Determinants of Dietary Calcium Intake in a Young Adult Population
by
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ABSTRACT

DETERMINANTS OF DIETARY CALCIUM INTAKE IN A YOUNG ADULT POPULATION

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Calcium is important for the development and maintenance of healthy bones, particularly in young adulthood. Many young adults do not meet dietary recommendations for calcium. Determinants of dietary calcium intake have been examined mainly in older adults; the young adult population has not been extensively explored. Quantitative and qualitative studies were conducted in young adults (18-34 years) to address these gaps in the literature. Our quantitative study assessed young adults' dietary calcium and milk and alternatives intake and milk product health beliefs. Seventy-nine participants (~25 years; 40 M & 39 F) completed a 3-day food record and a milk product health belief questionnaire. One-third of the sample were not meeting dietary calcium recommendations, with 52% of participants below recommendations of milk and alternatives for their age group. Participants expressed uncertainty about whether organic versus traditional milk products are healthier, whether milk products are important for weight control, and concerns regarding adulteration of milk products. More females than males valued milk products’ contribution to bone health and were concerned with the humane treatment of dairy cows. Our qualitative study examined young adults' knowledge of calcium in relation to health, and suggestions to increase dietary calcium intake and ways to communicate calcium-related messaging to this population. Eight gender-specific focus groups (n=53; 3M & 5F) were
conducted using a semi-structured interview guide grounded in Social Cognitive Theory. Participants perceived calcium to be important for children and older adults, but less so for their age group. The high cost of milk products, the inconvenience of purchasing milk products, and perceived negative practices of dairy farmers were barriers to increasing dietary calcium intake. Planning healthy meals and consuming calcium-rich foods habitually were recommended as strategies to increase dietary calcium intake. Participants suggested nutrition education in school curricula, and trusted advice from health professionals as means for communicating nutrition information. In conclusion, this dissertation identified that deterrents to adequate dietary calcium intake cited by participants were mainly based on negative perceptions relating to various aspects of milk products, and a lack of knowledge of the importance of dietary calcium intake for the young adults.
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List of Abbreviations

AI = Adequate intake
AMDR = Acceptable macronutrient distribution range
BC = British Columbia
BMD = Bone mineral density
CADIA = Calcium and Dairy Intake Assessment Study
CCHS = Canadian Community Health Survey
DASH = Dietary Approaches to Stop Hypertension
DRIs = Dietary Reference Intakes
EAR = Estimated Average Requirement
EWCFG = Eating Well with the Canada’s Food Guide
KT = Knowledge translation
PBM = Peak bone mass
PTH = Parathyroid hormone
RDA = Recommend Dietary Allowance
RCTs = Randomized control trials
SCT = Social Cognitive Theory
SD = Standard deviation
TPB = Theory of Planned Behaviour
Introduction

Calcium is an important nutrient for the development and maintenance of healthy bones (Ross, 2011). Inadequate calcium intake has been implicated in osteoporosis and osteoporosis-attributable fractures (Ross, 2011) as well as being associated with a higher risk of non-skeletal outcomes such as hypertension (Nicklas et al., 2011), obesity (Tremblay & Gilbert, 2011; Wang, Troy, et al., 2013), colorectal cancer (Larsson, Bergkvist, Rutegard, Giovannucci, & Wolk, 2006), and type 2 diabetes (Margolis et al., 2011; O’Connor et al., 2014). Despite the importance of adequate dietary calcium intake in relation to health, as many as 44%–61% of young Canadian adults are not meeting dietary recommendations for calcium (1000 mg/d) (Vatanparast, Dolega-Cieszkowski, & Whiting, 2009). This finding is concerning as it has been demonstrated that dietary calcium is a significant predictor of bone mineral density in young adults (Chouinard, Randall Simpson, & Buchholz, 2012). Obtaining adequate dietary calcium is important throughout young adulthood to maximize bone density and strength, for the prevention of osteoporosis, particularly since there is an opportunity to gain bone mass into the fourth decade of life for some skeletal sites (Berger et al., 2010).

Maximizing bone health has considerable implications for decreasing the economic burden on the Canadian health care system. In 2010, the annual health care expenditure in Canada due to osteoporosis and related fractures in adults over 45 was approximately 1.8 billion dollars (Tarride et al., 2012). Although osteoporosis is a disease often associated with older women (Nayak, Roberts, Chang, & Greenspan, 2010), male osteoporosis contributes to the economic burden and is expected to grow with the total number of hip fractures in men predicted to be similar to current estimates in women by the year 2025 (Tarride et al., 2012). Reducing the risk of osteoporosis in both men and women has substantial implications for the healthcare
Young adulthood is a time period characterized by broad shifts in lifestyle (e.g., moving away from home, marriage, pregnancy) that have the potential to strongly influence dietary habits and establishment of lifelong patterns (Arnett, 2000). Therefore, establishing dietary behaviours to ensure adequate dietary calcium intake in young adulthood may carry forward into later adulthood. These dietary behaviours will be important for the prevention of osteoporosis and other health-related outcomes such as hypertension or diabetes.

The determinants of dietary calcium intake in the young adult population have not been thoroughly examined; the few studies that have focused on young adults may not reflect current perceptions (Klesges et al., 1999; Lewis & Hollingsworth, 1992; Weiglein, 2000). Therefore, the purpose of this dissertation was to identify the determinants of dietary calcium intake in young adults ages 18-34 years. Our quantitative study aimed to assess the adequacy of young adults' dietary calcium and milk and alternatives, and to examine milk product health beliefs in this population. Our qualitative study explored young adults’ knowledge of the health benefits of dietary calcium and their perceptions of the importance of adequate dietary calcium intake. As well, the qualitative study sought to determine young adults’ recommendations for individual strategies and messaging to promote adequate calcium intake in this population. We undertook these research studies to gain a better understanding of young adults' general knowledge regarding calcium and the underlying motivations and/or deterrents to dietary calcium intake. This information will be useful for researchers, health professionals and public health advocates to develop messages for nutrition education interventions and knowledge translation initiatives.
Literature Review

Overview of Calcium

**Calcium absorption and metabolism.** Calcium is the most abundant mineral in the body, with over 99% of calcium stored as calcium hydroxyapatite in the bones and teeth, where it provides hard tissue with its strength (Ross, Taylor, Yaktine, & Del Valle, 2010a). The remaining 1% is present in intracellular fluid, blood, and other extracellular fluids, where it plays a critical role in nerve transmission, muscle contraction, intracellular signalling, blood pressure regulation, and hormonal secretion (Ross et al., 2010a). Calcium is absorbed by both active transport and passive diffusion across the intestinal mucosa. Active transport of calcium accounts for most calcium absorption at both low and moderate intakes, and is dependent on activation by calcitriol (the active form of vitamin D) and the intestinal vitamin D receptor (Ross et al., 2010a). Passive diffusion involves the movement of calcium between mucosal cells and often occurs when calcium intakes are high (Ireland & Fordtran, 1973).

When dietary calcium intake is very low in an individual, the percentage of a given dose of calcium that is absorbed (referred to as fractional calcium absorption) is inversely related with calcium intake (Hunt & Johnson, 2007; Ireland & Fordtran, 1973). Calcium absorption is increased when there is a greater need for calcium within the body, and as calcium intake increases, fractional calcium absorption declines. Fractional calcium absorption can vary throughout the lifespan. In infancy, fractional calcium absorption may range from 30% to 60%, with higher and lower calcium intakes, respectively (Abrams, 2010). In young adults, approximately 25% of dietary calcium is absorbed (Hunt & Johnson, 2007), but absorption begins to decline with age, declines further for females after menopause (Nordin et al., 2004).
Yet the maintenance of adequate calcium intake is critical for the body to function normally. As illustrated in Figure 1, the endocrine system tightly regulates serum calcium concentrations to remain between 2.12 and 2.62 mmol/L (Ross et al., 2010a). If serum calcium concentrations fall even slightly below this range, the parathyroid gland will signal the secretion of parathyroid hormone (PTH). Parathyroid hormone will stimulate the kidneys to produce calcitriol and activate bone resorption which will increase extracellular calcium levels. Any fluctuation above this range will inhibit PTH secretion, causing an increase in excretion of calcium by the kidney and resulting in decreased calcium absorption. The thyroid gland will also secrete calcitonin, which can block bone resorption and suppress the production and release of PTH, to inhibit the release of calcium (Ross et al., 2010a).

**Figure 1:** A representation of the regulatory role the endocrine system plays in maintaining serum calcium levels between 2.12 and 2.62 mmol/L.

**Source:** Smolin, Grosvenor, & Garfinkel. (2012). *Reproduced with permission through John Wiley & Sons Ltd*
**Sources of calcium.** Total calcium intake may come from either dietary sources or supplements (Ross et al., 2010a). Milk products (e.g., milk, yogurt, and cheese) are the primary source of dietary calcium in the North American diet (Johnson-Down, Ritter, Starkey, & Gray-Donald, 2006; Ross et al., 2010a). Calcium can also be found in other dietary sources, such as fish (e.g., sardines or canned salmon with bones), legumes (e.g., lentils), selected green vegetables (e.g., spinach, broccoli) and grains (e.g., whole wheat bread) (Ross, Taylor, Yaktine, & Del Valle, 2010). Certain foods in North America are also fortified with calcium, such as orange juice, plant-based milk alternatives, and cereal, with calcium (Poliquin, Joseph, & Gray-Donald, 2009; Rafferty, Walters, & Heaney, 2007). Additionally, supplement use has become a contributor to total calcium intake in the Canadian population, as approximately 35% of males and 47% of females were regularly consuming vitamin/mineral supplements (Vatanparast, Adolphe, & Whiting, 2010).

The bioavailability of dietary calcium (i.e., the amount of calcium that can be absorbed and used by the body) depends on the source (Ross et al., 2010). The absorption of calcium from milk products is approximately 30%, and from calcium-fortified foods it is nearly 60%. However, some plant sources of calcium contain compounds such as oxalic and phytic acid, both of which bind with calcium and interfere with its absorption (Ross et al., 2010). However, food items such as spinach, collard greens, and fibre-containing wheat products are considered to be poor sources of dietary calcium despite their high calcium content, due to low calcium bioavailability (Ross et al., 2010). Calcium supplements, when tested in pure chemical form, have been shown to have similar absorbability in comparison to dietary sources of calcium (Rafferty et al., 2007), with no significant differences in bioavailability between calcium carbonate and calcium citrate (Heller, Greer, Haynes, Poindexter, & Pak, 2000).
**Recommendations for dietary calcium intake.** The Dietary Reference Intakes (DRIs) for calcium developed by the Institute of Medicine were determined based on bone health and the state of calcium body stores (referred to as calcium balance) for each developmental life stage: bone accretion, bone maintenance, and bone loss (Ross et al., 2010b). The DRIs for children and adolescents were based on evidence of the intake needed to achieve bone accretion and positive calcium balance (Abrams et al., 1999; Lynch et al., 2007; Vatanparast, Bailey, Baxter-Jones, & Whiting, 2010). In establishing the DRIs for adults (19–50 years), the aim was to determine the amount of calcium needed to promote bone maintenance and maintain neutral calcium balance (Ross et al., 2010b). Based on a series of metabolic studies, Hunt and Johnson (2007) provided data to support a basis for the Estimated Average Requirement (EAR) for calcium of 800 mg/day. The upper limit of the 95% prediction interval around this estimate (1035 mg/day), that is required for neutral calcium balance, was determined to be reasonable as the basis for the Recommended Dietary Allowance for calcium and was rounded to 1000 mg/day (Hunt & Johnson, 2007; Ross et al., 2010b).

*Eating Well with Canada’s Food Guide (EWCFG)* emphasizes the importance of milk and alternatives as part of a healthy diet in order to meet DRIs for calcium intake and other essential nutrients, for the maintenance of optimal bone and overall health (Health Canada, 2011). The food guide’s recommended number of servings per day for milk and alternatives depends on the age group: 2 servings/day for ages 2–8; 3–4 servings/day for ages 9–18; 2 servings/day for ages 19–50; and 3 servings/day for adults over 50. One serving of milk and alternatives is equal to 1 cup of milk or soy beverage, 3/4 cup of yogurt, or 1.5 oz of cheese. However, adequate intake of daily servings from all four food groups is required to meet dietary calcium requirements (Health Canada, 2011).
Calcium Intake in the Canadian Adult Population

**Current calcium status of Canadians.** The most recent data on calcium intakes are available from the 2004 Canadian Community Health Survey (CCHS). The prevalence of inadequate dietary calcium intakes varied between 27% and 80% for males and between 48% and 87% for females (Health Canada, 2012b). Furthermore, approximately 44%–61% of young Canadian adults were not meeting the daily RDA for calcium (1000 mg/d). The percentage of inadequate intakes reported in young adult females was higher than in young adult males (70% vs. 47%) (Vatanparast et al., 2009). The impact of taking a vitamin/mineral supplement on calcium intake increased the percentage of men and women meeting recommendations. However, supplement use did not greatly affect the prevalence of inadequate calcium intakes in the Canadian population, with the exception of females ages 51–70 (Vatanparast, Adolphe, et al., 2010).

In the Canadian diet, milk products typically provide the richest source of calcium; however, Canadians have been least likely to meet their recommended intakes for milk and alternatives out of all the food groups in EWCFG (Johnson-Down et al. 2006). The most recent data report that per capita consumption of total fluid milk is 202 mL/person/day, total cheese is 33 g/person/day, and yogurt is 25 mL/person/day. This represents approximately 1.6 servings of milk products consumed per day by the average Canadian (CDIC, 2013). Plant-based beverages amount to just less than 4% of other types of “milk” consumed (Garriguet, 2008). Based on these data, 46%–65% of young adults (17–30 years), and 65%–84% of adults (>31 years) are not meeting the recommended two servings of milk and alternatives per day; these percentages are represented in Figure 2.
Figure 2: A representation of the percentage of Canadian adults (excluding Territories) who are not meeting the *Eating Well with Canada’s Food Guide* recommendations of milk and alternatives for their age group.

Source: Statistics Canada, 2004 Canadian Community Health Survey, *Reproduced and distributed on an “as is” basis with the permission of Statistics Canada.*

**Potential contributors to inadequate dietary calcium intake.** Contributors to inadequate intake may include the decline in dietary calcium and milk product intake during the transition from childhood to young adulthood, the overall decline in per capita milk consumption in Canada, and consumer confusion regarding milk products.

The transition from childhood into adolescence can be characterized by undesirable changes in eating behaviours and meal patterns (Birch, Savage, & Ventura, 2007), such as a decrease in milk product consumption and other nutrient-dense foods (Fiorito, Mitchell, Smiciklas-Wright, & Birch, 2006). Subsequently, these changes in dietary behaviours may continue into young adulthood. A review by Nicklas (2003) reported that dietary tracking studies have shown that overall dietary quality can decrease as individuals transition from childhood to young adulthood. One of the consequences reported was a decline in dietary calcium and milk product intake (Nicklas, 2003). Larson et al. (2009) examined longitudinal trends of calcium and
milk product intake as male and female adolescents (mean age 15.9 years at baseline) transitioned into young adulthood. During the five-year study period, approximately 60% of participants had a decline in dietary calcium intake, with a decrease in intake by 194 ± 23 mg/day and 153 ± 19 mg/day in males and females, respectively. Overall, milk product consumption decreased by 0.5 servings/day, mainly due to a decrease in fluid milk consumption. Longitudinal decreases in dietary calcium intake were associated with females who reported more time spent watching television and with males who reported perceived lactose intolerance (Larson et al., 2009). In contrast, data obtained from a seven-year longitudinal study reported that as males transitioned into young adulthood there was a significant increase in milk products, fruits and vegetables, and dietary calcium intake in comparison to females (p<0.05) (Vatanparast, Baxter-Jones, Faulkner, Bailey, & Whiting, 2005). Collectively, these findings highlight that as individuals transition into young adulthood, changes in dietary habits may influence dietary calcium and milk product intake; facilitators to adequate calcium intake may vary based on gender.

Inadequate dietary calcium intake may also be a result of the decrease in per capita fluid milk consumption observed in Canada over the last 20 years (CDIC, 2013). This decline in milk intake may be partly attributable to competition from other beverages that have been introduced to the consumer market (e.g., soft drinks, sports drinks, bottled water) (Wingrove, 2004). With such a variety of beverages becoming more readily available to consumers, approximately 28% of Canadians were not choosing milk as a beverage of choice (Wingrove, 2004). In addition, an increasing number of plant-based milk alternatives (e.g., soy, almond) became available and were typically marketed towards consumers who chose to limit their milk product intake (Cash, 2005). As well, according to the 2004 CCHS data, water, coffee, tea, alcohol, and soft drinks
were all consumed in greater quantities than fluid milk (Garriguet, 2008). Canadians also began consuming meals more frequently outside of the home, with individuals favouring other beverages over fluid milk when ordering meals (Wingrove, 2004).

Lastly, there has been a continuing societal shift away from the consumption of milk products in Canada. Consumers are often subjected to a variety of positive and negative messages regarding the benefits of milk product consumption (Cash, 2005). Previously, the demand for milk products in Canada varied depending on the health information that was being disseminated through the media (Cash, 2005). For example, previous media coverage has promoted the consumption of low-fat milk products for weight management (e.g., skim milk), while increasing consumer concerns regarding high-fat milk products (e.g., cheese) (Cash, 2005). More recently, the Canadian media has been reporting about the shift away from milk product consumption, which is a topic that has continuously gained media attention and has placed the dairy industry's marketing campaigns under scrutiny (Atkins, 2015). Reports from major media outlets include messages arguing that: milk is not essential; the production of milk is harmful for the environment; milk consumption is unnatural, lactose intolerance is prevalent for majority of individuals; and, dairy industry practices support animal cruelty (e.g., exposed cruel treatment of dairy cows from inside Canada's largest dairy factory farm in Chilliwack, BC) (Francois, 2015; Kingston, 2015). Conflicting messages can create challenge for consumers who want to make informed dietary choices to meet dietary needs and calcium recommendations.

**Calcium and its Relation to Health Outcomes**

Inadequate calcium and/or milk product intake has been implicated in an increased risk of osteoporosis (Ross, 2011), hypertension (Nicklas et al., 2011), obesity (Tremblay & Gilbert, 2011; Wang, Troy, et al., 2013), colorectal cancer (Larsson et al., 2006), and type 2 diabetes
(Margolis et al., 2011; O'Connor et al., 2014). Therefore, establishing adequate dietary calcium intake throughout adulthood is important not only for achieving optimal bone health, but for the prevention of other health-related outcomes. These outcomes will be further discussed in the following sections.

**Bone health and osteoporosis.** Osteoporosis is an age-related skeletal disorder associated with decreased bone mass, increased bone fragility, and increased fracture risk (Garriguet, 2011). Calcium is an important nutrient for the development and maintenance of bone mass and for the prevention of bone loss later in life to reduce osteoporosis risk (Ross et al., 2011). A review by Heaney (2000) reported that adequate calcium intake minimizes bone loss in the elderly, reduces the risk of fracture, and augments the osteo-protective effect of estrogen therapy in females. Furthermore, the Canadian Multicentre Osteoporosis Study research group (2013) studied changes in participants’ calcium and vitamin D intake over time (10 years for ages ≥25; 2 years for ages 16–24) to determine the cross-sectional and longitudinal associations with bone mineral density (BMD). The research group reported that baseline calcium and vitamin D intakes were associated with a greater total hip and femoral neck BMD in young males ages 16 to 24, and that females over the age of 25 who were maintaining a high calcium (≥1500 mg/day) and vitamin D intake (≥400 IU/day) at follow-up had improved BMD of the lumbar spine, total hip, and femoral neck (Zhou et al., 2013).

Similar findings have been reported in females over 55 years of age, with calcium obtained from milk products being positively associated with femoral neck BMD and negatively with previous fracture history (Wlodarek et al., 2012). Low consumption of fluid milk during childhood has also been associated with decreased calcium intake in adulthood and an increased risk of osteoporotic fractures (Kalkwarf, Khoury, & Lanphear, 2003; Opotowsky & Bilezikian,
In addition to calcium, milk products provide a rich source of phosphorus, magnesium, potassium, zinc, and protein (Bonjour, Kraenzlin, Levasseur, Warren, & Whiting, 2013). Dietary protein is required to promote bone formation and enhance intestinal calcium absorption, and in the kidney, phosphorus reduces urinary calcium. Both protein and phosphorus can enhance calcium balance within the body, and therefore support the positive impact milk products may have on bone health (Bonjour et al., 2013).

The above referenced studies demonstrate that adequate dietary calcium and milk product intake is important across various life stages, particularly for skeletal growth during childhood and adolescence and for bone remodeling throughout adulthood. Bone remodeling is a process that involves the balance between osteoblasts that deposit new bone (i.e., bone formation) and osteoclasts that break down bone (i.e., bone resorption) (Hadjidakis & Androulakis, 2006). Often, older adults have low calcium and protein intakes, as well as an insufficient vitamin D supply from the skin and dietary sources, resulting in the secretion of the PTH. During periods of consistently low intakes, constant stimulation of the thyroid gland to secrete PTH results in increased bone remodeling, and thus reduced BMD (Abellan van Kan et al., 2008). Therefore an adequate intake of calcium, as well as other nutrients supporting bone health, is an important consideration for the prevention of osteoporosis later in adulthood.

**Peak bone mass.** Bone modeling, which occurs when formation exceeds resorption, is the predominant skeletal process that occurs during childhood and adolescence (Weaver & Heaney, 2006). This stage of the life cycle is an important skeletal developmental period. During this stage calcium absorption is maximal, and bone that is accrued will determine adult bone mass; a significant predictor of fracture risk in older age (Matkovic et al., 2005). The maximum amount of bone mass that can be accumulated is referred to as peak bone mass (PBM).
Depending on the skeletal site, PBM can be achieved as early as age 16 or as late as into the fourth decade of life (Berger et al., 2010). For example, Berger et al. (2010) reported that the PBM of lumbar spine BMD occurred between ages 33 and 40 in females (1.046 ± 0.123 g/cm$^2$) and between 19 and 33 in males (1.066 ± 0.129 g/cm$^2$), whereas total hip BMD occurred from ages 16 to 19 years in females (0.981 ± 0.122 g/cm$^2$) and 19 to 21 years in males (1.093 ± 0.169 g/cm$^2$) (refer to Figure 3).

