dairy servings every day – counting all servings?
  - trying to meet 3-4 servings of dairy every day of the week
  - choosing alternatives
  - trying a new dairy product or alternative once a week
  - choosing dairy when eating out or when at friends
  - asking parents for dairy and/or alternatives at home and in lunches
  - talking to friends and family about dairy products and alternatives and encouraging everyone to meet their recommended servings
  - look up some other health benefits
Write down you goal again so you can remember what it is for the next few months!

5.0 THANK YOU/FUN FACTS: So, thanks so much for your attention today! Don’t forget to play around on the website and explore the games for yourself. We will be back one more time to do a survey with you guys, but we hope you enjoyed our visits together!
  **Time permitting: discuss and explore fun facts

VISIT 4/FOLLOW-UP VISIT 5 – SURVEY

1.0 INTRODUCTION
- short introduction and reminder of the study and right to withdraw

2.0 QUESTIONNAIRE/SURVEY (20 min)
2.1 TALK:
We are going to complete the survey you did way back in the first visit. I will read through the instructions and each question with you. So don’t start until I tell you. A few other things about
the survey;
- only 20 minutes to complete questionnaire
- no right or wrong answers
- remain quiet – this is an individual survey
- if you have a question, raise your hand

2.2 ACTION:
- distribute questionnaire package

2.3 TALK/DESCRIBE:
1. First names on top of page
2. Read through instructions with students
3. Read each question one at a time with students. YAQ approx. 10 min, knowledge and intention approx. 5 min each – STAY ON TIME AND BE QUICK
**Question 7 = dairy products in fast food restaurants needs to be explained thoroughly**
**Intention questionnaire = be thorough, good explanation**

2.4 ACTION:
- ensure students have filled out all questions – Ask them to double-check their surveys and flip through pages
- DOUBLE CHECK YOUR PACKAGE!
- collect questionnaires
- ensure all questionnaires are collected by 20 minutes
Appendix D – Description and Screenshots of the WhyDairy Website

This appendix contains screenshots of some website components used to teach the students in the WhyDairy intervention to provide tangible examples of the Knowledge, Interactive/Games, and Kitchen/Recipe sections mentioned in Chapter 4.

Home Page
First page students see when entering the website with their unique school URL.

Student Corner
Example of an interactive page on the student corner in which students can guess if these foods would be considered a dairy product or alternative and hover over the picture to see if they are right (green checkmark) or wrong (red x).
Student Corner

Another example of an interactive page. Students can select breakfast, lunch, or dinner from the dropdown menu. They can then select different foods to see the amount of dairy products or alternative servings in that meal. Different prompts are revealed depending on the number of dairy products they select.

Student Corner

An example of an interactive “game show” to help students guess the correct serving size of common dairy products.
Student Corner

Example of a knowledge page with primarily text. The “Fun Fact” on this page is expanded.

Student Corner

Interactive page example where students can “explore the human body” and see the potential health effects of dairy.
Student Corner

Interactive page where students can compare and contract different dairy products and alternatives to other common foods. The symbols make for easy comparisons and the nutrition facts tables are interactive in that students can hover over sections to learn more.

Parent Corner

Example of a Q&A page that parents would have been directed to during the follow-up email campaign.
Kitchen Corner

This is the landing page for the kitchen and recipe pages. From here, students can choose one of these meals or desserts/snacks.

Kitchen Corner

The breakfast page where students can try out recipes that include dairy products or alternatives.
Appendix E – Email Text for Follow-up Campaign for Chapter 4

This appendix contains the email text for the follow-up email campaign that was used to engage parents in the WhyDairy intervention mentioned in Chapter 4. The emails were formatted and designed with a similar theme to the website.

Email #1 – The Initial Invitation

*Subject line:* Nice to Meet You!

Dear Parents,

Welcome to the Why Dairy and Alternatives program where we hope to provide students and parents with the right tools to make informed dietary decisions.

On behalf of the Why Dairy and Alternatives program, **Welcome!** We are excited to have you on board in bringing the benefits of dairy and alternative nutrition to your dining table. It is no surprise that maintenance of a nutrient-rich, well-balanced diet from preadolescence into young adulthood is absolutely essential for healthy development and growth. That is why we at Why Dairy and Alternatives are dedicated to educating and motivating families to support their children’s diets with the necessary nutrition available from dairy and alternative food products.