**Figure 3**: Percent of peak bone mass achieved between 16 and 40 years of age in females (A) and males (B) (Berger et al., 2010). Reproduced with permission from John Wiley and Sons.

Peak bone mass has many contributing factors, such as genetics, nutrition, and physical activity (Heaney et al., 2000). Particular attention has been paid to the role of nutrition in the accumulation of bone mass. Matkovic et al. (2004) reported that both supplemental calcium and milk products were positively associated with BMD of the hip and forearm of females in late adolescence, while only milk products were associated with a higher BMD of the spine. The researchers suggested that calcium exerts its action on volumetric bone density, while milk products can additionally influence bone growth and periosteal bone expansion (Matkovic et al., 2004). The findings of this study thus highlight the influence that sufficient calcium intake, particularly from milk products, has on bone mass accrual, resulting in a higher PBM than is seen in individuals with lower calcium intakes.
**Weight management.** Cross-sectional studies have been consistent in demonstrating an inverse association between milk product intake and weight status (Jacqmain, Doucet, Depres, Bouchard, & Tremblay, 2003; Liu et al., 2005; Skinner, Randall Simpson, & Buchholz, 2011). These findings have prompted further investigation to determine if a causal relationship exists. Prospective cohort studies have demonstrated milk products’ protective effect on weight status (Wang et al., 2013); however, attempts to determine the causal link have produced conflicting results. This putative protective effect appears to depend on a host of individual characteristics, including weight status, gender, habitual dietary calcium intake, and types of milk product consumed (Boon, Koppes, Saris, & Van Mechelen, 2005; Vergnaud et al., 2008). Randomized control trials (RCTs) have also been inconsistent; nevertheless, findings suggest that milk products may be beneficial when included as part of weight loss regime (Bowen, Noakes, & Clifton, 2004; Harvey-Berino, Gold, Lauber, & Starinski, 2005; Zemel, Richards, Milstead, & Campbell, 2005).

Alternatively, data from studies of rodent models have been more robust in determining a causal relationship between calcium and weight than human trials (Bollen & Bai, 2005; Shi, Dirienzo, & Zemel, 2001; Zemel, Shi, Greer, Dirienzo, & Zemel, 2000). Current evidence suggests that dietary calcium has an effect on intracellular calcium and a subsequent impact on adipocyte lipid metabolism (i.e., promoting energy storage) and fatty acid absorption in the gastrointestinal tract. Furthermore, other components of milk products have been reported to have a positive impact on weight management by appetite regulation, and thus food intake (Dougkas, Reynolds, Givens, Elwood, & Minihane, 2011). Although attempts to determine the causal link between dietary calcium and/or milk products have produced conflicting results, the demonstrated protective effect of including milk products in the diet merits further investigation.
Blood pressure and hypertension. Increasing evidence also supports the role of calcium and/or milk products in the prevention of hypertension. This evidence stems from the Dietary Approaches to Stop Hypertension (DASH) trial, which has shown that a diet rich in fruit, vegetables, and low-fat milk products can substantially reduce blood pressure (Appel et al., 1997). Particularly, the risk of hypertension has been reported to be inversely associated with low-fat milk product intake (Alonso, Steffen, & Folsom, 2009; Engberink et al., 2009). However, RCTs examining milk product intake and blood pressure have been inconsistent. In studies examining calcium supplementation, a small but significant effect of approximately one gram per day of calcium on lowering both systolic and diastolic blood pressure (-1.9/-1.0 mmHg, p<0.05) has been observed (van Mierlo et al., 2006).

The underlying mechanisms by which calcium and/or milk products exert their effects on hypertension are yet to be established; however, Bohr (1963) suggested an association between decreased intracellular calcium and suppression of vascular smooth muscle tone with high dietary calcium intakes. Additionally, other researchers have suggested that the proteins and bioactive peptides found in milk products inhibit the angiotensin-I-converting enzyme, thus modulating endothelium function (Engberink et al., 2009). In addition to calcium, minerals such as magnesium and potassium in dairy products have been shown to be important for blood pressure regulation (Engberink et al., 2009). Therefore, there is evidence to support both calcium intake and/or low-fat milk product consumption for the prevention of hypertension.

Other health considerations. Decreased calcium and milk product intakes have also been associated with other adverse health outcomes, including an increased risk of developing type 2 diabetes and an increased incidence of colon cancer. Observational studies have shown an inverse association between low-fat milk product intake and type 2 diabetes, particularly in
females with a high body mass index (Margolis et al., 2011). Observational studies have also identified that milk product consumption has a beneficial effect on the prevention of type 2 diabetes (Margolis et al., 2011; O’Connor et al., 2014; Tong, Dong, Wu, Li, & Qin, 2011). Additionally, an inverse association has been observed between total calcium intake (diet and supplements), and milk products specifically, and the risk of developing colorectal cancer (Huncharek, Muscat, & Kupelnick, 2009; Larsson et al., 2006; Park et al., 2007). Although there is accumulating evidence in the literature that adequate calcium and milk product intake may have protective effects on many health-related outcomes beyond bone health, the Institute of Medicine has indicated that the evidence is not strong enough to determine cause and effect for non-skeletal health outcomes. However, there is no evidence to support that adequate dietary calcium and/or milk product intake is harmful and the potential for decreasing the risk of the associated non-skeletal health outcomes is worth considering.

**Determinants of Dietary Calcium Intake**

Many Canadian adults are not meeting dietary recommendations for calcium intake (Vatanparast et al., 2009). Inadequate calcium intake in adults may be attributable to the decline in dietary calcium intake during the transition from childhood to adulthood (Larson et al., 2009; Vatanparast, Baxter-Jones, Faulkner, Bailey, & Whiting, 2005), the overall decline in per capita milk consumption in Canada (CDIC, 2013), and/or consumer confusion regarding benefits of milk product consumption (Cash, 2005). The inadequacy of calcium intakes is concerning, given the many contributions of dietary calcium to human health. To better inform nutrition education interventions and knowledge translation (KT) initiatives, the determinants of dietary calcium intake, as well as the psychosocial factors that may influence dietary behaviours, require careful examination. Previous literature has examined the determinants of dietary calcium intake in
adults, particularly with regard to fluid milk or milk products, and will be further discussed in the subsequent sections.

**Theory-based evidence for predicting dietary calcium and milk product intake.** A review of the literature to examine theoretical determinants that may predict dietary behaviors related to calcium and milk product intake identified two most commonly used models: the Theory of Planned Behaviour (TPB) (Ajzen, 1991) and Social Cognitive Theory (SCT) (Bandura, 1989).

**Theory of Planned Behaviour.** Previous researchers have utilized the TPB to predict individuals’ intentions to choose healthy food options (Åstrøsm & Rise, 2001), as well as to predict milk product intake in adults (Brewer, Blake, Rankin, & Douglass, 1999; Kim, Reicks, & Sjoberg, 2003). According to the TPB, an individual’s intention to perform a specific behaviour is influenced by their attitude towards the behaviour (behavioural beliefs), their evaluation of subjective norms (normative beliefs), and their perception of their level of control and ability to adopt that specific behaviour (control beliefs) (Ajzen, 1991).

Kim, Reicks, and Sjober (2003), developed a questionnaire grounded in TPB to explain the intention to consume milk products in an older adult population (n=162, 75 ± 6 years), with examination of attitudes, subjective norms, and perceived behavioural control. Perceived behavioural control was found to be independently associated with milk product intake. Perceived behaviour control was also positively associated with the intention to consume milk products, indicating that participants may have been more likely to increase their milk product intake if perceived personal or environmental barriers were eliminated (Kim et al., 2003). Some of these barriers included difficulty substituting milk for other beverages, the high cost of milk products, difficulty getting to the store for grocery shopping, and the lack of availability of milk.
products in the home (Kim et al., 2003). An individual’s perception of control over these factors can have an influence over dietary behaviours and, in this case, can predict milk product consumption. The TBP is a useful model of health behaviour for predicting dietary habits such as increasing dietary calcium intake; however this theory does not provide any suggestions on how to mediate behaviour change.

**Social Cognitive Theory.** Social Cognitive Theory (Bandura, 1989), which provides a different framework for understanding the influence of personal factors and the environment on nutrition-related behaviours (Bandura, 2004), has been commonly used to examine dietary habits (Anderson, Winett, & Wojcik, 2007) and to design nutrition education and health promotion programs (Contento, 2011). Social Cognitive Theory is useful to predict dietary behaviour; however, SCT also describes potential mediators and mechanisms that can motivate individuals to change dietary habits to positively influence overall health (Bandura, 2004; Contento, 2011). From a perspective of SCT, the core determinants include knowledge of health outcomes (i.e., knowledge of the risks and benefits to performing a behaviour), self-efficacy (i.e., an individual’s confidence in their ability to perform a behaviour), outcome expectations (i.e., perceived costs and benefits from performing a behaviour), goal setting (i.e., the health goals individuals set for themselves and the regulatory strategies they use to meet these goals), and perceived facilitators and impediments (i.e., factors that may influence a behaviour (Bandura, 2004).

Perceived self-efficacy has been deemed the focal determinant of SCT because it plays a central role in personal change either by influencing health behaviours directly or by exerting influence on the other determinants (Bandura, 2004), as illustrated in Figure 4 in relation to increasing dietary calcium intake. The stronger an individual’s perceived self-efficacy, the higher
the goals that individual will set for themselves and, in turn, the more likely that they will maintain the commitment to achieve these goals through self-regulation (Bandura, 2004). For example, individuals with higher confidence in their ability to change their dietary habits will expect their efforts to produce more favourable health outcomes than those with low confidence, and they will in turn have a greater commitment to maintaining a dietary change regardless of potential deterrents.

**Figure 4**: A representation of the structural paths of self-efficacy and the direct and indirect influence self-efficacy has on an individuals’ dietary behaviour to increase calcium intake.

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Researchers have previously used SCT as a framework to guide qualitative analysis exploring the determinants of fluid milk (Mobley, Jensen, & Maulding, 2014) and milk product intake (Jung et al., 2014). Jung et al. (2014) held eight focus groups, with separate groups conducted for males (n=20, 42 ± 6 years) and females (n=20, 38 ± 7 years) and adequate (≥2 milk servings/day) and inadequate (<2 servings/day) milk product consumers, to investigate participants' outcome expectancies, and the motivators and barriers to milk product consumption.
Many participants believed that the benefits of milk product consumption included obtaining dietary calcium, protein, and other essential nutrients. Among parents, consuming milk products was viewed as a means to encourage adequate milk product consumption in their children. A common barrier to consumption that the study revealed was a lack of knowledge regarding milk products, which typically manifested as erroneous perceptions of the high fat and sugar content of milk products. Other commonly reported barriers to consumption of milk products included perceived lack of credible sources of information and concerns regarding contamination (e.g., added antibiotics and/or hormones). Individuals identified with inadequate milk product intake also reported a lack of convenience (with regard to cost or availability) and a dislike of milk products as deterrents. To overcome potential barriers, participants discussed consuming milk products as part of a routine, planning ahead, and combining milk products with other foods as strategies to increase milk product intake (Jung et al., 2014).

Similarly, Mobley, Jensen and Maulding (2014) developed focus group questions grounded in SCT to explore the attitudes, beliefs, and barriers regarding milk consumption in low-income females (n= 59, ≥60 years). Participants were aware of the bone health benefits of fluid milk consumption but were unaware of the additional nutritional benefits. The most cited barrier to consumption was perceived lactose intolerance. Other barriers included a dislike of the taste of milk, the fact that milk consumption was not a habit, the belief that milk consumption was not important in older age, the high cost of milk, and a perceived lack of convenience around purchasing milk (Mobley et al., 2014). These barriers to intake revealed concerns that may be specific to, or particularly relevant for, low-income females. Collectively, the findings of the two above studies demonstrate that the determinants of adequate dietary calcium intake may differ based on the particular needs of certain populations.
In a young adult population (n=294, 20.2 ± 0.1 years), Poddar, Hosig, Anderson, Nickols-Richardson, and Duncan (2010) evaluated a web-based nutrition education program, grounded in SCT, on outcome expectations, self-efficacy, self-regulation, and milk product consumption. Intervention material regarding milk products was developed to include topics such as the importance of milk products in relation to the health of young adults, ways to increase intake, nutritional content, and current recommendations. A validated Food Beliefs Survey, used in many previous nutrition studies, was used to measure various components of SCT. The findings of the five-week web-based intervention revealed that participants in the intervention group made greater increases in the use of self-efficacy and self-regulatory strategies for consuming milk products in line with national recommendations; yet milk product intake did not increase (Poddar, Hosig, Anderson, Nickols-Richardson, & Duncan, 2010). Despite this, the improvements in some of the behavioural determinants are encouraging and demonstrate the need to further explore the underlying motivations of young adults to increase dietary calcium intake.

**Empirical evidence of the motivators and barriers to adequate calcium intake.** In order to understand an individual's underlying motivations to change dietary habits to increase dietary calcium intake there are a number of aspects to consider. This includes the attitudes and beliefs towards, and the motivators and barriers to, increasing dietary calcium intake need to be examined. A further review of the literature focuses on the various perceptions of dietary calcium and/or milk products that may be potential barriers to adequate dietary calcium intake.

**Weight management concerns.** Due to the perceived fat content of milk products, weight-related concerns have been reported as a deterrent to calcium intake commonly in females (Cashel, Crawford, & Deakin, 2000; Eddy, Brochetti, & Duncan, 1999; Gulliver &
Cashel, Crawford, and Deakin (2000) examined the calcium intake of premenopausal (n=135, <50 years) and postmenopausal (n=121, ≥50 years) females to determine what effect the type of milk consumed had on dietary calcium intake. Milk consumption contributed to 55–66% of dietary calcium intake in both groups, and participants’ milk choices were influenced by the perceived fat content of milk. Both groups of females ranked eating foods low in fat as the most important dietary habit for their own health, and subsequently consumed larger quantities of low-fat milk. However, more postmenopausal than premenopausal participants were choosing milk high in calcium content, resulting in a higher mean intake from milk consumption (Cashel, Crawford, & Deakin, 2000). Additionally, Gulliver and Horwath (2001) explored perceived benefits and barriers to milk product consumption in females (n=1700, 25–70 years). Participants reported the relation of milk product intake with bone health as a perceived benefit and weight concerns as a perceived barrier to milk product consumption. Not surprisingly, barriers to increasing milk product intake were positively associated with weight (p<0.001), and body mass index (p<0.01) (Gulliver & Horwath, 2001). Therefore, perceived fat intake of milk products may outweigh any perceived benefits to milk product consumption.

Additionally, qualitative studies have examined how the dietary habits of adults may influence dietary calcium intake. In a study of a young adult population (n=23; 19–24 years), Lewis and Hollingsworth (1991) reported that participants suggested they would be more willing to consume calcium-rich foods if these foods were low in calories and could be incorporated into an active lifestyle, and also if nutrition labels explicitly identified the appropriate portion size needed to meet calcium recommendations (Lewis & Hollingsworth, 1992). Additionally, in a study by Weiglein (2000), young adult females (n=28, 19–22 years) reported that the high fat
content of milk products was a deterrent to including milk products in their diet. Previous studies in adults ages 30 years and older have also reported that even though participants acknowledged the benefits of milk product consumption for obtaining dietary calcium and preventing osteoporosis, the perceived importance of limiting fat in the diet led them to choose low-fat options, to limit milk product intake, and/or to consume calcium supplements to meet recommendations rather than increasing their intake of milk products (Eddy, Brochetti, & Duncan, 1999; Hagy, Brochetti, & Duncan, 2000). These studies indicate that maintaining a healthy weight may be a more important consideration for some individuals than meeting calcium or milk product recommendations.

**Self-reported Lactose Intolerance.** The increasing prevalence of perceived lactose intolerance, in the absence of a clinical diagnosis by a physician, has been well documented in the literature (Barr, 2013; Chapman, Chan, & Clark, 1995; French, Moore, Vernace-Inserra, & Hawker, 2005; Klesges et al., 1999; Lovelace & Barr, 2005; McBean & Miller, 1998; Nicklas et al., 2011). Lactose intolerance refers to the gastrointestinal discomfort, characterized by bloating, cramps, and diarrhea, that individuals may experience with lactose maldigestion (Lomer, Parkes, & Sanderson, 2008; Montalto et al., 2006; Vesa, Marteau, & Korpela, 2000). However, even individuals with lactose maldigestion are able to tolerate 12 grams of lactose (approximately 1 cup of milk) if consumed with other foods (Shaukat et al., 2010; Suchy et al., 2010). To complicate matters, many individuals who perceive themselves to be lactose intolerant show no evidence that they are lactose maldigesters; thus, the cause of the gastrointestinal discomfort is unlikely related to lactose (Suchy et al., 2010). Yet, individuals with perceived lactose intolerance still tend to avoid milk products (Keith, Nicholls, Reed, Kafer, & Miller, 2011; Matlik et al., 2007).
Barr (2013) developed a web-based survey to determine the prevalence, correlates, and potential impact of perceived lactose intolerance among adult Canadians (n=2251, >19 years). Overall, 16% of participants self-reported lactose intolerance (Barr, 2013). As expected, those with self-reported lactose intolerance had lower covariate-adjusted milk product intake than those who did not (1.4 ± 0.08 servings/day vs. 2.33 ± 0.03 servings/day, p<0.001). Despite the fact that a larger proportion of those with perceived lactose intolerance consumed supplements containing calcium in comparison to individuals who did not identify as lactose intolerant (52% vs. 37%, p<0.001), total calcium intake was found to be significantly lower in these individuals (739 ± 30 mg/d vs. 893 ± 13 mg/d, p<0.0001) (Barr, 2013). This suggests that the attempt to consume supplements to compensate for the lower dietary calcium intake was not substantial enough for participants to meet their dietary needs.

There is also evidence to suggest that individuals may experience discomfort when consuming calcium supplements in an effort to meet calcium recommendations. In a study of postmenopausal females (n=30, 52–87 years), researchers qualitatively explored concerns regarding milk product–related gastric distress (French et al., 2005). Participants expressed frustration with attempting to meet their calcium intake goals from dietary and supplemental sources of calcium. Many of these participants who perceived themselves to be lactose intolerant were also experiencing gastrointestinal side effects from calcium supplements. These participants were actively making an effort to reduce gastrointestinal side effects by limiting milk product intake, consuming lactose-free supplements, and taking multiple supplements over the course of the day to decrease the amount of calcium consumed at one given time (French et al., 2005). Limiting consumption of milk products or calcium supplements can put individuals at a higher risk for inadequate calcium intake. Additionally, researchers have identified that a
higher percentage of participants with self-perceived lactose intolerance reported being diagnosed with diabetes and hypertension in comparison to participants who do not identify as lactose intolerant (Nicklas et al., 2011). Individuals who perceive themselves to be lactose intolerant are more likely to decrease their milk product intake, potentially resulting in lower dietary calcium intake and compromising overall health.

Cost and convenience. In addition to the perceived negative outcomes of consuming milk products, the high cost of milk products has been reported as a deterrent to adequate calcium intake (Eddy et al., 1999; Hagy et al., 2000; Jung et al., 2014; Nolan-Clark, Neale, Probst, Charlton, & Tapsell, 2011; Wham & Worsley, 2003). For example, Wham and Worsley (2003) examined consumers’ usual milk intake in relation to their attitudes and beliefs towards milk (n=1,432; 16–94 years). More than one third of participants consumed less than one serving of milk per day, and researchers reported that the strongest attitudinal predictor of low milk consumption was in agreement with the statement, "milk is expensive compared to fizzy drinks" (Wham & Worsley, 2003). This finding aligned with earlier focus group studies that reported that individuals may limit milk product consumption based on the perception that modified milk products (e.g., fortified and low-fat options) are expensive and not economical. Elderly individuals (65-89 years) tended to believe that purchasing these types of milk products was wasteful for an individual living alone on a fixed income, as milk products are often sold in large quantities and spoil quickly (Eddy et al., 1999). For others, there was doubt that modified milk products actually contained fortified ingredients as advertised or that these added ingredients had any significant impact on overall health (Nolan-Clark et al., 2011). These studies show that the perception that milk products are not economical can influence consumers’ decisions to limit milk product intake.
In addition to cost factors, perceptions of convenience have been shown to have an effect on calcium intake. Researchers have reported various reasons that individuals perceive maintaining an adequate calcium intake as inconvenient, many of which are practical (French et al., 2005; Jung et al., 2014; Nolan-Clark et al., 2011). For example, changes in routine affecting dietary habits (e.g., vacation, shift work), having to remember to take calcium supplements, and eating out at restaurants were some examples of inconvenience mentioned by postmenopausal (52-87 years) females who were trying to meet calcium recommendations (French et al., 2005). Another reason cited included a lack of time and ability to understand nutrition food labels (Nolan-Clark et al., 2011). Time constraints, changes in routine, and a lack of skill to decipher nutrition labels may thus prevent individuals from adopting dietary behaviours to increase dietary calcium intake.

**Sensory Attributes.** In addition to concerns around health, cost, and convenience, sensory attributes, particularly those related to milk products, have been noted in the literature as a deterrent to calcium intake (Eddy et al., 1999; Hagy et al., 2000; Jung et al., 2014; Lewis & Hollingsworth, 1992; Mobley et al., 2014; Weiglein, 2000). Researchers have reported that participants have considered fluid milk to be bland or disliked the taste (Jung et al., 2014; Lewis & Hollingsworth, 1992). Elderly participants have expressed that they disliked the taste of milk products, but could not identify what specific attribute they did not enjoy (Eddy et al., 1999). In other studies, participants have described the texture and aroma of different milk products, such as cottage cheese, eggnog, and sour cream, as unpleasant (Hagy et al., 2000; Weiglein, 2000).