The Why Dairy and Alternatives Program is an educational platform designed as an intervention aimed at educating young children about the nutritional benefits of dairy and alternative products. With the goal of increasing knowledge about dairy products and alternatives, our hope is to provide students with the right tools to make informed and sound dietary decisions. Throughout the course of our visits, your child has learned about what dairy products and alternatives are, the nutrients within them, and the potential benefits if they choose to make dairy and alternatives a part of their daily life.

Much of the program education has been geared around an educational website which we have developed as a learning tool for both child and parent alike. **We want to encourage you to please visit the Parent Corner** of the website where we have provided a useful set of resources to help you get involved and stay active in the process. Throughout the next four months, you will receive four additional emails regarding the intervention process, totaling 5 emails in 5 months. We encourage you to visit the website which contains a wide variety of nutritional information. We used the website in your child’s classroom to teach them about dairy products and alternatives, so why not ask them to show you their favourite part!

**Parents are important role models for children** when it comes to dietary choices. We look forward to continuing our program with your help.

For more information about Genevieve Newton or Megan Racey’s research, visit [https://www.uoguelph.ca/hhns/People/GNewton.html](https://www.uoguelph.ca/hhns/People/GNewton.html). To leave questions, comments, or to unsubscribe/opt-out of future emails, please contact Megan Racey at mracey@uoguelph.ca.
Email #2 – The Benefits of Dairy/Alternatives-Sourced Protein

Subject line: How to Become a Protein Pro

Dear Parents,

Protein is used for more than just muscle on your body and dairy products and alternatives can be a great source of protein in your diet while also providing other nutrients, vitamins and minerals.

We hope that the website tools are serving you well in helping you incorporate dairy and alternatives into your family’s everyday lives. The purpose of today’s email is to emphasize the benefits of dairy and alternatives-sourced protein in order to help you make more informed choices for your child and family.

Building lean muscle mass is not only important for body builders and athletes. It is important for everyone, and is especially critical in preadolescence for encouraging the healthy growth and development of the body.

Though protein helps to build muscular tissue, through protein synthesis, it also used by the body to maintain the muscle it puts on. Protein is one of the three macronutrients (along with fat and carbohydrates) needed for the body to function optimally. The role of protein isn’t just limited to facilitating muscle growth as the nutrient can also be used maintain cartilage, enzyme activity and other important bodily functions.

Getting enough protein doesn’t have to be hard. In fact, ensuring that your child consumes a protein-rich diet during this crucial developmental stage is easy. Although meat and alternative products can be a reliable source of protein, dairy and alternative products are also packed with protein. Furthermore, dairy product and alternatives provide other healthy nutrients not found in other food products, including healthy fats, vitamins and minerals. These products can be similar sources of protein compared to meat, with the added benefit of a variety of healthy nutrients.

You can learn more about the benefits of dairy and alternatives-based protein by visiting the Student Corner on the website. Please click here. Other parts of the website also provide helpful information about high-protein dairy and alternative foods, as well as tasty recipes for the whole family.

Your support is important in helping us provide the necessary tools for your child to make healthy decisions.

For more information about Genevieve Newton or Megan Racey’s research, visit https://www.uoguelph.ca/hhns/People/GNewton.html. To leave questions, comments, or to unsubscribe/opt-out of future emails, please contact Megan Racey at mracey@uoguelph.ca.
Dear Parents,

Help your child understand the importance of keeping their bones strong with this month’s email about calcium.

Many people are unaware of the fact that children age 10-16 are the lowest consumers of dairy next to older adults above 65. In fact, children that fall into this age range require more servings of dairy products and alternatives than any other age group. Children in this age group may find it difficult to acquire certain nutrients due to low consumption of dairy and alternative products, most notably calcium.

Calcium is necessary for the body to function. It not only helps with muscle and heart function, but it is the foundational building block for developing strong bones needed to support the body. Maintaining a calcium-rich diet during preadolescence helps build stronger bones and helps ward off diseases such as osteoporosis later in life.

However, a bone-healthy diet can be difficult to obtain without regular intake of dairy products and alternatives. These are some of the best and most convenient sources to reach the daily requirements for calcium. Incorporating products such as milk, yogurt, cheese or plant-based alternatives such as soy milk into your child’s diet is one simple step that can help ensure their bones and muscles stay strong.