For those individuals (65-89 years) who were conscious of their fat intake, the dislike of modified milk products was another cited barrier to adequate calcium intake (Eddy et al., 1999). Young adult females (19-24 years) thought skim milk being low in calories was an advantage to
consumption, but they did not like its taste (Lewis & Hollingsworth, 1992). In other studies, individuals (ages 30-55 years) have described low-fat milk products as having a “rubbery” taste and as having different properties from non-modified milk products (e.g., low-fat cheese has a rubbery taste and does not melt well) (Hagy et al., 2000). These concerns may further limit milk product intake, and potentially dietary calcium intake, if individuals do not perceive low-fat milk products to be a feasible option due to a dislike of these products.

In addition to taste, participants also described how they preferred milk products to be prepared or stored. Particularly in situations where meals were consumed away from the home environment, milk products were not often served to customer satisfaction (Hagy et al., 2000; Lewis & Hollingsworth, 1992). For example, participants reported that in restaurants, milk is not served cold enough (Hagy et al., 2000; Lewis & Hollingsworth, 1992), milk does not taste fresh and has an acidic taste (Lewis & Hollingsworth, 1992), and meals are often not prepared to their satisfaction (e.g., meals served with too much cheese) (Hagy et al., 2000). These findings indicate that taste and preparation preferences may significantly impact the dietary choices individuals make when considering the consumption of milk products in an effort to meet dietary calcium needs.

Adulteration of milk products. More recent studies have reported that a barrier to milk product consumption for individuals (30-50 years) is the perception that milk products contain added antibiotics and/or hormones (Jung et al. 2014). Nolan-Clark, Neale, Probst, Charlton, and Tapsell (2011) reported that participants were skeptical of functional milk products (i.e., foods enhanced with bioactive ingredients and which have demonstrated health benefits), specifically of the fact that these products had been altered from their original state. Participants (~40 years of age) reported that they would prefer to consume what they considered to be ‘natural’ products
(i.e., unaltered milk products), but they believed that over the years milk products had deviated away from their natural state with the addition of bioactive ingredients. As a result, participants were not influenced to purchase milk products by dairy industry media advertising (Nolan-Clark et al., 2011). The prevalence of these concerns in recent studies highlights an increasingly critical attitude of the dairy industry, and a corresponding mistrust of the quality of milk products consumed.

**Gender- and age-related differences in determinants of dietary calcium intake.** Further examination of the literature has revealed gender- and age-related differences regarding determinants of adequate dietary calcium intake. Females were more likely than males to be aware of the nutritional and health benefits, such as the importance of milk for obtaining dietary calcium and for bone health maintenance, of milk and had more positive beliefs about these benefits (Wham & Worsley, 2003). Females also tended to have greater knowledge of the benefits of consuming milk in relation to osteoporosis prevention, whereas males viewed fluid milk as a beverage more suited for the older aging population. Males also reported that they were not convinced the benefits of consuming milk outweighed the high cost, but that they still felt obligated to consume milk (Wham & Worsley, 2003). This attitude is supported by the findings that males more often than females referred to milk product consumption as automatic (Jung et al., 2014), and more frequently emphasized making consumption of milk products habitual as a strategy to increase milk product intake.

As previously noted, women have often cited the high fat content of milk products as a barrier to adequate dietary calcium intake. Bus and Worsley (2003) investigated demographic influences on the health perceptions of milk consumption (n=345, >18 years), reporting that low-fat milk consumption was more frequent among females while a higher proportion of males
consumed whole milk (Bus & Worsley, 2003). This observation is consistent with previous studies that have shown women prefer to consume, low-fat milk or milk products (Cashel et al., 2000; Eddy et al., 1999; Gulliver & Horwath, 2001). Additionally, more females than males have self-reported lactose intolerance (Barr, 2013; Nicklas et al., 2011), with females reporting that they limit milk product intake to avoid gastrointestinal symptoms (Mobley et al., 2014). These findings may suggest that bone health is often not an immediate concern for females, and that other health outcomes, such as weight management or decreasing gastrointestinal symptoms, are a priority.

Jung et al. (2014) reported that the high cost and the short shelf-life of milk products were barriers specific to females (30-55 years). This finding was attributed to the fact that females may be more aware of these factors given that women have traditionally been the ones to regularly grocery shop for the family (Jung et al., 2014). To eliminate these barriers, more females than males frequently suggested that planning, in terms of scheduling and being organized for grocery shopping, would be effective to increase milk product consumption. These gender-specific barriers most often cited in females, combined with established concerns about the high fat content of milk products and perceived lactose intolerance in females, provide opportunities for females to avoid milk products and therefore decrease dietary calcium intake.

Furthermore, determinants of dietary calcium intake differed across age groups. Bus and Worsley (2003) reported that younger participants drank more whole milk than the older participants, and low-fat milk intake increased with age. Participants who did not consume any milk were also older in age. In a similar study, Wham and Worsley (2003) observed that older participants (>53 years) did not enjoy the taste of milk, were less likely to agree that milk had nutritional value, and would rather take supplements than drink milk to meet calcium
recommendations. Alternatively, younger participants (16-30 years) had more positive views towards milk consumption, with many consuming milk because they had done so in their childhood. However, despite these positive attitudes, the availability of competing beverages such as sodas and energy drinks meant that milk was not often a popular choice for young adults (Wham & Worsley, 2003).

Although young adults may be more willing to consume milk products in comparison to older adults, the perception of the importance of adequate dietary calcium intake differs between the age groups. Weiglein et al. (2000) reported that young adult females (19-22 years) associated calcium with bone strength, yet this perception would not influence their dietary calcium intake. Participants discussed that they would be concerned with their bone health later in life when they perceived there to be a greater risk of compromised bone health (Weiglein, 2000). Conversely, studies focusing on older individuals (>52 years) have reported that participants perceived adequate calcium intake as important for their age group for increasing bone density and for the prevention of osteoporosis (Eddy et al., 1999; French, Vernace-Inserra, & Hawker, 2008). The conflicting perceptions between young adults and elderly individuals suggest that motivations to increase dietary calcium intake may depend on the perceived associated risk related to bone health.

**Limitations of previous studies.** Previous studies have quantitatively and qualitatively examined the determinants of dietary calcium and milk product intake in adults. Although many studies have reported a general perception that adequate dietary calcium intake is important for bone health, there have been many reported deterrents including perceived high fat content of milk or milk products (Cashel et al., 2000; Gulliver & Horwath, 2001; Weiglein, 2000); self-perceived lactose intolerance (Barr, 2013; Nicklas et al., 2011); cost (Eddy et al., 1999; Hagy et
al., 2000; Wham & Worsley, 2003); a dislike of the taste of milk products, particularly low-fat options (Eddy et al., 1999; Hagy et al., 2000; Lewis & Hollingsworth, 1992; Weiglein, 2000); and, concerns with adulteration of milk products (Jung et al., 2014). Gender- and age-related differences have also been reported (Bus & Worsley, 2003).

The existing body of literature has been helpful in building a foundation to understand the determinants of dietary calcium intake. However, there are shortcomings in this literature that bear mention. First, the primary focus on older females leaves younger adults, particularly males, under-represented. This is concerning as there is an opportunity during young adulthood for the accumulation of bone mass to maximize bone density and strength (Ross, 2011). Therefore, there is a need to better understand young adults’ underlying motivations to increase dietary calcium intake to inform content for nutrition education interventions and KT initiatives.

Secondly, the common focus on milk in previous studies does not adequately capture the determinants of overall milk product intake. This is an oversight since other milk products such as yogurt and cheese can be large contributors to dietary calcium intake (Johnson-Down, Ritter, Starkey, & Gray-Donald, 2006). Additionally, many studies examine milk or milk products as a surrogate for dietary calcium. The findings of these studies may not reflect current factors that influence dietary calcium intake. This is especially true given the variety of plant-based milk alternatives (e.g., soy, almond), and non-dairy dietary sources that are available to consumers.

Many researchers have used quantitative questionnaires to examine determinants of dietary calcium intake, limiting the interpretation of responses. The few qualitative studies that have been conducted have focused mainly on elderly females and/or facilitators to milk product intake (Eddy et al., 1999; French et al., 2005; Hagy et al., 2000; Jung et al., 2014; Mobley et al., 2014). Two studies have explored perceptions of milk products (Weiglein, 2000) and calcium-
rich food consumption (Lewis & Hollingsworth, 1992) in young female college students. Reported determinants to dietary calcium intake included perceived fat intake of milk products, sensory perceptions (e.g., milk not served cold enough at restaurants), convenience (combining milk products with other foods), and a lack of knowledge of the calcium content of foods (Lewis & Hollingsworth, 1992; Weiglein, 2000). Considering the declining demand for milk in the last 20 years, conflicting messages regarding the benefits of milk products and the increase in plant-based alternative options, factors that may influence dietary calcium intake of present day young adults may differ from those previously reported.

Lastly, we are not aware of studies that have inquired into young adults' suggestions for individual strategies to increase dietary calcium intake. Knowing young adults’ suggestions for potential strategies to increase consumption of calcium-rich foods will help to develop content for nutrition education interventions that is relevant to this population. Also, there are no recent studies that have asked young adults how to convey calcium-related messages to their age group. Lewis and Hollingsworth (1992), reported that young adult females perceived news articles, magazines, radio and television advertisements as efficient modes of communicating nutrition information. However, these findings are outdated with the increasing usage of social media to access health information (Neiger et al., 2012). Determining ways to disseminate calcium-related messaging to present day young adults may be effective in engaging the young adult population to promote adequate dietary calcium intake.
Rationale, Objectives, Hypotheses

There is a scarcity of research examining the determinants of adequate dietary calcium intake in young adults, and as a result, there is little known about the reasons why young adults may or may not be meeting dietary calcium recommendations. The few studies that have examined the factors that influence young adults' dietary calcium intake may not be representative of the perceptions of present day young adults. A better understanding of the factors that may influence dietary calcium intake, particularly the underlying motivations to increase consumption of calcium-rich foods, is the first step towards developing key messages to be used for nutrition education interventions and knowledge translation initiatives. Therefore, we chose to explore the determinants of dietary calcium intake in a young adult population (18-34 years). Our objectives were to:

1. Assess the adequacy of dietary calcium and milk and alternatives intake in a young adult population.
2. Examine young adults' opinions, attitudes and beliefs towards milk products.
3. Explore young adults' knowledge of dietary calcium in relation to health outcomes and the perceived importance for the health of young adults.
4. Determine young adults' suggestions for strategies to increase dietary calcium intake, and suggestions for messaging to engage with young adults to promote adequate dietary calcium intake in this population.

Based on the review of the literature and the findings discussed in the preceding section of this dissertation, our hypotheses were:
1. Many young adults, particularly females in comparison to males, will have inadequate dietary calcium and/or milk and alternatives intake.

2. Young adults will be aware of the bone health benefits of adequate dietary calcium and/or milk product intake, but they will not be aware of the importance of adequate intake for the bone health of their age group.

3. Our findings will capture factors other than those previously reported in the literature that may influence the dietary calcium intake of present-day young adults.

4. There will be gender differences regarding attitudes and beliefs towards, and motivators and deterrents to, dietary calcium intake; based on these differences suggestions for increasing dietary calcium intake will differ by gender as well.
Study #1: Assessing Dietary Calcium and Milk and Alternatives Intake, and Milk Product Health Beliefs, in a Young Adult Population

Abstract

Adequate dietary calcium intake is important during young adulthood, as this is a critical time to optimize peak bone mass and reduce osteoporosis risk. Despite this, many young adults do not meet dietary recommendations for calcium or the milk and alternatives food group. The primary purpose of this study was to assess adequacy of dietary calcium and milk and alternatives intake, and to examine milk product health beliefs, of young adults aged 18 to 34 years. Seventy-nine participants (25 ± 4 years; 40 M & 39 F) completed a 3-day food record and a milk product health belief questionnaire. Approximately one-third of the sample were not meeting dietary calcium recommendations, and 52% of participants were not consuming the milk and alternatives recommendations for their age group. There was uncertainty regarding milk products in relation to health, nutritional value, and weight management. Motivators for milk product consumption included recommendations by a health professional and more research highlighting the benefits of consuming milk products. Potential barriers to milk product consumption included uncertainty regarding what information to believe regarding milk products, perceived adulteration of milk products, and concerns with the humane treatment of dairy cows. Based on $X^2$ analyses, females valued milk's contribution in relation to bone health more than males ($p=0.02$), and were more concerned with the humane treatment of dairy cows ($p<0.01$). Our findings extend the literature by providing an interpretation of the attitudes and beliefs towards, and motivators and barriers to, dietary calcium and milk product intake in the young adult population.

Keywords: Young adults; calcium, dietary intake; milk products; attitudes; nutrition education
Introduction

Calcium is an important nutrient for the development and maintenance of healthy bones (Ross, 2011). Inadequate calcium intake has also been implicated in non-skeletal outcomes such as hypertension (Nicklas et al., 2011), obesity (Tremblay & Gilbert, 2011; Wang, Troy, et al., 2013), colorectal cancer (Larsson et al., 2006), and diabetes (Margolis et al., 2011; O’Connor et al., 2014). Despite this, many young Canadian adults are not meeting the recommendations for dietary calcium (Barr, 2013; Vatanparast et al., 2009). This low intake is concerning, as bone mass for certain skeletal sites can be accumulated into the fourth decade of life (Berger et al., 2010).

In the Canadian diet, milk products typically provide the richest source of dietary calcium; however, Canadians have been least likely to meet their recommended intakes for milk and alternatives out of all the food groups in the Eating Well with Canada’s Food Guide (EWCFG) (Johnson-Down et al., 2006). Contributors to inadequate milk and alternatives intake may include the decline of milk consumption in Canada in the last 20 years (CDIC, 2013), competition of non-milk product beverages such as juice or soda (Wingrove, 2004), and consumer confusion regarding information that is disseminated about milk products in the media (Cash, 2005). Plant-based milk alternatives are available to consumers, but these beverages amount to just less than 4 % of other types of “milk” consumed in Canada (Garriguet, 2008). Thus, there is a need to identify the attitudes and beliefs towards, and the motivators and deterrents of, milk product intake in the young adult population.

Previous studies have examined the determinants of dietary calcium and/or milk product intake in adults. Reported deterrents included perceived high fat content of milk or milk products
(Cashel et al., 2000; Gulliver & Horwath, 2001; Weiglein, 2000); self-perceived lactose intolerance (Barr, 2013; Nicklas et al., 2011); lack of knowledge of calcium-rich food sources (French et al., 2005); cost (Eddy et al., 1999; Hagy et al., 2000; Wham & Worsley, 2003); a dislike of the taste of milk or milk products, particularly low-fat options (Eddy et al., 1999; Hagy et al., 2000; Lewis & Hollingsworth, 1992; Weiglein, 2000); and, concerns with adulteration of milk products (Jung et al., 2014). Deterrents to adequate dietary calcium and/or milk product intake have also been reported to differ between males and females (Bus & Worsley, 2003; Jung et al., 2014). Although the literature has identified the determinants of dietary calcium intake in adults, the young adult population has not been thoroughly examined. As well, previous studies have mainly examined the attitudes and beliefs of strictly milk, which does not adequately capture the factors that may influence intake of other milk products such as cheese or yogurt.

Identifying potential barriers to dietary calcium and/or milk product intake is key for health professionals to inform individual counselling strategies, and to better target population-specific nutrition education initiatives. Therefore, the purpose of this study was to assess the adequacy of dietary calcium and milk and alternatives intake, and to identify milk product health beliefs, of young adults aged 18 to 34 years.

**Materials and Methods**

**Participants and recruitment.** Participants were recruited for the Calcium and Dairy Intake Assessment Study (CADIA) from May to August 2012 and September 2013 to February 2014. This study was a cross-sectional, exploratory study, conducted to assess young adults’ dietary calcium intake, milk and alternatives intake, and milk product health beliefs. A sample size of 51 participants per gender group was determined using G*Power (version 3.0.10, UCLA) based on recommended guidelines ($\alpha = .05$, power = .8, medium effect size = .5) (Field, 2009a).
Seventy-nine participants (40M, 39F) were recruited from Guelph, ON and surrounding communities via poster campaigns, flyers posted on community boards in local businesses, websites such as www.kijiji.com, and word of mouth (refer to appendix A). Potential participants were screened by e-mail or telephone for eligibility. Inclusion criteria required participants to be aged 18 to 34 years. Participants were excluded if they self-reported as vegan (i.e., avoidance of all milk products and animal sources). This study was approved by the University of Guelph Research Ethics Board, and all participants provided written informed consent prior to study enrolment (refer to appendix B). Participants were provided with a $10 grocery gift card at the end of the study visit.

**Measurements.** The study took place at the University of Guelph Body Composition and Metabolism Lab. Participants completed a questionnaire that included demographic information such as age, gender, and highest level of education, and the section of the validated Nutrition and Health: Canadian Adults’ Opinions and Practices questionnaire that included questions regarding milk product health beliefs (refer to appendix C) (Barr 2013). The three categories of the milk product health beliefs questionnaire included for the CADIA study were: (1) health-related opinions, attitudes and beliefs towards milk products; (2) potential barriers to milk product consumption reflected by the opinions, attitudes and beliefs towards milk products; and, (3) factors that may affect milk product consumption in participants. Participants responded to the statements in each category on a 5-point Likert-type scale. Responses from categories (1) and (2) ranged from “disagree strongly” to “agree strongly,” and from category (3), responses ranged from "definitely no effect" to "definitely would increase." Anthropometric, body composition, physical activity and body image measurements were also taken (data not shown, refer to appendix D).
Participants were instructed to complete a 3-day food record (refer to appendix E), which included two consecutive weekdays and one weekend day that participants felt closely resembled their usual eating habits. Food records were e-mailed prior to the study visit and participants were provided with detailed instructions regarding how to complete the food records. Instructions included providing conversions for typical household measures, an example of a recorded menu, and directions for estimating portion sizes. Participants were instructed to record detailed descriptions (i.e., quantity, method of preparation, brand name) of any, and all, beverages, food items, and supplements consumed. During the study visit, food records were reviewed by a trained research assistant (H.A.S.) to ensure completion. Food records were analyzed by the PhD student investigator (M.L.M), using the ESHA Food Processor (version 10, ESHA Research, Salem, OR), to calculate energy and dietary nutrient intakes for each of the three days. A trained research assistant (R.H.) calculated the number of servings per day consumed from the four food groups of the EWCFG (i.e., vegetables and fruit, grain products, milk and alternatives, meat and alternatives).

**Statistical analysis.** Statistical analysis was performed using PASW Statistics for Windows (version 20.0, SPSS Inc., Chicago, IL). Descriptive statistics were used to determine demographic characteristics of participants, and the mean ± standard deviation (SD) of energy and nutrient intakes from food, as well as food group servings. The Shapiro-Wilk test was used to test the data for normality; nutrient distributions were found to be non-normal. To normalize the data, the raw nutrient intake values were transformed. Two different transformations were done with the raw data (log transformation and square root transformation); however, due to an inability to normalize the data non-parametric tests were used for further analyses (Field, 2009b).
The non-parametric Spearman's rank-order correlation was used to explore the relationship between dietary calcium and nutrient intakes (macro- and micronutrient), as well as the relationship with the food group servings from the EWCFG. A one-way ANOVA was used to compare dietary characteristics (i.e., energy, macro- and micronutrient intakes, servings of each food group in EWCFG) between genders using the Welch's F-ratio (used when the homogeneity of variance assumption has been violated). A p value ≤ 0.05 was considered significant. To control for energy intake the nutrient density approach was used, in which nutrient and food group intakes were divided by total energy intake and expressed per 1000 kcal (Willett, Howe, & Kushi, 1997). The effect sizes (ω) were hand calculated for analyses with adjusted intakes using the square root of the following formula (Field, 2009b):

\[ \omega^2 = \frac{SS_{Effect} - (df_{Effect})(MS_{Error})}{SS_{Total} + MS_{Error}} \]

To determine the percentage of participants at risk for inadequate dietary calcium intake and other micronutrients, the PC Software for Intake Distribution Estimation (PC-Side, version 1.0, Iowa City, Iowa) was used to adjust for day-to-day variation in intakes (refer to appendix F) (IOM, 2000). The prevalence of inadequate intakes was then estimated using the Estimated Average Requirement (EAR) cut-point method (IOM, 2000) for nutrients for which an EAR has been set (refer to Appendix G), differentiating by gender. Since the EAR cut-point method is not well suited for the estimation of prevalence's of inadequacy at the tails of the distribution (IOM, 2000), only the prevalence estimates of 10% or higher are reported. The full probability approach to estimate the prevalence of iron was used to account for the typical skewed requirement distribution of this nutrient (IOM, 2000). The distribution of requirements for menstruating
females in a mixed population was used for females in our sample, as 15% of female participants reported use of an oral contraceptive (refer to appendix H). The probabilities of inadequate iron intakes and associated ranges of usual intakes in a mixed female population assumes that 17% are oral contraceptive users and 83% are non-oral contraceptive users (IOM, 2000).

Frequency tables were developed to determine the percentage agreement of participant responses to each of the statements of the milk product health belief questionnaire. A Pearson's chi-square test was used to determine if a relationship existed between males and females and whether or not there was agreement with each statement.

Results

Demographics and dietary characteristics. Seventy-nine participants (40M, 39F) aged 25 ± 4 years met the eligibility criteria and were included in analyses. In general, the study sample consisted of mainly Caucasian (84%), well-educated individuals. There were no significant differences related to demographics noted between genders. Demographic characteristics of participants are summarized in Table 1.