You can learn more information on how to incorporate calcium-rich dairy and alternative products into your family’s diet by visiting the Why Dairy and Alternatives website. By clicking here, you will be directed to the Parent Corner which contains a variety of recipes, tips and other resources for you. We also want to encourage you check out other areas of the site to explore the educational content for students as well as the provided family-friendly games. Test your skills in our gameshow by clicking here, or get caught playing with your food over here. Once again, we want to thank you for your continued support.

For more information about Genevieve Newton or Megan Racey’s research, visit https://www.uoguelph.ca/hhnsp/People/GNewton.html.
To leave questions, comments, or to unsubscribe/opt-out of future emails, please contact Megan Racey at mracey@uoguelph.ca.
Dear Parents,

There is more to food than just nutrients! This month’s newsletter shows just how easy, healthy and tasty it can be to incorporate dairy and alternatives into your everyday meals. We hope you are continuing to discover the website and staying active throughout this educational process. This month’s newsletter acts only as a simple reminder that nutrition is just the beginning—dairy and alternatives are tasty too!

Having food that is healthy is one thing, but having something delicious for dinner is another. We know it isn’t always easy to get your child to eat healthy food. That is why we have chosen to include a number of healthy, nutrient-rich, easy and delicious recipes to help your family get the dairy and alternative nutrition they need. Please check out these recipes as they show how easily dairy products and alternatives can add great flavour and nutritional boosts to classic dishes.

If at any time you get lost on the website, you can be redirected to the Parent Corner by clicking here. The site also includes a number of other websites which have great recipes and tips for cooking with dairy and alternatives. These links are located on the “Resources” page which can be found by clicking here.

Your participation in this research project is greatly appreciated as parents continue to be key role models for displaying dietary behaviour for their children and improving health through nutrition.

For more information about Genevieve Newton or Megan Racey’s research, visit https://www.uoguelph.ca/hhns/People/GNewton.html. To leave questions, comments, or to unsubscribe/opt-out of future emails, please contact Megan Racey at mracey@uoguelph.ca.
Email #5 – Closing Thoughts

Subject line: Thank You from the Researchers

Dear Parents,

Thank you for your support throughout the research process – and don’t forget, the website has great resources and information for you to explore!

Welcome back for the last time! As things come to a close, we hope you are able to feel confident in your child’s ability to make health-conscious decisions regarding dairy products and alternatives.

As the Why Dairy and Alternatives website will continue to be up and running, we want to send a final reminder for you to please explore the site. If you haven’t yet, there are a number of different resources, recipes, games, fun facts, and nutritional information for you to check out. Click here to be sent to the Parent Corner. As well, feel free to explore other related websites by checking out the links on the Resources page here.

We want to remind you that we will be returning for our last visit later this month. The results of the study will likely become available in Winter/Spring 2017. If you are interested about the results or have any other questions or comments, please feel free to contact any of the lead researchers involved. Their information can be found below.

We want to once again extend our appreciation for your support and participation throughout the intervention process.

For more information about Genevieve Newton or Megan Racey’s research, visit https://www.uoguelph.ca/hhns/People/GNewton.html.

To leave questions, comments, or to unsubscribe/opt-out of future emails, please contact Megan Racey at mracey@uoguelph.ca.
FIRST NAME: ____________________________

Hi Students!

You have 20 MINUTES to fill out THREE short surveys. Remain quiet and do not talk your neighbour or classmates. Raise your hand for any questions!

**BBUBBLES**
When a question has a bubble to fill in, please:

- Read each question CAREFULLY.
- Select only ONE answer per question.
- Do not leave any question blank.

The RIGHT way to mark your answer! The WRONG way to mark your answers!

![Correct Bubble](image)

**SCALE**
When a question has a scale, please:

- Please read each question carefully and answer it to the best of your ability.
- Some questions may appear to be similar, but they are not.
- There are NO correct or incorrect responses, only your personal point of view.
- Circle only ONE answer per question

This survey uses a rating scale. Please circle the number that best describes your opinion.

We will do this example as a class:

For me to do well in school and get a high grade is
very unimportant : 1 : 2 : 3 : 4 : 5 : 6 : 7 : very important

I think it is important to do my homework every day

REMEMBER, there are NO right or wrong answers and it is OKAY to not know the answer! Try your best and answer as honestly as possible
ABOUT YOU!