Table 1: Demographic Characteristics of Participants Enrolled in the Calcium and Dairy Intake Assessment Study (CADIA) Study

<table>
<thead>
<tr>
<th></th>
<th>Group (n=79)</th>
<th>Males (n=40)</th>
<th>Females (n=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>25 ± 4</td>
<td>26 ± 4</td>
<td>24 ± 4</td>
</tr>
<tr>
<td>Ethnicity n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>66 (84)</td>
<td>34 (85)</td>
<td>32 (82)</td>
</tr>
<tr>
<td>Non-Caucasian</td>
<td>13 (16)</td>
<td>6 (15)</td>
<td>7 (18)</td>
</tr>
<tr>
<td>Highest Level of Education n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School</td>
<td>19 (24)</td>
<td>7 (18)</td>
<td>12 (31)</td>
</tr>
<tr>
<td>College/University</td>
<td>41 (52)</td>
<td>25 (62)</td>
<td>16 (41)</td>
</tr>
<tr>
<td>Post-Graduate</td>
<td>19 (24)</td>
<td>8 (20)</td>
<td>11 (28)</td>
</tr>
</tbody>
</table>
Dietary characteristics of participants are summarized in Tables 2-4. The majority of participants greater than 19 years of age (97%) consumed protein in quantities within the Acceptable Macronutrient Distribution Range (AMDR) set for protein for this age group (10-35%). Both 18 year old participants were also within an acceptable range for their age group (10-30%). With respect to carbohydrates, a smaller proportion of participants (62%) greater than 19 years of age consumed quantities within AMDRs set for carbohydrates (45-65%). No participants exceeded the AMDR for carbohydrate. As well, both 18 year old participants fell within an acceptable range (45-65%). With respect to total fat intake, 61% of participants greater than 19 years of age consumed quantities within AMDRs set for fat (20-35%), with 38% consuming above this range and 1% consuming below. One of the 18 year olds was above the acceptable range, while the other fell just below the acceptable range (25-35%). Males had significantly higher energy intakes than female participants. Males had significantly higher intakes than females for all the macronutrients; when adjusted for energy intake males had significantly higher intakes of protein than females, while females had higher intakes of carbohydrates (Table 2).

The prevalence of inadequate micronutrient intakes for the group was the highest for vitamin D (91%), folate (48%) and calcium (32%). A low prevalence of inadequate intake was observed for phosphorus for the entire sample (<10%). There was a higher proportion of females with a prevalence of inadequacy for vitamin D, folate, calcium, vitamin A, and zinc in comparison to males. Low prevalence of inadequacy was observed in males for the B vitamins. Similar observations were made in females for riboflavin and niacin, with a slightly higher proportion of females than males who were inadequate in the other B vitamins (thiamin, vitamin
B₆ and B₁₂). For both genders the prevalence of inadequate magnesium intakes were similar (Table 3). When comparing mean intakes between gender, males were consuming significantly consuming higher amounts of the micronutrients than females with the exception of vitamin C, vitamin B₁₂, and sodium. When adjusted for energy intake females were only getting significantly more of vitamin C than males (Table 3).

In comparison to findings from the most recent Canadian national 2004 CCHS data for young adults (19-30 years) (Kirkpatrick & Tarasuk, 2008; Vatanparast et al., 2009), both genders in our sample had a similar prevalence of inadequacy for many micronutrients, with the exception of a larger proportion of participants in our sample being inadequate for zinc and folate. A smaller proportion of males in our sample had inadequate intakes of vitamin A and calcium, and a larger proportion of females in our sample had inadequate intake of thiamin, in comparison to the CCHS participants (Table 4).

Within the Milk and Alternatives food group, 85% of participants consumed only milk products, 11% consumed strictly plant-based milk alternatives (e.g., soy, almond or rice), and 4% consumed a combination of milk and alternatives. The mean milk and alternatives intake for the study sample was 2.2 ± 1.7 servings per day. Approximately 52% of participants did not meet the EWCFG recommendations of milk and alternatives for their age group. Furthermore, greater than 80% of participants were not meeting the recommended servings of either the fruit and vegetable or grain product food groups; 29% were not meeting recommendations for meats and alternatives (Table 5) (Health Canada, 2011). Males were consuming significantly more foods from all the food groups, except for vegetables and fruit, than females; when adjusted for energy intake, males were significantly consuming more meat and alternatives than females, while females consumed more vegetables and fruits and (Table 5).
With respect to the macronutrients, dietary calcium intake was positively associated with protein, carbohydrate, fat, but not fibre intake; dietary calcium intake adjusted for energy was positively associated with protein intake (Table 6). Dietary calcium intake was positively associated with intake of all micronutrients except vitamin C. When adjusted for energy intake, dietary calcium intake was positively associated with intakes of vitamin A, riboflavin, vitamin B₁₂, vitamin D, phosphorus and zinc (Table 7). Dietary calcium intake was positively associated with intake of all food groups with the exception of vegetables and fruit; dietary calcium was only positively associated with the milk and alternatives food group when adjusted for energy intake (Table 8). Furthermore, dietary calcium intakes were compared between participants who were either meeting, or not meeting, the EWCFG recommendations for each food group. The only significant difference observed was for mean dietary calcium intakes between those who were meeting the EWCFG recommendations for milk and alternatives (1439 mg/d) and those who were not (745 mg/d) [F(1,77) = 54.7, p<0.001, w = 0.71].

Table 2: Mean Energy and Macronutrient Intakes from 3-day Food Records of Calcium and Dairy Intake Assessment Study (CADIA) Participants

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>Males</th>
<th>Females</th>
<th>p-value</th>
<th>p-value adj</th>
<th>w</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy, kcal</strong></td>
<td>2542 ± 864</td>
<td>3054 ± 859</td>
<td>2016 ± 465</td>
<td>&lt;0.001</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>Protein, g</strong></td>
<td>119 ± 63</td>
<td>155 ± 64</td>
<td>82 ± 33</td>
<td>&lt;0.001</td>
<td>0.001</td>
<td>0.36</td>
</tr>
<tr>
<td><strong>Carbohydrate, g</strong></td>
<td>288 ± 102</td>
<td>327 ± 115</td>
<td>249 ± 67</td>
<td>&lt;0.001</td>
<td>0.001</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>Fat, g</strong></td>
<td>98 ± 39</td>
<td>117 ± 41</td>
<td>77 ± 23</td>
<td>&lt;0.001</td>
<td>0.88</td>
<td>--</td>
</tr>
<tr>
<td><strong>Fibre, g</strong></td>
<td>27 ± 10</td>
<td>28 ± 10</td>
<td>25 ± 10</td>
<td>0.14</td>
<td>0.001</td>
<td>0.35</td>
</tr>
</tbody>
</table>

* Values are mean ± SD; A p value ≤ 0.05 was considered significant; n=79
* p-values derived from a one-way ANOVA using the Welch's F-ratio for gender comparison of macronutrient intakes adjusted for energy intake (per 1000 kcal).
* Effect size hand calculated for energy adjusted significant findings.
Table 3: Mean Micronutrient Intakes from 3-day Food Records of Calcium and Dairy Intake Assessment Study (CADIA) Participants\textsuperscript{a} and Prevalence of Micronutrient Inadequacy for Nutrients with an EAR\textsuperscript{b,c}

<table>
<thead>
<tr>
<th>Group</th>
<th>%&lt;EAR\textsuperscript{d}</th>
<th>Males</th>
<th>%&lt;EAR</th>
<th>Females</th>
<th>%&lt;EAR</th>
<th>P-value</th>
<th>p-value adj\textsuperscript{e}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A, RAE</td>
<td>825.9 ± 600.7</td>
<td>--</td>
<td>932.3 ± 633.0</td>
<td>&lt;10</td>
<td>716.9 ± 552.6</td>
<td>35</td>
<td>0.11</td>
</tr>
<tr>
<td>Vitamin D, µg</td>
<td>5.1 ± 5.0</td>
<td>91</td>
<td>6.5 ± 6.1</td>
<td>81</td>
<td>3.7 ± 3.1</td>
<td>99</td>
<td>0.01</td>
</tr>
<tr>
<td>Vitamin C, mg</td>
<td>130.2 ± 89.7</td>
<td>--</td>
<td>135.2 ± 89.5</td>
<td>18</td>
<td>125.2 ± 90.8</td>
<td>2</td>
<td>0.63</td>
</tr>
<tr>
<td>Thiamin, mg</td>
<td>1.4 ± .89</td>
<td>--</td>
<td>1.6 ± 0.78</td>
<td>&lt;10</td>
<td>1.3 ± 1.3</td>
<td>28</td>
<td>0.08</td>
</tr>
<tr>
<td>Riboflavin, mg</td>
<td>2.0 ± 1.0</td>
<td>--</td>
<td>2.3 ± 1.1</td>
<td>&lt;10</td>
<td>1.6 ± 1.6</td>
<td>&lt;10</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Niacin, mg</td>
<td>23.5 ± 14.7</td>
<td>--</td>
<td>29.7 ± 13.1</td>
<td>&lt;10</td>
<td>17.2 ± 13.6</td>
<td>&lt;10</td>
<td>0.001</td>
</tr>
<tr>
<td>Vitamin B6, mg</td>
<td>1.9 ± 1.1</td>
<td>--</td>
<td>2.4 ± 1.0</td>
<td>&lt;10</td>
<td>1.6 ± 1.1</td>
<td>17</td>
<td>0.006</td>
</tr>
<tr>
<td>Vitamin B12, µg</td>
<td>4.7 ± 4.4</td>
<td>11</td>
<td>6.0 ± 4.4</td>
<td>&lt;10</td>
<td>3.3 ± 4.0</td>
<td>12</td>
<td>0.63</td>
</tr>
<tr>
<td>Folate, µg</td>
<td>347.6 ± 182.1</td>
<td>48</td>
<td>417.3 ± 200.8</td>
<td>29</td>
<td>288.9 ± 150.9</td>
<td>66</td>
<td>0.004</td>
</tr>
<tr>
<td>Calcium, mg</td>
<td>1078.6 ± 597.8</td>
<td>32</td>
<td>1316.1 ± 682.5</td>
<td>15</td>
<td>835.1 ± 367.7</td>
<td>52</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Iron, mg</td>
<td>18.1 ± 9.6</td>
<td>--</td>
<td>20.8 ± 9.2</td>
<td>&lt;10</td>
<td>15.2 ± 9.3</td>
<td>14</td>
<td>0.01</td>
</tr>
<tr>
<td>Magnesium, mg</td>
<td>307.6 ± 124.5</td>
<td>--</td>
<td>344.9 ± 574.7</td>
<td>45</td>
<td>269.4 ± 122.8</td>
<td>53</td>
<td>0.006</td>
</tr>
<tr>
<td>Phosphorus, mg</td>
<td>1257.6 ± 552.3</td>
<td>&lt;10</td>
<td>1522.8 ± 1384.9</td>
<td>&lt;10</td>
<td>985.6 ± 370.2</td>
<td>&lt;10</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Zinc, mg</td>
<td>11.4 ± 9.3</td>
<td>--</td>
<td>13.7 ± 8.1</td>
<td>19</td>
<td>9.0 ± 8.9</td>
<td>33</td>
<td>0.02</td>
</tr>
<tr>
<td>Potassium, mg</td>
<td>2947.8 ± 1432.6</td>
<td>n/a</td>
<td>4213.8 ± 1384.9</td>
<td>n/a</td>
<td>2622.3 ± 1424.7</td>
<td>n/a</td>
<td>0.05</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Values are means ± SD; A p value ≤ 0.05 was considered significant; n=79
\textsuperscript{b} Values are represented as a percent (%). Prevalence of inadequacy was calculated using the EAR cut-point method, with the exception of iron for which the probability approach was used.
\textsuperscript{c} n=79 for nutrients where the EAR is the same for 18 years and older; n=77 for nutrients where the EAR is different for 18 year olds and 19+, as prevalence of inadequacy cannot be determined for <30 individuals.
\textsuperscript{d} Group prevalence of inadequacy was determine for nutrients with an EAR that is the same across gender.
\textsuperscript{e} p-values derived from a one-way ANOVA using the Welch's F-ratio for gender comparison of micronutrient intakes adjusted for energy intake (per 1000 kcal).
\textsuperscript{f} Effect size hand calculated for energy adjusted significant finding.
Table 4: Prevalence of Micronutrient Inadequacy for Nutrients (%) of Calcium and Dairy Intake Assessment Study (CADIA) (CADIA) and the Canadian Community Health Survey (CCHS)\textsuperscript{a} participants

<table>
<thead>
<tr>
<th></th>
<th>CADIA Males</th>
<th>CCHS Males</th>
<th>CADIA Females</th>
<th>CCHS Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A, RAE</td>
<td>&lt;10</td>
<td>46</td>
<td>35</td>
<td>39</td>
</tr>
<tr>
<td>Vitamin C, mg</td>
<td>18</td>
<td>18</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Thiamin, mg</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>28</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Riboflavin, mg</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Niacin, mg</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Vitamin B6, mg</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>17</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Vitamin B12, µg</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Folate, µg</td>
<td>29</td>
<td>&lt;10</td>
<td>66</td>
<td>17</td>
</tr>
<tr>
<td>Iron, mg</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Magnesium, mg</td>
<td>45</td>
<td>34</td>
<td>53</td>
<td>34</td>
</tr>
<tr>
<td>Phosphorus, mg</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Zinc, mg</td>
<td>19</td>
<td>&lt;10</td>
<td>33</td>
<td>12</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Data analyzed from the 2004 CCHS data for food secure young adult males and females (19-30 y) for nutrients with an EAR (Kirkpatrick & Tarasuk, 2008).

Table 5: Consumption of food groups from Eating well with Canada's Food Guide from 3-day Food Records of Calcium and Dairy Intake Assessment Study (CADIA) participants\textsuperscript{a}

<table>
<thead>
<tr>
<th>Food Groups</th>
<th>Group</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Servings, n</td>
<td>% &lt;CFG</td>
<td>Servings, n</td>
</tr>
<tr>
<td>Vegetables and Fruit</td>
<td>5.6 ± 2.6</td>
<td>82</td>
<td>5.8 ± 2.6</td>
</tr>
<tr>
<td>Grain Products</td>
<td>5.3 ± 2.6</td>
<td>80</td>
<td>6.3 ± 2.8</td>
</tr>
<tr>
<td>Milk and Alternatives</td>
<td>2.2 ± 1.7</td>
<td>52</td>
<td>2.7 ± 1.9</td>
</tr>
<tr>
<td>Meat and Alternatives</td>
<td>3.7 ± 3.2</td>
<td>29</td>
<td>5.2 ± 3.9</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Values are means ± SD; A p value ≤ 0.05 was considered significant; n=79
\textsuperscript{b} p-values derived from a one-way ANOVA using the Welch’s F-ratio for gender comparison of EWCFG intakes adjusted for energy intake (per 1000 kcal).
\textsuperscript{c} Effect size hand calculated for energy adjusted significant finding.
Table 6: Spearman’s Rank Order Correlation ($r_s$) for Dietary Calcium and Macronutrients$^{a,b}$

<table>
<thead>
<tr>
<th></th>
<th>Protein</th>
<th>Carbohydrate</th>
<th>Fat</th>
<th>Fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>.416**</td>
<td>-.185</td>
<td>.068</td>
<td>-.066</td>
</tr>
<tr>
<td>Protein</td>
<td>-.496**</td>
<td>-.046</td>
<td>-.035</td>
<td></td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>-.117</td>
<td>-.010</td>
<td>-.171</td>
<td>-.188</td>
</tr>
<tr>
<td>Fat</td>
<td></td>
<td>.440**</td>
<td>-.156</td>
<td></td>
</tr>
</tbody>
</table>

$^a$ Spearman's Rank Order Correlation analyses done using energy adjusted intakes (per 1000 kcal).

$^b$ ** p-value < 0.01

Table 7: Spearman’s Rank Order Correlation ($r_s$) for Dietary Calcium and foods from Eating Well with Canada’s Food Guide$^{a,b}$

<table>
<thead>
<tr>
<th></th>
<th>Vegetables and Fruit</th>
<th>Grain Products</th>
<th>Milk and Alternatives</th>
<th>Meat and Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary Calcium</td>
<td>.065</td>
<td>-.202</td>
<td>.767**</td>
<td>-.035</td>
</tr>
<tr>
<td>Vegetables and Fruit</td>
<td>-.117</td>
<td>-.010</td>
<td>.033</td>
<td></td>
</tr>
<tr>
<td>Grain Products</td>
<td>-.171</td>
<td>-.188</td>
<td></td>
<td>-.126</td>
</tr>
</tbody>
</table>

$^a$ Spearman’s Rank Order Correlation analyses done using energy adjusted intakes (per 1000 kcal).

$^b$ ** p-value < 0.01
Table 8: Spearman’s Rank Order Correlation ($r_s$) for Dietary Calcium and Micronutrients\textsuperscript{a,b}

<table>
<thead>
<tr>
<th>Vitamin/Mineral</th>
<th>Vit A</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B6</th>
<th>$B_{12}$</th>
<th>Vit C</th>
<th>Vit D</th>
<th>Folate</th>
<th>Iron</th>
<th>Mg</th>
<th>P</th>
<th>K</th>
<th>Na</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (Ca)</td>
<td>.283*</td>
<td>.193</td>
<td>.539*</td>
<td>.027</td>
<td>.094</td>
<td>.475**</td>
<td>-.058</td>
<td>.369*</td>
<td>.110</td>
<td>.122</td>
<td>.088</td>
<td>.424*</td>
<td>.150</td>
<td>.136</td>
<td>.331**</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>.269*</td>
<td>.396**</td>
<td>.090</td>
<td>.396**</td>
<td>.267*</td>
<td>.276*</td>
<td>.305**</td>
<td>.341**</td>
<td>.219</td>
<td>.421**</td>
<td>.495**</td>
<td>.472**</td>
<td>-.113</td>
<td>.137</td>
<td></td>
</tr>
<tr>
<td>Thiamin (B1)</td>
<td>.613**</td>
<td>.270*</td>
<td>.468**</td>
<td>.268*</td>
<td>.022</td>
<td>.216</td>
<td>.625**</td>
<td>.407**</td>
<td>.374**</td>
<td>.498**</td>
<td>.370**</td>
<td>.077</td>
<td>.415**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riboflavin (B2)</td>
<td>.358**</td>
<td>.494**</td>
<td>.662**</td>
<td>.016</td>
<td>.479**</td>
<td>.565**</td>
<td>.372**</td>
<td>.434**</td>
<td>.635**</td>
<td>.437**</td>
<td>.011</td>
<td>.555**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Niacin (B3)</td>
<td>.677**</td>
<td>.495**</td>
<td>-.072</td>
<td>.283*</td>
<td>.288*</td>
<td>.059</td>
<td>.206</td>
<td>.465**</td>
<td>.248**</td>
<td>-.121</td>
<td>.350**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>.486**</td>
<td>.239*</td>
<td>.389**</td>
<td>.462**</td>
<td>.281*</td>
<td>.513**</td>
<td>.635**</td>
<td>.611**</td>
<td>-.233*</td>
<td>.508**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>.103</td>
<td>.540**</td>
<td>.292**</td>
<td>.191</td>
<td>.217</td>
<td>.563**</td>
<td>.280*</td>
<td>-.004</td>
<td>.714**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin C</td>
<td>.134</td>
<td>-.015</td>
<td>.002</td>
<td>.440**</td>
<td>.242*</td>
<td>.481**</td>
<td>-.268*</td>
<td>.220</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin D</td>
<td>.233*</td>
<td>.215</td>
<td>.293*</td>
<td>.559**</td>
<td>.370**</td>
<td>-.147</td>
<td>.352**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Folate</td>
<td>.305**</td>
<td>.348**</td>
<td>.383**</td>
<td>.455**</td>
<td>-.149</td>
<td>.380**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>.374**</td>
<td>.302**</td>
<td>.282*</td>
<td>-.055</td>
<td>.394**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>.673**</td>
<td>.703**</td>
<td>-.343**</td>
<td>.457**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>.611**</td>
<td>-.204</td>
<td>.577**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>-.280*</td>
<td>.419**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>-.072</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a} Spearman’s Rank Order Correlation analyses done using energy adjusted intakes (per 1000 kcal).

\textsuperscript{b} * p-value < 0.05; ** p-value < 0.01
**Opinions, attitudes, and beliefs towards milk products.** Figure 5 presents the opinions, attitudes and beliefs of participants regarding milk products and the perceived implications of milk products in relation to health. The majority of participants (78%) acknowledged that milk products are important to the health of young adults, and many (63%) understood the importance of milk products for bone health. Not surprisingly, 76% of participants were in favour of including milk products as part of a healthy diet. This may be reflective of the 71% of participants who agreed that they would rather obtain calcium from milk products versus supplements. There was a significant association between gender and the statement "*Increasing my milk product intake would help me maintain stronger bones,*" ($X^2 (2) = 7.65, p=0.02$). This finding reflects the fact that more females agreed with this statement than males (72% vs. 55%).

Figure 6 presents potential barriers to milk product consumption. Overall, 37% of participants expressed uncertainty regarding milk products, demonstrated by the varying agreement in responses related to: organic milk products being more beneficial versus traditional milk products (35% agree, 33% neutral, 32% disagree); milk products providing extra unwanted calories (23% agree, 55% neutral, 22% disagree); and, milk products contain added antibiotics and/or hormones (33% agree, 30% neutral, 37% disagree). Despite this, a large majority of participants appeared to enjoy the taste of cheese and/or yogurt (95%) and milk (75%). No gender differences were noted.

Figure 7 presents the factors that may potentially affect participants’ milk product consumption. In general, milk product intake did not appear to be notably influenced by more attractive packaging, longer shelf life, or availability of milk products. However, 51% of participants indicated that lowering the cost of milk products would most likely increase their intake. Furthermore, 47% of participants indicated they would be more likely to increase their
milk product intake if recommended to do so by a health care provider. Conversely, of these participants, 57% stated they would increase their intake only if there were more studies exemplifying the benefits of consuming milk products for health. There was a significant association between gender and the statement "...more likely to increase my intake of milk products if was confident they do not contain antibiotics or unnatural hormones, " ($X^2(2) = 5.80, p=0.05$); noted more so in females than males (46% vs. 23%). There was also an association between gender and the statement "...more likely to increase my intake of milk products if I was confident cows were humanely treated," ($X^2(2) = 11.97, p<0.01$). Similarly, more females than males agreed with this statement (54% vs. 20%).
I’d rather get the calcium and vitamin D I need from supplements than from milk products.