1. What is your AGE (years)?
   - Less than 9
   - 9
   - 10
   - 11
   - 12
   - 13
   - 14

2. Are you:
   - Male
   - Female

3. Your Height:

   _________ ft _________ inches

4. Your Weight (pounds):

   __________________________ lbs

THESE QUESTIONS ASK ABOUT WHAT YOU ATE AND DRANK OVER THE PAST MONTH

DRINKS

1. Smoothies (eg. Booster Juice or Orange Julius)
   - Never/less than 1 per month
   - 1-3 glasses per month
   - 1 glass per week
   - 2-4 glasses per week
   - 5-6 glasses per week
   - 1 glass per day
   - 2 glasses per day
   - 3 or more glasses per day

2. What liquid do you use in your smoothie?
   - Cow’s milk
   - Soy milk
   - Almond milk
   - Rice milk
   - Other milk
   - Water
   - Juice
   - Don’t know/don’t drink

3. Milkshake (1)
   - Never/less than 1 per month
   - 1-3 per month
   - 1 per week
   - More than 1 per week

4. What liquid do you use in your milkshake (other than ice cream)?
   - Cow’s milk
   - Soy milk
   - Almond milk
   - Rice milk
   - Other milk
   - Don’t know/don’t drink
5. Hot tea and/or coffee with added milk or cream (1 cup or 1 mug)
   - Never/less than 1 per month
   - 1-3 cups per month
   - 1-2 cups per week
   - 3-6 cups per week
   - 1 cup per day
   - 2 or more cups per day

6. Coffee drinks with milk or cream (eg. Cappuccino, Mocha, Latte)
   - Never/less than 1 per month
   - 1-3 cups per month
   - 1-2 cups per week
   - 3-6 cups per week
   - 1 cup per day
   - 2 or more cups per day

7. Iced coffee with milk or cream (eg. Iced Cap, Frappuccino)
   - Never/less than 1 per month
   - 1-3 cups per month
   - 1-2 cups per week
   - 3-6 cups per week
   - 1 cup per day
   - 2 or more cups per day

DAIRY FOODS

1. How much white milk (glass or with cereal) do you usually drink?
   - Never/less than 1 per month
   - 1 glass per week or less
   - 2-6 glasses per week
   - 1 glass per day
   - 2-3 glasses per day
   - More than 3 glasses per day

2. How much chocolate or other flavoured milk (glass) do you usually drink?
   - Never/less than 1 per month
   - 1-3 glasses per month
   - 1 glass per week
   - 2-6 glasses per week
   - 1-2 glasses per day
   - More than 2 glasses per day

3. How much of a dairy alternative beverage (glass) do you drink?
   - Never/less than 1 per month
   - 1 glass per week or less
   - 2-6 glasses per week
   - 1 glass per day
   - 2-3 glasses per day
   - More than 3 glasses per day

4. Instant breakfast drink (1 serving or can)
   - Never/less than 1 per month
   - 1-3 times per month
   - Once per week
   - 2-4 times per week
   - More than 4 times per week

5. High Protein shake or drink (1 packet, serving/can)
   - Never/less than 1 per month
   - 1-3 times per month
   - Once per week
   - 2-4 times per week
   - More than 4 times per week

6. Yogurt, plain or sweetened (eg small container, 4-6 oz) – NOT frozen
   - Never/less than 1 per month
   - 1-3 cups per month
   - 1 cup per month
   - 2-6 cups per week
   - 1 cup per day
   - More than 1 cup per day
7. Cottage or ricotta cheese (1/2 cup)
   - Never/less than 1 per month
   - 1-3 times per month
   - Once per week
   - More than once per week

8. Cheese (1 slice) – eaten alone or added to main dish, sandwich, or quesadilla – EXCLUDE grilled cheese and cheeseburger
   - Never/less than 1 per month
   - 1-3 slices per month
   - 1 slice per week
   - 2-6 slices per week
   - 1 slice per day
   - 2-3 slices per day
   - More than 3 slices per day

SNACK FOODS/DESSERTS

1. Pudding or pudding pops (1 serving)
   - Never/less than 1 per month
   - 1-3 times per month
   - Once per week
   - More than once per week

2. Frozen yogurt (1 serving = 1/2 cup)
   - Never/less than 1 per month
   - 1-3 times per month
   - Once per week
   - More than 4 times per week

3. Ice cream (1 serving = 1/2 cup)
   - Never/less than 1 per month
   - 1-3 times per month
   - Once per week
   - More than 4 times per week

MAIN DISHES

1. Cheeseburger (1)
   - Never/less than 1 per month
   - 1-3 per month
   - One per week
   - 2-4 per week
   - More than 4 per week

2. Macaroni and cheese OR other pasta with cream sauce (1 serving)
   - Never/less than 1 per month
   - 1-3 per month
   - Once per week
   - More than once per week

3. Grilled cheese sandwich (1)
   - Never/less than 1 per month
   - 1-3 per month
   - One per week
   - 2-4 per week
   - More than 4 per week
PART 2

1. A dairy product is any product that is made from the milk of a mammal (such as a cow, goat or sheep).
   ○ True
   ○ False
   ○ Not sure

2. Dairy product alternatives like soy milk do NOT provide similar nutrients to dairy products like cow’s milk.
   ○ True
   ○ False
   ○ Not sure

3. Lactose is the natural sugar found in some dairy products. Is lactose-free milk a dairy product?
   ○ Yes
   ○ No
   ○ Not sure

4. For each of the following foods, state whether you consider it a dairy product or a dairy product alternative. Selecting “Yes” means it IS a dairy product or alternative. Selecting “No” means it IS NOT a dairy product or alternative.

<table>
<thead>
<tr>
<th>Food</th>
<th>Yes</th>
<th>No</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almond milk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yogurt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cottage Cheese</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eggs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. One cup (250 mL) of milk is considered one dairy product serving.
   ○ True
   ○ False
   ○ Not sure

6. Youth between 9-18 years old should consume _________ servings of dairy products and/or dairy product alternatives per day for a healthy diet.
   ○ None
   ○ Less than 1 serving
   ○ 1-2 servings
7. Dairy products are NOT available from fast food restaurants like McDonalds.
○ True
○ False
○ Not sure

8. For each of the following nutrients, state whether it is found in milk.
   - Protein
     ○ Yes
     ○ No
     ○ Not sure
   - Carbohydrates
     ○ Yes
     ○ No
     ○ Not sure
   - Fat
     ○ Yes
     ○ No
     ○ Not sure
   - Water
     ○ Yes
     ○ No
     ○ Not sure
   - Cholesterol
     ○ Yes
     ○ No
     ○ Not sure

9. For each of the following vitamins and minerals, state whether it is found in milk.
   - Calcium
     ○ Yes
     ○ No
     ○ Not sure
   - Vitamin E
     ○ Yes
     ○ No
     ○ Not sure
   - Vitamin A
     ○ Yes
     ○ No
     ○ Not sure
   - B Vitamins
     ○ Yes
     ○ No
     ○ Not sure
   - Vitamin D
     ○ Yes
     ○ No
     ○ Not sure

10. The sugar in milk (called lactose) is the same as the sugar found in juice and soft drinks.
○ True
○ False
○ Not sure

11. Are dairy products and alternatives important for ____________________?
   - Healthy bones and teeth?
     ○ Yes
     ○ No
     ○ Not sure
   - Maintaining a healthy body weight?
     ○ Yes
     ○ No
     ○ Not sure
   - Improving sports performance?
     ○ Yes
     ○ No
     ○ Not sure
   - Improving quality of sleep?
     ○ Yes
     ○ No
     ○ Not sure
PART 3

In general, most dairy foods or dairy alternatives taste…

In general, most dairy foods or dairy alternatives have a texture that is…

Eating dairy foods or dairy alternatives is…

Having dairy products or dairy alternatives as a snack is…

Dairy products or dairy alternatives go well with other foods…
Do not go well: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Go very well

My parents think it is important that I eat…

My friends think it is important that I eat…

The media or advertisements on TV, the radio or in magazines say it is important that I eat…

What my parents think is important matters to me
Not at all: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Very much

What my friends think is important matters to me
Not at all: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Very much

What the media or advertisements think is important matters to me
Not at all: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Very much

How easy or difficult is it for you to find dairy products or dairy alternatives in your home?

How easy or difficult is it for you to choose dairy products or dairy alternatives when eating out?

How confident are you that you can choose snacks or meals containing dairy products or dairy alternatives?
How confident are you that you could keep to a diet containing more dairy products or dairy alternatives?


ALL things considered, how easy or difficult would it be for you to eat dairy products or dairy alternatives every day?


How likely is it that you will eat dairy products or dairy alternatives regularly (2-3 servings a day) for the next month?