Milk products are NOT important to the health of adults of my age.

In my opinion, a diet that includes milk products is healthier than one without milk products.

Overall, I think I would be healthier if I kept my milk product intake to a minimum.

Increasing my milk product intake would help me maintain stronger bones.

I would feel I was looking after myself if I had more milk products every day.

It’s easy to get the nutrients you need without using any milk products in your diet.

Figure 5: Calcium and Dairy Intake Assessment (CADIA) participants' health-related opinions, attitudes and beliefs of milk products (n=79).
<table>
<thead>
<tr>
<th>Statement</th>
<th>Disagree Strongly/Disagree</th>
<th>Neutral</th>
<th>Agree Strongly/Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk products are hard for me to digest</td>
<td>20%</td>
<td>0%</td>
<td>80%</td>
</tr>
<tr>
<td>Overall, I think organic milk products are better for me than conventional milk products.</td>
<td>40%</td>
<td>20%</td>
<td>40%</td>
</tr>
<tr>
<td>Having more milk products would provide extra calories I'd rather not have.</td>
<td>60%</td>
<td>0%</td>
<td>40%</td>
</tr>
<tr>
<td>Milk products are important to include when people are trying to control their weight.</td>
<td>30%</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>There are so many different things being said about milk products that it's hard to know what I should believe.</td>
<td>30%</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>I don't like the taste of milk.</td>
<td>20%</td>
<td>60%</td>
<td>20%</td>
</tr>
<tr>
<td>I enjoy the taste of cheese and/or yogurt.</td>
<td>40%</td>
<td>60%</td>
<td>0%</td>
</tr>
<tr>
<td>Milk is expensive compared to other beverages.</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>I think that milk products contain antibiotics and unnatural hormones.</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Figure 6:** Potential barriers to milk product consumption reflected by the opinions, attitudes and beliefs of Calcium and Dairy Intake Assessment (CADIA) participants (n=79).
Figure 7: Factors that may affect milk product consumption in Calcium and Dairy Intake Assessment (CADIA) participants (n=79).
Discussion

The main findings of our research suggest that in a well-educated group of young adults, there was uncertainty regarding milk products in relation to health, nutritional value, and weight management; these factors may be potential barriers to increasing milk product intake in young adults. Approximately, one-third of participants aged 19 years and older were not meeting dietary calcium recommendations, with 52% of participants not meeting recommendations for milk and alternatives for their age group. Participants who were meeting recommendations for milk and alternatives had significantly higher dietary calcium intake than those who did not meet recommendations. Potential motivators for milk product consumption included recommendations by a health professional, more research highlighting the benefits of consuming milk products and less expensive milk products. Females had more positive views regarding milk products in relation to bone health than males. As well, more female participants than male participants would be motivated to increase milk product intake if they were confident that milk products did not have added antibiotics and/or hormones and that dairy cows were humanely treated.

Attitudes and beliefs towards milk products. The majority of participants acknowledged the contribution of milk products in relation to bone health and would prefer to consume milk products to obtain dietary calcium. However, participants expressed uncertainty about whether milk products are important for weight control, whether organic versus traditional milk products are healthier, and whether they contain antibiotics and/or unnatural hormones. The uncertainty towards the role milk products play in weight management is not surprising, as previous research studies have cited individuals' concerns regarding the fat content of milk products (Cashel et al., 2000; Eddy et al., 1999; Gulliver & Horwath, 2001; Hagy et al., 2000; Weiglein, 2000). However, low-fat milk products have been associated with improved diet
quality and weight management in young adults (Poddar et al., 2009), and many studies support an inverse relationship between dietary calcium intake and body fat (Jacqmain et al., 2003; Skinner et al., 2011). Therefore, educational materials should promote low-fat or fat free milk product options to increase dietary calcium intake among young adults.

As well, the lack of knowledge about whether organic milk products are healthier than traditional milk products is not surprising. There is limited research examining the nutritional quality of organic versus conventional milk products in relation to health outcomes. A meta-analysis was conducted by Palupi et al. (2012) to examine the differences between organic versus conventional milk products. Compared to conventional milk products, organic milk products were found to have significantly higher protein, alpha lipoic acid, total omega-3 fatty acid, eicosapentaenoic acid, docosapentaenoic acid, \( trans-11 \) vaccenic acid, and \( cis-9,trans-11 \) conjugated linoleic acid. This clinical implications of these findings were unclear (Palupi, Jayanegara, Ploeger, & Kahl, 2012). Data from experimental models suggest that trans fatty acids found in ruminant-derived foods (e.g., vaccenic acid and \( cis-9,trans-11 \) and conjugated linoleic acid) may have an inverse association with the risk of cardiovascular disease and cancer (Gebauer et al., 2011); yet, data arising from clinical human trials are not consistent with findings from the experimental studies (Gebauer et al., 2011). Furthermore, a systematic review published in 2012 found that organic milk products had higher levels of omega-3 fatty acids and total phenols. Unfortunately, the clinical significance of these differences was not reported in the studies examined for the review. The researchers concluded that the published literature was lacking in strong evidence to support that organic milk products are more nutritious than conventional milk products (Smith-Spangler et al., 2012). Therefore, based on the limited
evidence, it is not possible to inform young adult consumers whether or not they should be consuming organic milk products based on health outcomes.

Although the health benefits of organic milk products is not well substantiated, the farming production methods are distinctly different between organic and conventional milk products. Organic Canadian dairy farmers must strictly follow the Canadian Organic Standards, which indicate that dairy cattle must be raised in living conditions that better mimic their natural environment (AAFC, 2012). Generally, a certified organic milk product must meet the following conditions: 1) grown without the use of toxic or persistent synthetic pesticides, herbicides, fungicides or fertilizers; 2) produced without fossil fuel (nitrogen) based fertilizers or sewage sludge and without nanotechnology; 3) produced without the use of synthetic growth hormones or antibiotics; and, 4) produced under humane animal health and welfare standards, including having outdoor access for the dairy cattle (AAFC, 2012). Thus, the decision to choose organic rather than conventional milk products would depend on an individuals’ personal preference in relation to the farming practices and methods of milk production.

In Canada, growth hormones are not permitted in any circumstance in either organic or conventional milk products, but antibiotics are permitted for use in the case of illness (OMAFRA, 2013). The dairy cow undergoing antibiotic treatment must be clearly identified, and the farmer must discard the milk for a mandatory withdrawal period until the dairy cow's system has cleared the medication. The Ontario Ministry of Agriculture, Food and Rural Affairs has a program in place to conduct random testing of milk from every dairy producer once a month. This program routinely tests for antibiotics most commonly used in treatment of animal diseases. Very strict penalties apply if regulations are not met (OMAFRA, 2013). Additionally, the Canadian Food Inspection Agency has the authority to sample and test both domestic and
imported milk products to provide consumers with the confidence that milk products sold in Canada are safe for consumption (CFIA, 2013).

However, in moving forward there will be challenges with consumer perceptions of adulteration of milk products. These concerns are due to the recent agreement in principle reached on October 5th, 2015 that will allow increased imports of milk products from the United States under the terms of the Trans-Pacific Partnership trade deal. The biggest concern is that the bovine growth hormone is illegal in Canada to administer to dairy cattle to boost milk production, but no such restrictions exist in the United States. Therefore, the Dairy Farmers of Canada are lobbying to have stricter labelling in place for food products that will clearly identify the origin of milk ingredients (McGregor, 2015). In this case, Canadian consumers would be able to make better informed decisions when shopping to avoid foods that contain milk products that do not meet their expectations.

Despite participants’ uncertainty regarding the nutritional quality of milk products, the majority of participants held positive perspectives towards milk products including: being willing to include milk products as part of a healthy diet; preferring to obtain dietary calcium from milk products instead of supplements; and, enjoying the taste of milk products, particularly cheese and/or yogurt. Therefore, current misperceptions regarding adulteration of milk products should be addressed, and consumer knowledge regarding nutritional benefits of milk products should be improved, to facilitate young adults in making informative dietary choices to increase dietary calcium intake.

**Dependence on plant-based food sources for adequate dietary calcium intake.**

Conversely, 30% of participants were convinced they could obtain dietary calcium from non-dairy dietary sources, but were consuming 18% less dietary calcium (~200mg less per day)
on a daily basis than participants with opposing views. Our findings suggest that these young adults may want to limit their milk product intake, but either are unaware of calcium-rich non-dairy sources such as kale or canned salmon with bones, or are consuming non-dairy sources that are not comparable to the calcium bioavailability of milk products. To meet dietary calcium recommendations, bioavailability of calcium needs to be a consideration when choosing foods rather than simply focusing on the nutrient content. For example, calcium’s bioavailability in spinach is 5%, whereas calcium's bioavailability can be greater than 50% in some foods such as broccoli (Zhao, Martin, & Weaver, 2005). As well, when choosing foods there must be consideration towards other components of the food that may either work synergistically (e.g., vitamin D in milk) or antagonistically (e.g., oxalate in spinach) to affect the absorption of dietary calcium. Lastly, the types and amounts of fortificants that are used in fortified non-dairy beverages will contribute to the variability of calcium and its absorption (Heaney, Rafferty, & Bierman, 2005; Heaney, Dowell, Rafferty, & Bierman, 2007; Rafferty et al., 2007).

Dependence on consuming plant-based food sources for ensuring adequate dietary calcium intake is often unsuccessful (Fulgoni, Keast, Auestad, & Quann, 2011; Weaver, Proulx, & Heaney, 1999), unless fortified foods or supplements are included (Weaver et al., 1999). According to NHANES 2003–2006 data for individuals aged two years and greater, milk products contribute approximately 51% of total dietary calcium intake based on an average consumption of 1.7 milk product servings per day (Rice, Quann, & Miller, 2013). Therefore, limiting milk product consumption may result in a decrease of dietary calcium intake. According to a study that used two dietary modelling approaches, one based on USDA’s My Pyramid food patterns and another on 2003–2006 NHANES data from 16,822 individuals, researchers determined that dietary patterns that do not include milk products provide only 387 mg per day
of dietary calcium versus 1300 mg per day in dietary patterns that include three servings of milk products daily (based on mostly white milk, mixtures containing milk products, and cheese) (Fulgoni et al., 2011). It is possible to replace milk products with other calcium-rich foods to obtain calcium-equivalent servings. For example, a calcium-equivalent serving of a milk product would require an individual to consume 1.1 servings of a fortified soy beverage, 0.6 servings of fortified orange juice, 1.2 servings of bony fish or 2.2 servings of leafy greens. However, based on consumption data, these foods are not generally consumed, and are unrealistic substitutions for milk products (Fulgoni et al., 2011). Therefore, for young adults who choose to limit their milk product intake, they should be educated regarding the calcium content and bioavailability of non-dairy calcium-rich food sources to ensure dietary calcium intake is adequate through nutrition education health initiatives.

**Dietary intakes of participants and national recommendations.** The varying attitudes and beliefs regarding milk products may reflect the fact that 52% of participants were not meeting the EWCFG recommendations for milk and alternatives for their age group, with 32% of participants aged 19 years and over not meeting dietary calcium requirements. These findings are comparable to the most recent national Canadian data from the 2004 Canadian Community Health Survey (CCHS) reporting that 45-65% of young adults are not meeting the milk and alternatives and dietary calcium recommendations (Garriguet 2006; Vatanparast 2009). Our findings are concerning, as dietary calcium intake has been reported to be a marker for nutrient inadequacy and poor diet quality. Low dietary calcium intake has been found to be associated with low intakes of magnesium, zinc, potassium, thiamin, riboflavin, vitamin B\textsubscript{6}, and vitamin B\textsubscript{12}. (Barger-Lux, Heaney, Packard, Lappe, & Recker, 1992; Rafferty, Heaney, & Lappe, 2011).
In our study, we found similar associations between dietary calcium and certain nutrients when controlled for energy, such as vitamin D, riboflavin, zinc, as well as phosphorus and vitamin A.

Many of these above mentioned nutrients can be obtained from a variety of foods from the EWCFG; however, milk products provide a substantial amount of many of these essential nutrients, particularly protein, minerals such as calcium, potassium, phosphorus, magnesium and zinc, and vitamins A, D, B₁₂, and riboflavin (Fulgoni et al., 2011). Milk products supply approximately 70% of the calcium, 30% of the phosphorus, 26% of the vitamin A, 25% of the riboflavin, 18% of the protein, 18% of the vitamin B₁₂, and 16% of the potassium in the food supply (Hiza, Bente, & Fungwe, 2005). Limiting intakes of milk products could potentially contribute to decreased intakes of these essential nutrients in addition to lower dietary calcium intakes. For example, Wang et al. (2013) conducted a cross-sectional study to examine whether yogurt consumption was associated with better diet quality in participants in the Framingham Heart Study Offspring (1998-2001) and Third Generation (2002-2005) cohorts. Researchers found that yogurt consumers had better diet quality scores than yogurt non-consumers, and yogurt consumers versus non-consumers were 47%, 55%, 48%, 38%, and 34% less likely to have inadequate dietary intakes of riboflavin, vitamin B₁₂, calcium, magnesium, and zinc, respectively (Wang, Livingston, Fox, Meigs, & Jacques, 2013).

The most recent national Canadian data from the 2004 CCHS, suggests that many adults greater than 19 years of age have a prevalence of inadequate intakes of dietary calcium, magnesium, zinc, vitamin A, and vitamin D (Health Canada, 2012a). Similar findings were noted in our sample in comparison to the findings for young adults (19-30 years) from the CCHS data (Kirkpatrick & Tarasuk, 2008; Vatanparast et al., 2009), with the exception of a larger proportion of our sample being inadequate for zinc (19-33% vs. <10-12%) and folate (29-66% vs. <10-
17%). As well, a smaller proportion of males in our sample had inadequate intakes of vitamin A (<10% vs. 46%) and calcium (15% vs. 46%), and a larger proportion of females in our sample had inadequate intake of thiamin (28% vs. <10%), in comparison to the CCHS participants (Kirkpatrick & Tarasuk, 2008; Vatanparast et al., 2009).

Based on the dietary patterns examined by Fulgoni et al. (2011), increasing milk product intake by one serving per day, in individuals two years of age and greater, would result in significantly improved nutrient intakes. For example, dietary calcium, vitamin D, and magnesium intakes would improve by 301 mg/day, 2.1 µg/per day, and 24 mg/per day, respectively (Fulgoni et al., 2011). These nutrients, with the exception of vitamin D, could also be obtained by consuming foods from the other food groups, such as vegetables and fruits and grain products. However, in our sample there were a substantial number of participants that were not meeting the EWCFG recommendations for their age group for these two food groups (82% and 80%, respectively); which is higher than the national Canadian average according to the 2004 CCHS (44% and 45-60%, respectively) (Statistics Canada, 2007). Thus similar to Fulgoni et al. (2011), relying on non-dairy foods to obtain adequate nutrient intakes is not a realistic alternative, unless consumption of foods from other food groups were to be increased.

Fulgoni et al. (2011) also reported that either increasing or decreasing milk product intake by one serving would result in an increase or decrease of dietary protein intake by 8 g per day. In relation to the other food groups, there was a smaller proportion of our participants that were not meeting the EWCFG recommendations for meat and alternatives (29%). Considering 97% of participants were within the AMDR for protein, this may indicate that participants were obtaining their dietary protein from other food sources not limited to the milk and alternatives food group. Based on our findings, it is important to further understand young adults' motivators
and barriers to increasing milk product intake. This will assist in promoting adequate dietary calcium intake, as well as other essential nutrients, in this population for which they may be at risk for inadequacy.

**Motivators to increase milk product intake.** Participants expressed a willingness to increase milk product intake if instructed to do so by a health care professional and/or if they were shown more studies that exemplify the health benefits associated with consuming milk products. Previous studies have reported that individuals can be influenced by health care practitioner recommendations to consume milk products (Eddy et al., 1999; Nolan-Clark et al., 2011). However, participants who were enrolled in a nutrition education intervention desired to seek independent scientific studies in addition to the information they were given by the health care practitioner (Nolan-Clark et al., 2011). Considering our participants were well-educated, they may be able to comprehensively make their own interpretations of evidence-based literature. Therefore, this may explain why some of our participants would not solely trust a health care practitioners' advice, and wanted further evidence supporting the benefits of increasing their milk product intake.

Lower cost milk products would also be a motivator to increase milk product intake. Our finding is similar to previous studies that have reported that a deterrent adequate dietary calcium intake is the high cost of milk products (Eddy et al., 1999; Hagy et al., 2000; Jung et al., 2014; Nolan-Clark et al., 2011; Wham & Worsley, 2003). These studies have shown that the perception that milk products are not economical can have an influence over consumers’ decisions to limit their intake. Young adults should be educated that milk and milk products have been reported to be the lowest-cost source of dietary calcium in the diet (Drewnowski, 2011).
Gender differences. In our study, milk product health beliefs, and motivators to increase milk product intake also differed based on gender. More females than males expressed a willingness to increase milk product intake if they were confident that milk products did not contain any added antibiotics and/or hormones, and if cows were humanely treated. Similar findings have been reported in adults aged 31 to 50 years, with participants having discussed a distrust of the dairy industry and concerns that milk products are contaminated with antibiotics and/or hormones (Jung et al. 2014). However, there is no literature to date that has identified the ethical treatment of cows as a potential deterrent to milk product consumption in young adults. The questionable treatment of cows was discussed by elderly females (≥ 60 years) in a focus group study, but this concern was not cited as a barrier to milk product intake. Our finding is novel and demonstrates that current concerns regarding milk products may now extend beyond health beliefs to animal welfare in the young adult population.

More males than females undervalued the contribution of milk products in relation to bone health, and 40% of males thought they could obtain the nutrients they need without consuming any milk products. Despite this, 55% of male participants still believed that increasing milk products would contribute to the maintenance of strong bones. These opposing views are consistent with those of Wham and Worsley (2003) who found that males felt obligated to drink milk even though they were less convinced than women of milk’s nutritional benefits. Although bone health is often considered a concern of postmenopausal females (Nayak et al., 2010), the total number of hip fractures in males is predicted to be similar to current estimates in females by the year 2025 (Tarride et al. 2012). Thus, the apparent under appreciation of milk products among young males is concerning.
Interestingly, males and females were equally concerned with the perceived high energy intake of milk products. Previous research has shown that the fat content of fluid milk is a barrier to consumption in females (Cashel et al. 2000; Gulliver and Horwath 2001). However, more recent research has shown that as males enter young adulthood they become increasingly concerned with their weight and body shape (i.e., muscularity), and may control their diet to maintain their physique (Field et al. 2014). This suggests that maintaining a healthy weight may be an important consideration not only for young female adults, but also for males, and perhaps outweighs the perceived importance of meeting dietary calcium requirements.

Consistent with the literature, more males than females were meeting dietary calcium (Vatanparast et al. 1999, 2010) and milk product (Klesges et al. 1999; Wham and Worsley 2003) recommendations. However, when intakes were adjusted for energy intake (per 1000 kcal) there were no significant differences between gender in either dietary calcium or milk and alternatives intakes. Similar findings were also observed for many of the other micronutrients, with the exception that males had higher intakes of vitamin C when controlled for energy intake. These findings suggest that males are meeting dietary recommendations for most micronutrients due to a higher caloric intake than females. Rafferty et al. (2011) found that among adult females reporting lower dietary calcium intakes, predominately obtained from milk products, a higher proportion of nutrients (vitamin D, magnesium, and zinc) were below the EAR or adequate intake (AI) relative to the group with higher dietary calcium intakes. As well, poor diet quality was more prevalent among females in the low dietary calcium group in comparison to those in the higher dietary calcium group (Rafferty et al., 2011). In our study, although there were no significant differences between gender regarding mean micronutrient intakes, for the nutrients that the prevalence of inadequate intakes were highest for males and females (i.e., vitamin D,
calcium, magnesium, and zinc) there were a larger proportion of females not meeting dietary recommendations for these nutrients in comparison to males. This inadequacy in various essential nutrients could put females at an increased risk for poor health outcomes, such as osteoporosis, cardiovascular disease, and type 2 diabetes. Therefore, females need to ensure that they consume higher proportions of foods that rich in these nutrients.

Strengths and limitations. The novel finding of our work is that we identified that females would be influenced to increase milk product intake if they were confident that dairy cows were humanely treated. To date we are unaware of any studies that have identified ethical considerations of dairy cows as a potential motivator to increase milk product intake in young adults. Our findings extend the literature by providing a current interpretation of the attitudes and beliefs towards, and motivators and barriers to, dietary calcium and milk product intake in the young adult population. Previous research examining the determinants of dietary calcium intake is dated. Considering the growing diversity of dietary behaviours in consumers (e.g., vegetarianism, veganism), increase plant-based alternative options, declining demand for milk, and consumer confusion regarding benefits of milk products, previous studies may not capture the prevailing milk product health beliefs of present day young adults. This age group has also not been thoroughly examined in previous literature. Without understanding the determinants of dietary calcium and milk product intake in young adults, developing messages to promote increased dietary calcium intake may be futile.

In addition to assessing adequacy of dietary calcium and milk product intake, our research group examined other dietary characteristics (mean intake of macro- and micronutrients, and food groups) of participants' diets, and the prevalence of inadequacy of other essential nutrients. We identified inadequacy in nutrient intakes that have an association with dietary
calcium (e.g., vitamins A, D and minerals magnesium and zinc). These nutrients can be obtained from milk product and alternatives, but are not limited to this food group. Therefore, promoting adequate dietary calcium intake can assist in promoting consumption of nutrient-dense foods that will not only increase dietary calcium intake but also other nutrients for which young adults may be at risk for inadequacy.

Lastly, the few studies that have focused on the young adult population have explored determinants of dietary calcium intake mainly in females. Based on the gender differences we identified in both dietary nutrient intakes and attitudes and beliefs towards milk products, there is a need to target males and females separately to promote adequate dietary calcium intake, as well as other essential nutrients.

Some limitations do bear mention. The milk product health belief questionnaire was quantitative, precluding interpretation of participant responses. However, our findings provide information to inform future qualitative work to explore and contextualize these beliefs; our research group has undertaken this type of qualitative work. As well, underreporting is a potential concern in dietary research studies and can affect estimates of dietary nutrient intakes (IOM, 2000); however, to account for this limitation energy adjusted intakes were used for analyses (Mirmiran, Esmailzadeh, & Azizi, 2006). As well, to reduce respondent bias (i.e., inaccurate reporting of food items) a 3-day food record was used for nutritional assessment to increase the number of days of intake data to obtain a reproducible estimate of usual nutrient intakes (Gibson, 2005).

Also, our sample consisted of well-educated, Caucasian individuals from Southwestern Ontario; results cannot be generalized to the larger Canadian young adult population. Previous studies have shown that consumption of milk and/or calcium-rich foods can vary based on socio-
demographics (e.g., ethnicity, socioeconomic status) (Klesges et al. 1999; Nelson et al. 1999). Therefore, a larger, more diverse sample stratified by ethnicity, education and/or income might reveal that dietary intakes may vary among certain subgroups more than reported in the current study. Individual attitudes and misconceptions towards milk products may also vary.

In conclusion, despite generally positive views towards milk products, well-educated young adults expressed uncertainty towards milk products in relation to health, nutritional value, weight management, and ethical concerns. While qualitative studies are needed to determine effective strategies to increase dietary calcium intake in young adults, in the interim, we suggest that educational and counseling priorities should address current misperceptions regarding milk products, and improve consumer knowledge regarding nutritional benefits of milk products and other calcium-rich sources. These efforts may influence dietary behaviours to increase the intake of nutrient-dense foods in young adults to increase dietary calcium intake and other essential nutrients.
Study #2: Young Adults' Perceptions of Calcium and Health: A Qualitative Study

Abstract

Many young Canadian adults are not meeting dietary calcium recommendations. This is concerning as adequate dietary calcium is important throughout young adulthood to maximize peak bone mass and thereby prevent osteoporosis later in life. Two qualitative studies have explored young female adults' perceptions of calcium-rich foods, and are dated. The objectives of our study were to determine young adults' (18 to 34 years) knowledge of calcium in relation to health, and to explore young adults' recommendations for individual strategies to increase dietary calcium intake, and ways to communicate calcium-related messaging to this population. Eight gender-specific focus groups (3M and 5F) were conducted using a semi-structured interview guide grounded in Social Cognitive Theory. Thematic analysis was used to generate themes. Participants perceived adequate dietary calcium intake to be important for children and older adults, but were uncertain for their age group. Positive outcomes (e.g., aesthetics) associated with adequate calcium intake were commonly cited as a motivator to increase dietary calcium intake. Barriers to achieving adequate calcium intake included the high cost and inconvenience related to milk products, and perceived negative practices of dairy farmers. Participants recommended planning healthy well-balanced meals and forming a habit of consuming calcium-rich foods as individual strategies to increase dietary calcium intake. Suggestions to convey calcium-related information to young adults included increasing awareness, unbiased advice, and development of nutrition education curricula. Social media and advertising were often mentioned as ineffective. Our findings provide key information for nutrition education initiatives.

Key words: Social cognitive theory, young adults, dietary calcium, motivators, barriers, nutrition education
Introduction

Calcium is an important nutrient for the development and maintenance of healthy bones and for the prevention of osteoporosis (Ross, 2011). Deficiency has also been implicated in non-skeletal outcomes such as hypertension (Nicklas et al., 2011), obesity (Tremblay & Gilbert, 2011; Wang, Troy, et al., 2013), certain types of cancer (Larsson et al., 2006), and diabetes (O’Connor et al., 2014). Calcium is found in milk products as well as non-dairy sources including legumes, selected green vegetables (e.g., spinach, broccoli), fortified beverages, and canned salmon with bones. Despite the variety of sources, many young Canadian adults are not meeting dietary calcium recommendations (Barr, 2013; Vatanparast et al., 2009). This is concerning as it has been demonstrated that dietary calcium is a significant predictor of bone mineral density in young adults (Chouinard et al., 2012). Obtaining adequate dietary calcium is important throughout young adulthood to maximize bone density and strength [i.e., peak bone mass (PBM)] and for the prevention of osteoporosis (Ross, 2011). Therefore, there is a need to identify effective strategies to increase dietary calcium intake in young adults.

To change dietary habits, young adults’ knowledge regarding calcium in relation to health, and the factors that may influence intake, must be understood. Social cognitive theory (SCT) (Bandura, 1989) provides a framework for understanding the influence of personal, behavioural, and environmental factors on nutrition-related behaviours (Bandura, 2004; Contento, 2011). The core determinants include knowledge of health outcomes, self-efficacy (i.e., confidence to perform the behaviour), outcome expectations (i.e., costs vs. benefits), goals (i.e., goal setting and regulatory strategies used to meet goals), and perceived facilitators and impediments. Facilitators to behaviour change are rooted in the core belief that an individual has the control to generate desired behaviour changes by one's actions (Bandura, 2004). Therefore,
individuals with higher confidence in their ability to change their dietary habits will expect their efforts to produce favourable health outcomes, and will have a greater commitment to maintaining this dietary change regardless of potential deterrents.

Reported deterrents to dietary calcium intake have included perceived high fat content of milk products (French et al., 2008; Gulliver & Horwath, 2001; Klesges et al., 1999), self-perceived lactose intolerance (Barr, 2013), cost (Eddy et al., 1999; Jung et al., 2014), preference for non-dairy beverages (Wham & Worsley, 2003), and lack of awareness of non-dairy calcium-rich foods (French et al., 2008). Previous research has used quantitative questionnaires, limiting the interpretation of responses. Qualitative studies have focused mainly on elderly females, and/or knowledge and attitudes towards milk products (Eddy et al., 1999; French et al., 2005; Hagy et al., 2000; Jung et al., 2014; Mobley et al., 2014). Two previous studies explored young female adults’ perceptions of milk products (Weiglein, 2000) and calcium-rich foods (Lewis & Hollingsworth, 1992). In the last 20 years, however, the Canadian dairy industry has been faced with many challenges, including the decline in fluid milk demand ("Consumption of dairy products," 2014) and the continuing societal shift away from consuming milk products (Atkins, 2015). These studies do not capture present day young adults' attitudes towards, and facilitators and deterrents to, dietary calcium intake.

Theory-based nutrition education interventions to increase milk product and dietary calcium intake have used information that is relevant and targeted towards young adults. These interventions were successful in improving perceived self-efficacy and self-regulation to milk product intake (Poddar et al., 2010), as well as increasing and maintaining dietary calcium intake (Jung, Martin Ginis, Phillips, & Lordon, 2011). Targeted messaging may be an effective way to increase dietary calcium intake in the young adult population; however, no recent qualitative
studies have explored the general perceptions of 18 to 34 year old adults regarding the
importance of dietary calcium and health, and the motivators and barriers to adequate dietary
calcium intake. Therefore, the objectives of our study were to determine young adults' (18 to 34
years) perceived knowledge of the health benefits of dietary calcium, and to explore young
adults' suggestions for strategies to increase dietary calcium intake and how to communicate
calcium-related messaging to this population. These findings will help to inform content for
nutrition education initiatives.

Methods

**Recruitment.** Participants were recruited from communities in Southwestern Ontario
Canada for the " Dietary Calcium: Young Adults’ Knowledge, Attitudes and Beliefs Focus
Group Study," via poster campaigns, flyers posted on community boards in local businesses,
online classified websites (e.g., kijiji), and in-person recruitment in the downtown core of
Guelph and Hamilton, ON (e.g., coffee shops, farmers markets) (refer to appendix I). Potential
participants contacted researchers by phone or e-mail, where they were screened for eligibility
(refer to appendix J). Eligibility criteria included males and females who were between the ages
of 18-34 years. Participants were excluded if they identified as vegan (i.e., avoidance of all
animal products), or if they regularly consumed calcium supplements, as supplement users may
differ from non-supplement users (Lyle, Mares-Perlman, Klein, Klein, & Greger, 1998).
Individuals with self-diagnosed milk allergy or lactose intolerance were considered eligible as
this may be a potential deterrent to adequate calcium intake. Researchers also inquired about age,
gender, ethnicity, education, and employment status to collect demographic data. This study was
approved by the University of Guelph Research Ethics Board, and all participants provided
written informed consent prior to study enrolment (refer to appendix K). Participants were provided with a $20 grocery gift card once they had attended the focus group.

**Study design.** In-depth gender-specific focus groups were held to create a permissive environment for participants to share and build on each other's responses (Krueger & Casey, 2009), and to explore the salient cognitions of males and females separately. Food choices differ between males and females, which may elicit varying attitudes and beliefs that would be important to consider for nutrition interventions (Wardle et al., 2004). Eight focus groups (5-9 participants/group) were held to yield diversity in participant responses, while still keeping groups small enough to create a comfortable environment, and to ensure that adequate theoretical saturation was reached (Krueger & Casey, 2009).

Focus groups were held on the University of Guelph or McMaster university campus and lasted 60 to 90 minutes. Focus groups were moderated by Clear Pane Research Services (http://clearpane.ca/), a professional service that provides academic research support by facilitating focus groups in an impartial manner. Field notes were taken by the PhD student investigator (M.L.M) to record group dynamics and non-verbal communication within groups. A semi-structured interview guide (refer to appendix L) was developed to understand the ways in which young adults construe various characteristics of dietary calcium (e.g., general knowledge, influence on health); the impact these characteristics may have on consumption such as motivators and barriers; recommended individual strategies to increase dietary calcium intake; and, suggested ways to convey calcium-related messaging to young adults to promote adequate dietary calcium intake. Interview questions were developed with consideration of the tenets of SCT (Bandura, 1989), and our previous quantitative findings that revealed facilitators to increasing milk product intake in young adults which we wanted to further explore (e.g., ethical
treatment of dairy cows). Examples of focus group questions are listed in Table 8. Each focus group was digitally recorded and transcribed with participants' permission. Subsequent to each focus group, the research team discussed how well the semi-structured interview guide elicited responses from participants and modified questions accordingly.

Table 9: Focus Group Questions developed for the "Dietary Calcium: Young Adults’ Knowledge, Attitudes and Beliefs Focus Group Study" Grounded in Social Cognitive Theory

<table>
<thead>
<tr>
<th><strong>General Calcium Knowledge</strong></th>
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<tbody>
<tr>
<td>What do you know about calcium? (Knowledge)</td>
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<tr>
<td>How do you think calcium influences overall health? (Knowledge)</td>
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<tr>
<td>What comes to mind of sources in the diet that provide calcium? (Knowledge)</td>
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<tr>
<td>Which of these sources would you consider the best source of calcium? (Knowledge)</td>
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<tr>
<td>Do you think getting enough calcium in your diet is an important consideration for individuals in your age group? (Outcome Expectations)</td>
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<tr>
<th><strong>Milk Product Considerations</strong></th>
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<tr>
<td>Milk products offer one way to include calcium in the diet. Other than calcium, what else do milk products contain? (Knowledge)</td>
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<tr>
<td>What do you know about the treatment of Canadian dairy cows? (Knowledge)</td>
</tr>
<tr>
<td>How do you feel about the way dairy cows are treated in Canada? (Facilitators/Impediments)</td>
</tr>
<tr>
<td>Does your knowledge affect your consumption of milk products? (Facilitators/Impediments)</td>
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<tr>
<th><strong>Bone Health and Peak Bone Mass</strong></th>
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<tr>
<td>What comes to mind when you think about having strong bones? (Knowledge)</td>
</tr>
<tr>
<td>What do you think influences the health of our bones? (Outcome Expectations)</td>
</tr>
<tr>
<td>Do you think there is a time in our lives where bones stop growing? (Knowledge)</td>
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<table>
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<tr>
<th><strong>Facilitators of Calcium Intake</strong></th>
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<tr>
<td>Is getting enough calcium a concern for you? (Outcome Expectations)</td>
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<tr>
<td>Are there any strategies that you use to help make sure you are getting enough calcium in your diet? (Goal Setting)</td>
</tr>
<tr>
<td>What strategies would be helpful to motivate you to consume more calcium-rich foods? (Facilitators/Impediments)</td>
</tr>
<tr>
<td>Do you think knowing that our bone mass reaches a peak in young adulthood, that would influence your dietary choices to include more calcium-rich foods? (Facilitators/Impediments)</td>
</tr>
<tr>
<td>What would you consider to be the most effective way to convey messages about the importance of getting enough calcium in your diet to people in your age group?</td>
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**Thematic analysis.** The digital audiotapes were transcribed verbatim by Cornerstone Transcription Services (Toronto, ON). Transcripts were compared with the audiotapes for quality control and then imported into NVivo (software version 10, QSR International, Burlington MA). Three individuals (PhD student investigator, an undergraduate research assistant, and an experienced transcriptionist from Clear Pane) independently reviewed transcripts and generated commonalities and connections among key concepts to identify major themes (Braun & Clarke, 2006). After independent analyses, researchers met and came to a consensus that saturation (i.e., no new themes identified) had been reached after conducting eight focus groups. Males and females generated similar overarching and sub-themes. Unless otherwise noted, themes were aggregated across focus groups.

**Results**

A total of 53 males and females (26 ± 4 years) participated in 8 focus groups (approximately 7 participants/group; 5 female groups; 3 male groups). Demographic characteristics are summarized in Table 10. Described below are themes that emerged from the focus groups related to: 1) young adults' general knowledge of the health benefits of calcium; 2) factors that may affect dietary calcium intake; 3) strategies to increase dietary calcium intake; and, 4) participant suggestions of effective; and, 5) non-effective ways of conveying calcium-related messaging to this age group. Quotes illustrating these themes are included in Table 11.

**Knowledge of calcium in relation to health.** Three themes emerged within the data: knowledge of physiological roles; uncertainty about peak bone mass (PBM); and, lack of knowledge of the importance of adequate dietary calcium intake for young adults. Physiological roles included calcium intake being associated with strong bones and osteoporosis prevention. This knowledge was obtained through parental influence and popular marketing campaigns from
childhood. Uncertainty about PBM included whether bones stop growing at any point in the lifespan, and confusion between the concepts of gaining versus rebuilding bone mass. Lastly, the importance of calcium regarding bone health was primarily associated with children and older females, but not with young adults. One gender difference noted was that only female participants discussed the importance of calcium during pregnancy, and some females with children discussed maintaining personal calcium intake for the sake of their children.

**Motivators for increasing dietary calcium intake.** Participants reported that they would be motivated to consume more calcium-rich foods if an immediate tangible outcome was associated with this behaviour; however, not all examples mentioned by participants had evidence to support the relationship with dietary calcium. Outcomes mentioned included aesthetics (e.g., stronger hair and nails), physiological outcomes (e.g., more energy, increased bone density), and pain management (e.g., managing menstruation and labour pains). In response to learning that young adults can gain bone mass into the fourth decade of life (Berger et al., 2010), female participants indicated they would be more likely to increase their calcium intake in order to prevent osteoporosis-related outcomes (e.g., fractures, decreased mobility). Conversely, male participants mentioned that having this knowledge would not act as a motivator.

**Deterrents to adequate dietary calcium intake.** Participants perceived milk products, especially cheese, to be expensive, and the cost of milk in Canada was considered high compared to other countries. For many participants, cost considerations would take priority when purchasing food items. The issue of convenience was also raised in terms of milk product packaging. For example, participants mentioned that milk packaged in cartons is inconvenient because the milk can spoil quickly and can easily leak from the carton. Pre-packaged bottled
milk was mentioned as a potential alternative, but that the high cost for such a small quantity of milk was not economical.

When asked about the perceived treatment of dairy cows in Canada, there were mixed opinions. Many participants mentioned media reports and documentaries that gave them the impression that dairy cows are not treated well, although many participants perceived the treatment of dairy cows in Canada to be better than elsewhere. Overall, participants felt that it most likely depended on the individual farmer and farm size. Some participants also stopped consuming milk because they had heard that hormones were given to cows to encourage greater milk production. Individuals were conscious of ethical considerations, such as the treatment of dairy cows, when making food choices; however, for a few participants cost was still the deciding factor when purchasing food, regardless of their ethical beliefs.

**Strategies to increase dietary calcium intake.** When asked if there are any strategies participants use to make sure they are getting enough dietary calcium, the majority of participants reported that they are focused on purchasing nutrient-dense food items while shopping and preparing health meals. As a result, many participants made the assumption that they were meeting calcium, as well as other nutrient, recommendations. Additionally, when asked what would help to motivate participants to increase their dietary calcium intake, making it habitual to consume calcium-rich foods on a daily basis suggested.

**Suggested calcium-related messaging.** Many participants were unaware of messaging directed towards young adults to promote adequate dietary calcium intake. Not surprisingly, participants suggested that there should be an emphasis on the importance of adequate dietary calcium intake in young adulthood in calcium-related messaging. Additionally, participants mentioned that they would be more likely to increase their dietary calcium intake if advised to do
so by a trusted health professional, particularly if the results of a health exam suggested that there was a reason for concern. Participants also suggested that nutrition education should be implemented in both the elementary school and secondary school curricula to promote and engrain the importance of continued healthy dietary habits throughout adulthood.

**Ineffective calcium-related messaging.** Interestingly, many participants believed that television commercials, online advertisements, and social media outlets would not be effective in targeting the young adult population. Participants perceived that young adults ignore current nutrition-related messaging because they feel overwhelmed by the volume of nutritional information that is disseminated regarding individual nutrients. Participants also identified that some young adults, including themselves, may not be exposed to online or televised nutrition messaging as many individuals block online advertisements, do not subscribe to cable television, or do not own a television. Participants also discussed that young adults would be least likely to 'follow' nutrition-related social media accounts, especially if these accounts belonged to sources participants considered to be biased, such as the dairy industry.

**Table 10:** Demographic Characteristics of Participants Enrolled in the Dietary Calcium: Young Adults’ Knowledge, Attitudes and Beliefs Focus Group Study

<table>
<thead>
<tr>
<th></th>
<th>Group (n=53)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>26 ± 4</td>
</tr>
<tr>
<td>Gender n (%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>18 (34)</td>
</tr>
<tr>
<td>Female</td>
<td>35 (66)</td>
</tr>
<tr>
<td>Ethnicity n (%)</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>43 (81)</td>
</tr>
<tr>
<td>Non-Caucasian</td>
<td>10 (19)</td>
</tr>
<tr>
<td>Highest Level of Education n (%)</td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>12 (23)</td>
</tr>
<tr>
<td>College/University</td>
<td>30 (56)</td>
</tr>
<tr>
<td>Post Graduate Degree</td>
<td>11 (21)</td>
</tr>
</tbody>
</table>
Table 11: Quotations illustrating generated themes across focus groups

<table>
<thead>
<tr>
<th>Themes</th>
<th>Sub-Themes</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of Calcium in</td>
<td>Physiological</td>
<td>&quot;Yeah, I’d say calcium is important, but I don’t really know what it does besides bone strength and just general nutrients.&quot; (Male, FG#3)</td>
</tr>
<tr>
<td>Relation to Health</td>
<td></td>
<td>&quot;I know that it makes your bones strong, that's what I learned.&quot; (Female, FG#2)</td>
</tr>
<tr>
<td></td>
<td>Pregnancy</td>
<td>&quot;I also remember learning that it was really important, especially when you are pregnant— that was a time I think a lot of calcium could leave your bones &quot; (Female, FG#6)</td>
</tr>
<tr>
<td></td>
<td>Uncertainty of peak bone mass</td>
<td>&quot;[Calcium is important during pregnancy] because you are growing a person!&quot; (Female, FG#6)</td>
</tr>
<tr>
<td></td>
<td>Lack of Knowledge</td>
<td>&quot;My impression is probably our age is this black hole where the impression is it’s not as important, because when you’re growing it’s said to be important, and if you’re older it’s said to be important, if you’re a woman it’s said to be important. I guess we should be more aware of it than we are?&quot; (Male, FG#3)</td>
</tr>
<tr>
<td>Motivators of calcium intake</td>
<td>Association of positive outcomes</td>
<td>&quot;If I found that I had like a big glass of milk and all of a sudden I felt really aware and awake, energized or whatever, if it were like coffee [I'd increase my intake]&quot; (Male, FG#8)</td>
</tr>
<tr>
<td></td>
<td>Peak bone mass awareness</td>
<td>&quot;Just think, if [calcium] helped with your pregnancy and everything and like made you have less labour pains think of how many more mothers would pick up on it?&quot; (Female, FG#4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;Like I don't care like how vain it is, if your calcium–if they promoted more like, it's great for your hair, it's great for your nails. I'd be like, hey, I'd like some great nails.&quot; (Female, FG#4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;I think I would [increase my calcium intake]. I don’t want to be old and frail and falling and breaking your hip and stuff like that, it sounds awful.&quot; (Female, FG#2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;Definitely worthwhile to make changes, knowing that I can still build bone mass&quot; (Female, FG#2)</td>
</tr>
</tbody>
</table>

*Sub-themes generated by female focus groups
<table>
<thead>
<tr>
<th>Themes</th>
<th>Sub-themes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deterrents to calcium intake</strong></td>
<td><strong>Cost</strong></td>
</tr>
<tr>
<td></td>
<td>&quot;Milk in Canada is expensive compared to the US.&quot; (Male, FG#8)</td>
</tr>
<tr>
<td></td>
<td>&quot;[At this age] we just care about getting the cheapest thing and just getting on with it, we don’t really care about what’s gonna happen when we’re 10 years down the road.&quot; (Female, FG#6)</td>
</tr>
<tr>
<td></td>
<td><strong>Convenience</strong></td>
</tr>
<tr>
<td></td>
<td>&quot;But [milk cartons] are not re-sealable, you know, you can’t just throw one in your knapsack.&quot; (Female, FG#7)</td>
</tr>
<tr>
<td></td>
<td>&quot;Milk doesn’t come in like 1 litre – like convenient – like these convenient bottles often.&quot; (Female, FG#7)</td>
</tr>
<tr>
<td></td>
<td><strong>Perceived negative practices of dairy farmers</strong></td>
</tr>
<tr>
<td></td>
<td>&quot;I’ve seen documentaries where the cows are like in a circle, and they can’t even turn around or sit, and it’s really like, it’s really depressing.&quot; (Female, FG#4)</td>
</tr>
<tr>
<td></td>
<td>&quot;You know, you go to the grocery store, there’s 15 different types of milk on the wall, if one of them is known to come from a place that does treat its animals well, I’d probably go to that one&quot; (Male, FG#5)</td>
</tr>
<tr>
<td></td>
<td>&quot;Definitely hearing stories like that [unethical treatment of cows] puts me off consuming those products.&quot; (Female, FG#6)</td>
</tr>
<tr>
<td><strong>Strategies to Increase Dietary Calcium Intake</strong></td>
<td><strong>Plan healthy meals</strong></td>
</tr>
<tr>
<td></td>
<td>&quot;Kind of, but more so for a healthy balanced diet, more so than like calcium being on the forefront of my mind.&quot; (Male, FG#5)</td>
</tr>
<tr>
<td></td>
<td>&quot;I can’t say that I focus on particular nutrients really when I’m eating or shopping even... My main focus is that I’m buying fresh foods and not so many processed foods.&quot; (Male, FG#5)</td>
</tr>
<tr>
<td></td>
<td>&quot;I make sure to eat lots of vegetables everyday and like nuts, almonds milk.&quot; (Female, FG#6)</td>
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<tr>
<td></td>
<td><strong>Habitual</strong></td>
</tr>
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<td></td>
<td>&quot;I drink milk and I have a lot of it. That’s why I don’t worry about calcium&quot; (Male, FG#8)</td>
</tr>
<tr>
<td></td>
<td>&quot;I have cheese every day, I have a yogurt every day, and I have my almonds every day. And sometimes I have almond milk. And I have the vegetables, and that’s every day. So I think I’m okay.&quot; (Female, FG#6)</td>
</tr>
<tr>
<td></td>
<td>“We drink, between my partner and I, we drink like at least the three bags of milk per week, um, so I’m not too concerned [with my calcium intake].” (Female, FG#6)</td>
</tr>
<tr>
<td>Themes</td>
<td>Sub-Themes</td>
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<tr>
<td>--------</td>
<td>------------</td>
</tr>
<tr>
<td></td>
<td>Increased awareness</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Suggested calcium-related messaging</td>
<td>Trusted advice</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nutrition education</td>
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</tbody>
</table>
| Themes                               | "Especially our generation, we’re all sort of jaded of everything on TV, you know what I mean - like there’s commercials for everything and it becomes – you’re saturated and it all becomes kind of meaningless.” (Male, FG#8)  
|                                     | “For example, we don’t have television either, and a lot of people my age don’t either.” [In relation to discussion regarding how young adults may not even be exposed to any nutrition messaging] (Female, FG#6)  
|                                     | "If it’s the milk board promoting milk then it’s biased.” [In relation to discussion regarding how young adults would be least likely to 'follow' nutrition related social media accounts, especially if they were considered to be biased] (Female, FG#1) |
Discussion

The findings of our study suggest that young adults aged 18 to 34 years were aware of the relationship between adequate dietary calcium intake and bone health. However, the importance of calcium regarding bone health was primarily associated with children and older females not with their own age group. A common motivator to increase dietary calcium intake was the expectation of positive outcomes such as aesthetic or physiological outcomes. Barriers to dietary calcium intake included the high cost and inconvenience of purchasing milk products and perceived negative dairy farming practices. Participants recommended planning healthy well-balanced meals and forming a habit of consuming calcium-rich foods as strategies to increase dietary calcium intake. Increasing awareness of the importance of adequate dietary calcium intake for young adults was also identified. Participants recommended several strategies to convey calcium-related messages to young adults, including advice from trusted health professionals and school-based nutrition education initiatives. Ineffective messaging included social media and advertisements. Gender differences were also identified. Females associated adequate dietary calcium intake with pregnancy, and females were also willing to increase their intake if they were made aware of PBM. Taking into consideration the determinants of SCT that influence dietary behaviours, suggestions for future nutrition education interventions are provided.

Participants were aware of the benefits associated with bone health in relation to adequate dietary calcium intake. This is consistent with previous literature reporting that young adults associated adequate milk product intake, an excellent source of dietary calcium, with positive bone health outcomes (Lewis & Hollingsworth, 1992; Weiglein, 2000). However, many
participants did not recognize that there are opportunities in young adulthood to gain bone mass. In fact, participants frequently cited adequate dietary calcium intake to be more important for bone health in children and older females. Therefore, increasing young adults' knowledge about the importance of adequate calcium intake for their age group could provide the awareness needed to elicit changes in dietary habits to increase calcium intake.

Female participants mentioned the importance of adequate dietary calcium intake during pregnancy. The mention of calcium related to pregnancy is not surprising given that some females in the study had children. These females also discussed the importance of adequate dietary calcium intake to maintain their own health for longevity. Discussions regarding calcium and pregnancy (Hagy et al., 2000) and the value of role modelling for one's children (Jung et al., 2014) have also been previously reported. Collectively, these findings may be reflective of how life transitions during young adulthood, such as marriage or pregnancy, often influence dietary habits as health considerations become a priority (Arnett, 2000). Therefore, as young females transition through young adulthood, they may be more inclined than males to engage in dietary habits to increase calcium intake. This is an important consideration for calcium-related messaging.

Although knowledge of health outcomes is a precondition to behaviour change, perceived motivators and deterrents need to be examined to understand the underlying personal motivations for change (Bandura, 2004). Participants most often identified observing short-term benefits as a motivator to consume calcium-rich foods; long-term bone health benefits were an afterthought. Researchers have reported that motivation to adhere to calcium intake goals decreased in the absence of noticeable physical symptoms of bone deterioration (French et al., 2005). Educational materials should mainly focus on the short-term health outcomes related to adequate dietary
calcium intake that are relevant to young adults, but also include the long-term bone health benefits. These messages could include topics such as the importance of maternal calcium intake for pregnancy and lactation (Heringhausen & Montgomery, 2005), management of premenstrual symptoms (Chocano-Bedoya et al., 2013), maintaining mobility as young adults age (Tenta, Moschonis, Koutsilieris, & Manios, 2011), and contributing to improving oral health (Antonenko, Bryk, Brito, Pellegrini, & Zeni, 2015).

A motivator specific to female participants was the likelihood that participants would increase their dietary calcium intake after learning about the timing of PBM. Conversely, male participants expressed that this knowledge should, but would not, impact their behaviour. The difference between genders may be that males often view osteoporosis as a concern for females and older adults (Wham & Worsley, 2003), whereas, females tend to appreciate the importance of adequate dietary calcium intake to prevent osteoporosis and are concerned with their intakes (Hagy et al., 2000; Lewis & Hollingsworth, 1992). Considering that the total number of male hip fractures is predicted to be similar to current estimates for females by the year 2025 (Tarride et al., 2012), interventions should stress the importance of adequate calcium intake as a preventative measure for both males and females.

Barriers to adequate dietary calcium consumption included the perceived high cost of milk products and the potential for milk products to spoil quickly, making milk products inconvenient to purchase and costly to replace. These concerns are important to consider as young adults may be pursuing studies, beginning careers, and starting families, all of which may contribute to financial constraint. Therefore, intervention materials should emphasize that milk products are the lowest-cost source of dietary calcium and other essential nutrients (e.g., vitamin D, vitamin A, riboflavin, phosphorus) (Drewnowski, 2011). As well, individuals should be
informed of non-refrigerated options (i.e., shelf-stable cow's milk) that are also available to deter concerns of spoiling (e.g., President's Choice Tetra Pak Milk Box). These milk products are heated to a much higher temperature than regular milk to eliminate bacteria. The milk is sealed in an air-tight aseptic package that preserves the freshness for months, and the milk does not require refrigeration until opened (Gedam, Prasad, & Vijay, 2007).

Our previous quantitative findings identified that more females in comparison to males, would increase their milk product intake if they were confident that milk products did not contain added antibiotics and/or hormones and that dairy cows were treated humanely. This finding is one that we wanted to explore further in this qualitative study. When asked if concerns about the treatment of dairy cows would affect milk product intake, many participants mentioned that unethical dairy farm practices would be a deterrent. These findings have been noted in more recent literature (Jung et al., 2014; Mobley et al., 2014); however, our research group is the first to identify that increased confidence in the humane treatment of dairy cows would motivate young adults to increase milk product consumption. Our findings also demonstrate that current concerns regarding milk products may now extend beyond health beliefs to ethical considerations about the treatment of dairy cows. For example, milk product packaging could contain a quick response (QR) bar code that would provide this information. Consumers can capture this QR bar code with a scanner app on a Smartphone, easily accessing this information.

Motivation alone is not sufficient to elicit behaviour change (Contento, 2011). When participants in our study were asked what individual strategies they use, and would suggest, to increase dietary calcium intake in young adults, participants recommended that forming habits around consuming calcium-rich foods (particularly milk products) and planning healthy well-
balanced meals would be sufficient in order to meet calcium and other nutrient recommendations. Participants expressed that they felt overwhelmed with the amount of information currently disseminated regarding individual nutrients. Researchers have shown that dietary calcium intake is a marker of overall diet quality, and that low dietary calcium intakes are associated with inadequacies of other nutrients, such as magnesium and vitamin D (Rafferty et al., 2011). Therefore, intervention material could include information that discusses the health benefits of whole foods, rather than a reductionist view that emphasizes the benefits of one single nutrient. By promoting intake of nutrient-dense foods, such as milk products, this may contribute to increasing dietary calcium intake in the young adult population, as well as other important nutrients.

Participants were also asked to suggest preferred methods to convey calcium-related messaging to the young adult population. As expected, the most common suggestion that emerged across all focus groups was the need for calcium-related messaging to be targeted towards young adults. Participants were not aware of any messaging targeted specifically for young adults stressing bone health and the importance of adequate dietary calcium intake during young adulthood. Previous research has reported that young adults did not realize bone health could be compromised during young adulthood and subsequently have implications later in life (Weiglein, 2000). Therefore, targeted messaging that is relevant to young adults may be more effective than generic messaging regarding calcium in relation to bone health.

In addition to targeted messaging, communication modality used to disseminate knowledge needs to be considered. Lewis and Hollingsworth (1992) reported that female young adults perceived news articles, magazines, radio and television advertisements as efficient modes of communicating nutrition information. However, these findings are outdated as they do not
capture the advances made in contemporary communication technologies and concurrent changes to consumer marketing strategies. Social media is becoming an increasingly prevalent venue through which adult Internet users access health information (Neiger et al., 2012). Despite this, our participants expressed that advertising through television or social media campaigns would not be effective in reaching the young adult population, particularly if such information was promoted by the dairy industry. If young adults are skeptical of advertisements and social media campaigns, these efforts will not effectively influence and engage young adult consumers. Therefore, more trusted sources of information should be utilized in order to promote nutrition messaging among young adults.

Health professionals were one information source that our participants cited as being trustworthy. Many participants stated that they would be more likely to increase their dietary calcium intake if instructed do so by a trusted health care professional, particularly if the advice was based on a health assessment. Previous studies have reported that individuals distrust media campaigns and research supported by profitable industries such as the dairy industry (Jung et al., 2014; Lewis & Hollingsworth, 1992), but that individuals can be influenced by physician recommendations (Eddy et al., 1999; Hagy et al., 2000; Nolan-Clark et al., 2011). Therefore, health care professionals should take the opportunity during annual physical examinations with young adult patients to discuss broader dietary patterns and health benefits related to adequate dietary calcium intake and overall diet. As well, researchers could work with public health organizations to develop health information that highlights the importance of consuming calcium-rich foods for young adults. This information could be distributed as pamphlets or posters to be placed in family physician waiting rooms, university/college student health services, and/or health and wellness workplace bulletin boards/newsletters.
In order to promote adequate dietary calcium intake, participants also felt that nutrition education should be incorporated into school curricula. Research has shown that eating patterns developed in early childhood persist into adulthood (Mikkila, Rasanen, Raitakari, Pietinen, & Viikari, 2005). Creating an environment in which children and adolescents are educated about nutrients and related health outcomes, particularly in combination with positive parental influence, may increase the motivation and efficacy to maintain these dietary habits throughout adulthood. Furthermore, information could continue to be disseminated to individuals throughout young adulthood through nutrition education campaigns developed for various environments (e.g., workplaces, university/college campuses, local community and athletic centres).

The findings of this study are novel, as our research group was the first to focus on the young adult population using SCT as a guide to developing a semi-structured interview and to determine key information to inform future nutrition education initiatives. Strengths include having elicited in-depth responses from participants to open-ended questions that may not otherwise be captured with a quantitative questionnaire (Krueger & Casey, 2009). Qualitative studies focusing on the young adult population are limited and dated, and therefore do not capture present day knowledge and attitudes towards, and facilitators of, dietary calcium intake. Research has shown that identifying key facilitators of behaviour change is best for health-related communication campaigns (Carpenter, 2010). Therefore, understanding the facilitators of dietary calcium intake will aid in developing key messages for future interventions. Furthermore, to our knowledge, no recent studies have asked young adults for their suggestions regarding how to disseminate calcium-related messaging to their age group. This information could be used to develop effective nutrition education intervention material.

Focus group methodology has inherent limitations. Individuals in a group may feel
insecure or embarrassed about sharing their thoughts and opinions. As a result, participants may feel the need to fabricate information, or conform their opinions to the dominant individual speaker within the group (Krueger & Casey, 2009). However, to limit these occurrences, a professional moderator skilled at minimizing this risk was hired to create a comfortable environment for participants.

Based on our findings, we feel that it is necessary to increase young adults' awareness of the health benefits of adequate calcium intake. As well, disassociating osteoporosis as a disease that only affects females, and increasing awareness of the concept of PBM, may facilitate adequate dietary calcium intake among young males and females, respectively. We also need to recognize the personal factors that may motivate young adults to consume calcium rich foods. Educating young adults about positive outcomes associated with increasing dietary calcium intake (e.g., increased mobility with aging, improved oral health) may motivate individuals to make this dietary change. To minimize potential barriers to adequate dietary calcium intake, young adults should be informed about the cost-effectiveness of milk products, shelf-stable milk, and production and farming practices in Canada. Lastly, the strategies participants recommended to increase dietary calcium intake, and the suggestions for disseminating calcium-related messaging, are key points to consider when developing intervention material relevant for young adults. Collectively, increasing knowledge about the health benefits of adequate dietary consumption for young adults, overcoming obstacles to adequate calcium intake, and providing unbiased information about the importance of adequate dietary calcium intake, may serve to increase the intake of calcium-rich foods among the young adult population.
Integrated Discussion

Summary of Findings

The purpose of this dissertation was to examine the determinants of dietary calcium intake in young adults aged 18 to 34 years. Our quantitative study aimed to assess the adequacy of dietary calcium and milk and alternatives intake, and to identify milk product health beliefs, in this population. Guided by our quantitative findings and the tenets of Social Cognitive Theory (SCT), our qualitative study explored young adults’ knowledge of the health benefits of dietary calcium and their perceptions of the importance of adequate dietary calcium intake. Further, we inquired into young adults’ recommendations for strategies to increase dietary calcium intake and for ways to promote adequate dietary calcium intake in this population through calcium-related messaging. The major findings of this dissertation are as follows:

1) Approximately one-third of the sample were not meeting the Estimated Average Requirement for calcium (800mg/day), and 52% of participants were not consuming the recommended servings of milk and alternatives per day for their age group (Health Canada, 2012). Participants who were meeting recommendations for milk and alternatives had significantly higher dietary calcium intake than those who did not meet recommendations for their age group. Due to having a higher caloric intake, more males were meeting dietary calcium and milk and alternatives recommendations more than females.

2) Despite expressing generally positive views towards milk products, participants voiced uncertainty about milk products’ relationship to health, nutritional value, and weight management. They were also critical of the dairy industry, raising concerns regarding
perceived adulteration of milk products and the questionable treatment of dairy cows. Having an increased confidence that milk products do not contain added antibiotics and/or hormones and that cows are humanely treated would act as motivators to increase dietary calcium and milk product intake.

3) Participants identified the importance of adequate calcium intake in relation to bone health for children and older adults, but they were unaware of its importance for their age group. Participants displayed particular confusion regarding the timing of peak bone mass (PBM). Participants suggested that calcium-related messaging should increase young adults’ awareness of the importance of adequate dietary calcium intake for their age group.

4) More females than males believed that increasing milk product intake would contribute to the maintenance of strong bones, and female participants indicated that they would be more motivated than male participants to increase dietary calcium intake if they were informed about PBM.

5) Participants expressed a desire to be better educated about calcium and its relation to health, and suggested that nutrition education should begin at an earlier age. Participants also expressed that they would like to be provided with unbiased nutrition information, in the form of advice from health professionals and research studies. Participants also recommended planning healthy, well-balanced meals and consuming calcium-rich foods habitually as strategies to ensure adequate dietary calcium intake.

This dissertation has discussed that many young Canadian adults, particularly females, are not meeting dietary recommendations for calcium, and identified the implications inadequate dietary calcium intake can have for overall health. As we expected, our quantitative findings in a
sample recruited from Southwestern Ontario were comparable to national Canadian data (Vatanparast et al., 2009), with our data showing that many participants had inadequate intakes of dietary calcium and/or milk and alternatives.

The milk and alternatives food group contributes a substantial amount of calcium to total daily intake. The food intake pattern (i.e., amount and type of food) recommended in the *Eating well with Canada's Food Guide (EWCFG)* contributes approximately 60% to dietary calcium intake from milk and alternatives, 16% from grain products, 16% from vegetables and fruit, and 8% from meat and alternatives. In addition to the milk and alternatives food group, the contribution of foods from the other food groups to dietary calcium intake was taken into account when evaluating the nutrient content of the food intake pattern (Health Canada, 2011). Individuals may limit or eliminate milk products from their diets for various reasons, such as perceived lactose intolerance, ethical considerations, and vegetarianism. Our quantitative findings showed that participants who were meeting the milk and alternatives recommendations for their age group had significantly higher dietary calcium intakes than those who were not meeting recommendations. This may indicate that these individuals who were below recommendations were not compensating for the decreased milk and alternatives intake by increasing their intake of calcium-rich foods from the other food groups. This is particularly evident as the intakes of the majority of our participants were inadequate in the number of servings for the vegetables and fruit and grain product food groups.

It is possible for individuals to find calcium replacement foods (e.g., fortified soy or orange beverages, leafy greens, or bony fish) (Fulgoni et al., 2011; Johnson, Frary, & Wang, 2002), and educated consumers may seek out these options when limiting or eliminating milk products from their diet. However, consumption of these calcium replacement foods is
unrealistic because individuals are either rarely consuming these foods, or they are not consuming enough servings to provide calcium-equivalent amounts similar to milk products (Fulgoni et al., 2011). Previous studies have reported that dependence on consuming plant-based food sources (Fulgoni et al., 2011; Weaver et al., 1999) and/or limiting milk product intake (Barr, 2013) is often unsuccessful for ensuring adequate dietary calcium intake. Calcium supplements may be an alternate option for individuals, but these attempts to compensate for low dietary calcium intake may not be a viable alternative to meet dietary requirements. For example, Barr (2013) reported that a larger proportion of those with perceived lactose intolerance consumed supplements containing calcium in comparison to individuals who did not identify as lactose intolerant (52% vs. 37%, p<0.001); yet, total calcium intake (diet + supplements) was found to be significantly lower in these individuals (739 ± 30 mg/d vs. 893 ± 13 mg/d, p<0.0001). Therefore, careful consideration must be taken when an individual chooses to limit their milk product intake.

An important factor to also consider is the impact of choosing replacement foods to increase a single nutrient intake on an individual's overall nutrient profile. Individuals with low dietary calcium intake may be at a higher risk for inadequacy of other nutrients, such as vitamin D, riboflavin, zinc, magnesium, and protein (Fulgoni et al., 2011; Rafferty et al., 2011). Therefore, consuming calcium-rich foods to increase dietary calcium intake will not account for the inadequacy of these related nutrients. For example, Fulgoni et al. (2011) demonstrated that calcium replacement foods (e.g., leafy greens, bony fish) may provide similar amounts of calcium in comparison to milk products, but these foods were not nutritionally equivalent to milk products. This may put individuals at a higher risk for inadequacy of other nutrients, as milk products are an excellent source of vitamin D (if fortified), riboflavin, phosphorus, potassium,
magnesium, zinc, vitamin A, vitamin B₁₂, and high-quality protein (Fulgoni et al., 2011). This is a concern, as some of these essential nutrients including, vitamin A, vitamin D, calcium, and magnesium, have been identified as shortfall nutrients in the Canadian diet (Health Canada, 2012a), and in our own quantitative findings.

Determining those who are at risk for low dietary calcium intake is important, as low calcium intake is associated with poor diet quality and an increased risk for nutrient inadequacy (Rafferty et al., 2011). This may be particularly true for individuals who limit consumption of, or avoid, milk products. Therefore, appropriate dietary strategies need to be developed to increase dietary calcium intake; acknowledging that for those individuals with decreased milk product intake will have to make substantial changes to their diet to increase the likelihood that they will meet requirements for nutrient intakes. Therefore, the finding that dietary calcium intakes are consistently inadequate among young adults highlights the need to understand the determinants of adequate dietary calcium intake in this population.

Additionally, adequate dietary calcium intake and its relation to bone health has been well documented in the literature, and milk products have been marketed towards adults as an excellent source of dietary calcium for the maintenance of strong bones and prevention of osteoporosis. Thus, we hypothesized that our participants would be aware of the bone health benefits related to obtaining adequate dietary calcium. As we expected, participants acknowledged the importance of adequate dietary calcium and milk product intake for overall bone health; however, many participants were uncertain of its particular importance in young adulthood, despite calcium’s continued importance for bone development well into adulthood, suggesting that participants were unaware of the opportunity in young adulthood to maximize bone mass accretion. In fact, our participants expressed that they were not aware of any targeted
messaging informing young adults to consider increasing dietary calcium intake for this reason. There was also no mention of the relation of calcium and other health-related outcomes beyond bone health. This apparent lack of knowledge of the importance of dietary calcium intake in young adulthood is concerning, because young adults may be less inclined to increase consumption of calcium-rich foods if they are unaware of the significant role dietary calcium has in relation to health outcomes. Therefore, young adults need to be better educated regarding the importance of adequate dietary calcium intake both for maximizing bone density and for maintaining overall health.

The fact that our participants perceived adequate dietary calcium intake to be important for children and older adults may, to a certain extent, explain why many participants were not meeting dietary calcium requirements. In order to gain a better perspective as to the reasons why young adults are not meeting recommendations, we explored the potential motivators and barriers to increasing dietary calcium intake. We hypothesized that our findings would capture factors other than those previously reported in the literature that may influence the dietary calcium intake of present-day young adults. The most novel findings of our work related to concerns regarding the perceived adulteration of milk products and humane treatment of dairy cows. These findings have been noted in more recent literature as potential deterrents to adequate milk product intake (Jung et al., 2014); however, our research group is the first to identify that having an increased confidence that dairy cows are humanely treated would likely motivate young adults aged 18 to 34 years to increase milk product consumption. Our finding that animal welfare is an important concern in the young adult population, and may be a significant barrier to adequate dietary calcium intake, has not been previously captured.
This finding could be the result of the emergence of ethical consumption; defined as the purchasing of products that are produced in a manner that meet a consumers’ ethical criteria (e.g., buying organic or Fair Trade foods) (Carrier, 2007). In Canada, 28-32% of young adults (20-34 years) have reported boycotting a product for ethical reasons, with some experts stating that young adults choosing to consume ethical products is an important way to become politically engaged (Turcotte, 2010). In Canada, there are governing bodies in place to ensure that dairy farmers are following best practices (NFACC, 2009). A code of practice has been developed by the Dairy Farmers of Canada and the National Farm Animal Council in collaboration with scientists, government experts and the Canadian Federation of Humane Societies to lay out the expectations for standards of care to be provided to farm animals in Canada (NFACC, 2009). Despite these efforts, consumers may not have the confidence that the dairy industry is being held accountable when these standards are not met; particularly in light of the 2014 animal abuse allegations against a dairy farm in Chilliwack, British Columbia (BC). These types of media reports can impact a consumer's perception of the Canadian dairy industry. Subsequently, consumers may not trust any claims the industry may make regarding farming practices that are of sound nature.

This presents a challenging situation for the dairy industry; however, a consumer’s perception towards an industry's attempt to be transparent about production can have an influential role in building consumers' trust and positive attitudes towards that industry (Kang & Hustvedt, 2014). Therefore, by asking the dairy industry to communicate directly to consumers their efforts to ensure that dairy farmers are following best practices may increase consumer trust in the dairy industry. Although, this can be a difficult conversation for an industry to admit where there are faults in their management of misconduct, this conversation can be beneficial
for their relationship with the consumer (Kang & Hustvedt, 2014). For example in an effort to rectify the situation in Chilliwack, the Provincial Government, working with the BC Dairy Association and the BC SPCA, has taken steps to ensure better treatment of dairy cows in BC. On July 8, 2015 the BC government announced it will adopt a new regulation to improve protection of dairy cattle within the Prevention of Cruelty to Animals Act. The Dairy Farmers of Canada expects all dairy farmers to implement the code of practice, as these codes will now constitute what is considered reasonable and accepted practices in any future investigations launched under BC's Prevention of Cruelty to Animals Act ("Humane Treatment for Dairy Cattle," 2015). Therefore, to build consumers' confidence this will involve efforts from all stakeholders including: governing bodies supplying unbiased information to Canadian consumers regarding farming practices of dairy farmers; the dairy industry must be transparent to build and/or regain trust with milk product consumers; researchers can explore the salient cognitions of young adults' and ethical consumption; and, consumers can take actions themselves to influence over industry and government policy based on their ethical considerations.

Lastly, recognizing that previous studies have identified gender differences regarding the determinants of dietary calcium intake, we hypothesized that we would observe differences between males and females with regard to both attitudes and beliefs regarding milk products, and the factors that may influence young adults to either increase or limit calcium-rich foods. In our quantitative findings, the main differences we noted were that more females than males agreed that increasing dietary calcium and milk product intake would help to maintain stronger bones, and that a larger proportion of females would increase milk product intake if they were confident that dairy cows were humanely treated and that milk products did not contain antibiotics and/or
hormones. In our qualitative findings, we identified that being made aware of PBM would be a motivator for female participants to increase dietary calcium intake. Conversely, male participants expressed that having this knowledge should, but would not, be a motivator to increase their dietary calcium intakes. Additionally, female participants cited the importance of adequate dietary calcium intake during pregnancy and for maintaining their own health for the sake of their children. These differences suggest that in order to promote adequate dietary calcium intake in both genders, health-related calcium messaging should target males and females separately.

**Contributions of this Dissertation**

The major contribution of our work was the generation of information that is relevant to present day young adults, which will be informative for the development of future evidence-based material for nutrition education interventions and knowledge translation (KT) initiatives.

Previous research has helped build a foundation for understanding the motivators and barriers to calcium intake by establishing the determinants of dietary calcium intake in adults. However, motivators and barriers to adequate dietary calcium intake have not been extensively explored in the young adult population, particularly with regard to the attitudes and beliefs that influence dietary calcium consumption. In light of the challenges the dairy industry has been facing in the last 20 years, with a decline in the demand for milk products (Atkins, 2015; CDIC, 2013) and a distrust of the dairy industry and its marketing claims (Atkins, 2015; Jung et al., 2014; Nolan-Clark et al., 2011), we must consider that there may be additional factors influencing dietary calcium intake than those previously reported. Therefore, we undertook our work, through the use of quantitative and qualitative methodologies, to thoroughly examine the determinants of dietary calcium intake in young adults aged 18 to 34 years.
Our quantitative study was conducted to investigate young adults’ milk product health beliefs, and to determine whether there was a relationship between gender and milk product health beliefs. As we have discussed, the most novel finding of our quantitative work was that more females than males would be more likely to increase milk product intake if they were confident that milk products did not contain added antibiotics and/or hormones and if dairy cows were humanely treated. Although the questionnaire used provided insight into young adults’ attitudes and beliefs regarding milk products, its quantitative nature limited our interpretation of participant responses.

Our qualitative study grounded in SCT, was conducted to contextualize certain aspects of our quantitative findings, such as the perceived treatment of dairy cows, and to explore in-depth young adults’ knowledge of calcium in relation to health and the factors that may influence dietary calcium intake. To our knowledge there are no studies that inquire into young adults’ knowledge of PBM and its timing, and was one aspect in particular that we wanted to explore through the use of focus groups. Given that certain skeletal sites can accumulate bone mass into the fourth decade of life (Berger et al., 2010), it was imperative to discover whether young adults were conscious of PBM and its relation to adequate dietary calcium intake, and if having this knowledge would motivate individuals to increase consumption of calcium-rich foods.

Additionally, our qualitative work provided a forum for young adults to give their suggestions for strategies to increase dietary calcium intake. Our findings identified that young adults were more concerned with planning healthy, well-balanced meals to ensure adequate dietary intake of all nutrients, rather than meal planning with specific nutrient recommendations in mind. These findings reflect previous studies emphasizing that making food choices based on
a desired adequacy for a single nutrient (Fulgoni et al., 2011) and mono-nutrient treatment strategies (Rafferty et al., 2011) are not ideal goals for dietary planning.

The EWCFG was developed to promote a desirable pattern of eating for Canadians, and to assist individuals with making food choices that promote overall health and reduce the risk of nutrition-related chronic disease (Katamay et al., 2007). However, researchers have indicated a need to update the EWCFG given the number of limitations in the development; changes in the Canadian food supply; more available national data from nutrition surveys; and, recent advances in dietary guideline development methodology (Jessri & L'Abbe, 2015). Furthermore, the EWCFG has gone under public scrutiny with many individuals criticizing the current recommendations, particularly with the milk and alternatives food group. These criticisms have been highly publicized in the media in the last few years including: the guide promotes weight gain; the guide does not reflect current food choices of Canadians; the guide is driven by industry; and, the guide does not make provisions for "other foods" which account for 25% of our calories (Picard, 2014). Individuals are particularly lobbying to remove the milk and alternatives food group. Milk products are perceived to contribute substantial amounts of sugar and calories to our diets and its placement in the EWCFG is assumed to be solely driven by industry (Hamilton, 2015). Researchers would argue instead that milk products are nutrient-dense and the lowest-cost source of dietary calcium in the diet, and are important contributors of essential nutrients to the diet that are associated with health outcomes, such as osteoporosis, diabetes, and cardiovascular disease (Drewnowski, 2011; Fulgoni et al., 2011).

In our focus groups, the EWCFG was not discussed as a tool that could be used to assist individuals to ensure they are obtaining adequate dietary calcium intake. In fact, some participants mentioned that they do not actively consider the food guide while grocery shopping
or preparing meals. This may partly explain participants' suggestions that nutrition education should be incorporated into school curricula, with the intention to provide individuals with the information (e.g., healthy food choices) and skills (e.g., cooking) they will require in young adulthood to maintain healthy overall dietary habits. Other countries, such as Brazil, are moving away from guides that are categorized based on food type towards guides that provide guidelines to achieve a healthy diet including but not limited to, recommending whole foods, discussing contexts in which food should be eaten, promoting development of cooking skills, and being conscious of food marketing and advertising (FAO, 2015). Our work identified that young adults may appreciate a focus on whole foods and overall health rather than a reductionist view point singling out individual nutrients. Therefore, perhaps young adults would be more receptive to national dietary recommendations that promote strategies for healthy eating rather than recommendations for servings based on food groups.

Lastly, our qualitative work provided a forum for young adults to give their suggestions for on ways to effectively disseminate calcium-related messaging to their age group. Our participants mainly believed that advertising through television or social media campaigns would not be effective in engaging the young adult population, as they felt young adults ignore current messaging and were mistrustful of perceived bias sources such as the dairy industry. Our findings are counterintuitive, as research has shown that adult Internet users are increasingly using social media to access health information (Neiger et al., 2012). Instead, participants suggested that trusted advice from health professionals would be more effective for communicating nutrition information to young adults. The implication of these findings is that young adults are becoming increasingly critical of the nutrition information they are receiving.
This should be an important consideration in nutrition education interventions when determining the manner of communicating educational material to young adult participants.

**Limitations and Future Directions**

Although our study yielded important information regarding the determinants of dietary calcium intake in young adults, we acknowledge that our study sample in both studies were not representative of the general young adult population. However, we did identify that even well-educated young adults were uncertain regarding what information to believe regarding milk products and were not aware of the specific benefits of ensuring adequate dietary calcium intake for their age group. We also did not develop and pilot specific messages based on our findings to be used for calcium-related messaging based on our findings. Instead, our two studies were meant to be exploratory in nature to fill the gaps in the literature that we have identified, and to provide information that may contextualize why or why not young adults are meeting dietary calcium recommendations.

Lastly, the original goal of the qualitative study was to examine the attitudes, knowledge and beliefs towards dietary calcium of low- and high calcium consuming young males and females. Particularly, we wanted to investigate self-regulatory behaviours of high dietary calcium consumers to determine effective strategies that could be used to encourage those with low intakes to increase their dietary calcium intake to meet recommendations. Unfortunately, recruitment proved to be more challenging than expected. Our efforts to reach a young adult population included, but were not limited to, advertising through online ads (e.g., kijiji), distributing recruitment posters throughout the city in areas young adults frequently visit (e.g., coffee shops, mall, gyms), student volunteers recruiting in person downtown Guelph and Hamilton (e.g., local farmer's market), reaching out to local companies/industries to recruit
young adult employees (e.g., Sleeman Breweries in Guelph), approaching local sports teams, and word of mouth.

Despite our best efforts, we were unable to recruit enough participants to hold gender specific low-and high calcium consuming focus groups within our anticipated timeframe (May 2014-August 2014). Instead, we chose to focus on recruiting participants for only gender specific focus groups, and recruitment was completed in March 2015. We often noticed during recruitment that older individuals were interested in participating in our study, but the interest from the young adult population was minimal. The term "young invincibles" has been used to describe young adults, as this age group often elicits feelings of invincibility and disregard for future health consequences (Bibbins-Domingo & Burroughs Pena, 2010). Therefore, this may explain young adults' lack of interest in joining a focus group study in which they would discuss dietary calcium and its relation to health outcomes, such as osteoporosis.

Therefore, the following are suggestions for future research:

1. Future studies should recruit a larger, more diverse sample stratified by ethnicity, education, geographical location, and/or income, as these variables might reveal that dietary intakes, and individual attitudes and beliefs about calcium and health, will vary among subgroups. Future research should aim to further refine these results by considering variables other than gender in constructing a profile of dietary calcium intake in young adults.

2. Future studies should investigate self-regulatory behaviours in young adults with high and low dietary calcium intakes. Identifying successful self-regulatory strategies in high calcium consumers could provide useful information for those failing to meet dietary
calcium recommendations. Exploring the behaviours of low calcium consumers may provide a deeper understanding of the barriers to increasing dietary calcium intake in these individuals.

3. Future studies should build from the findings of this dissertation, and the suggestions discussed in (1) and (2), to pilot key messages based on participant suggestions to determine how to effectively communicate strategies to increase dietary calcium intake to the young adult population.

4. Few studies have tested the effectiveness of the constructs of SCT with regard to predicting changes in dietary behaviour (Contento, 2011); particularly in relation to dietary calcium intake in young adults. Once appropriate messages have been developed and piloted, nutrition education interventions can be done to test the various components of SCT in predicting dietary calcium intake in young adults.

Additionally, a key finding of this dissertation was that there is a need for targeted information, addressing the specific needs of this population, to be disseminated to young adults. This information should include increasing young adults’ awareness of the importance of adequate dietary calcium intake in relation to bone and overall health, addressing current misperceptions regarding milk products, and improving consumer knowledge regarding the nutritional benefits of milk products and other calcium-rich and nutrient-dense sources. These initiatives can be implemented by researchers, public health advocates, health care professionals, and/or the dairy industry to promote the importance of adequate dietary calcium intake in the young adult population. The following are suggestions for knowledge translation initiatives:
1. Researchers can raise awareness about the reasons young adults choose to consume or not consume calcium-rich foods, and share effective strategies to encourage young adults to increase dietary calcium intake. Researchers can disseminate this information amongst various knowledge translation users such as dietitians and physicians. For example, researchers could host “Lunch and Learns” for health care professionals to provide a forum to disseminate and discuss this information.

2. Researchers could also work with public health organizations to convey calcium-related messages to young adult consumers. Plain language research summaries (e.g., pamphlets) and infographic posters that visually represent research findings could be developed to highlight key facts about dietary calcium and health-related and dietary benefits that would be relevant to young adults. This information could be made available in health care settings such as patient waiting rooms (e.g., walk-in clinics, family physician offices, student health services). As well, information should be disseminated through nutrition education campaigns developed for various environments (e.g., workplace wellness programs, university/college campuses, local community and athletic centres).

3. Health care professionals should take responsibility to ensure they are communicating unbiased nutrition information to help their patients adequately meet nutrient needs, particularly for those individuals limiting milk product intake or who have a family history of osteoporosis. For example, the dietetic community should ensure that individual counselling strategies take into account the factors that may influence young adults' dietary calcium intake. Dietitians can also take opportunities to disseminate
unbiased nutrition information during individual counselling sessions, through online resources (e.g., blogs, online articles), and while interacting with young adult consumers as in-store dietitians. As well, general practitioners in private practice or in student health services should take opportunities to discuss broader dietary patterns and health benefits related to adequate dietary calcium intake with their young adult patients when the opportunities arise.

4. With the most recent developments under the Trans-Pacific Partnership trade deal that will allow an increase in milk product imports from the United States and other countries ("TPP would allow milk from cows receiving hormones into Canada," 2015), there will need to be a collective effort between governing bodies and the dairy industry to communicate with consumers in a transparent manner, particularly regarding the regulation of production and farming practices in Canada. This could involve milk product packaging containing a quick response (QR) barcode that could supply further information regarding the origin of the product, its nutritional content in relation to health benefits, and the farming practices involved in its production.
Conclusion

In summary, this dissertation explored the potential determinants of dietary calcium intake in a young adult population aged 18-34 years, using both quantitative and qualitative methods. We identified that while many young adults acknowledged the health benefits of adequate dietary calcium and/or milk product intake, even well-educated young adults were not aware of the specific benefits of increasing dietary calcium intake for their age group. Despite a general liking of milk products, the majority of the deterrents to adequate dietary calcium intake cited by participants were mainly based on negative perceptions relating to various aspects of milk products (e.g., adulteration of milk products, uncertainty of the role in weight management, conflicting messaging, nutritional value). We also identified that approximately one-third and one-half of participants were not meeting the recommendations of dietary calcium and milk and alternatives intake for their age group, respectively. Suggestions to increase dietary calcium intake included making calcium-rich food consumption habitual and planning well-balanced, healthy meals. Lastly, nutrition education at an earlier age and unbiased information provided by health professionals were suggested as effective messaging to engage with the young adult population to promote adequate dietary calcium intake.
References


Poddar, K. H., Hosig, K. W., Anderson, E. S., Nickols-Richardson, S. M., & Duncan, S. E. (2010). Web-Based Nutrition Education Intervention Improves Self-Efficacy and Self-


Appendix A: CADIA Study Recruitment Poster

**HOW DOES CALCIUM & DAIRY AFFECT YOUR WEIGHT, LIFESTYLE & OVERALL HEALTH???**

**PARTICIPANTS NEEDED FOR THE "CALCIUM AND DAIRY INTAKE ASSESSMENT (CADIA) STUDY"**

We are recruiting a diverse group of **men and women** (18-34 years old).

**HOW WILL YOUR PARTICIPATION BENEFIT YOU?**

- **Learn about your body composition**
- **Receive feedback based on a nutritional analysis of your diet.**
- **Receive resources regarding healthy eating and how calcium and dairy play a role.**

Your participation will involve completing a 3-day food record prior to your visit, and a **1 hr session** in the Body Composition and Metabolism Lab located at the University of Guelph.

You will receive a **$10 Zehrs gift card** and take home "grab bag" with fun items!

This project requires interaction one on one with a female researcher and wearing tight fitting clothing. Please contact Michelle to see whether you are eligible and to discuss any concerns:

519-824-4120 ext. 56715
bodycomp@uoguelph.ca
[www.uoguelph.ca/bodycomp](http://www.uoguelph.ca/bodycomp)
J.T. Powell Building, Rm 206, University of Guelph
Appendix B: CADIA Study Consent Form

CONSENT TO PARTICIPATE IN RESEARCH

The Calcium and Dairy Intake Assessment (CADIA) Study

You are being asked to participate in a research study conducted by Dr. Andrea Buchholz (Faculty Investigator/Supervisor), Dr. Janis Randall Simpson (Co-Investigator) of the Department of Family Relations and Applied Nutrition at the University of Guelph, Dr. Susan Whiting (Co-investigator/Advisor) of the Division of Nutrition and Dietetics at the University of Saskatchewan, and Michelle Marcinow (University of Guelph Graduate Student Investigator). The results of this study will be part of a doctoral student thesis project and research publications.

If you have any questions or concerns about this project please feel free to contact:
- Faculty Investigator: Dr. Andrea Buchholz, tel 519-824-4120 ext 52347, email abuchhol@uoguelph.ca
- Graduate Student Investigator: Michelle Marcinow, tel 519-824-4120 ext 56715, email mmarcino@uoguelph.ca

PURPOSE OF THE STUDY
To learn what factors affect calcium and dairy intake in young adults and to explore the differences between dairy and non-dairy consumers (i.e., gender, body weight, physical activity).

PROCEDURES
If you volunteer to participate, we would ask you to come into the University of Guelph Body Composition and Metabolism Lab (Room 206 of the J.T. Powell Building) for a one time visit and ask you to complete the following items:

Prior to the Study Visit
We will mail or e-mail you a 3-day food record and ask that you fill out this record and bring this record completed to your scheduled study visit. For this record we ask that you write down anything that you eat and drink for three consecutive days. We ask that you pick two weekdays and one weekend day that resemble your normal eating patterns.

During the Study Visit
To begin, we will provide you with an overview of the sequence of events for this study visit and collect your completed 3-day food record. The study visit will take approximately 1 hour and consists of two parts:
Part 1: Questionnaires (Approximately 40 minutes):
We will ask that you fill out the following four questionnaires during your study visit.

1. General background questionnaire about your health and lifestyle.
2. A food frequency questionnaire about your usual calcium and dairy intake.
3. A body image questionnaire.
4. A physical activity questionnaire.

You can decline to answer any question(s).

Part 2: Body Composition (Approximately 20 minutes):
First we will measure your height, weight and hip measurement. Next your body composition will be assessed by using an instrument called the BODPOD™. The BOD POD™ is fast and safe and takes very accurate measurements of your weight and volume (size of your body).

Anything that isn't "you"-including clothing, jewelry, or eyeglasses-can produce inaccurate results. Therefore, we ask that you bring minimal, form-fitted clothing such as a Spandex® swimsuit. We will also ask that you wear a swim cap (provided) to prevent any air pockets from developing in your hair. We will also ask that you do not eat, drink (other than water) or exercise 2 hours prior to the BOD POD™ test. The BOD POD™ is an extremely sensitive machine and the results can be affected by minor changes in body weight and body temperature. Following these recommendations will ensure that your results are as accurate as possible.

We recognize the intimate nature of these measurements. You will be provided with a private area to dress and will be provided with a gown to wear until the moment you are required to step into the BOD POD™. There is also a film on the window of the lab, preventing passersby from seeing into the lab. You will not be required to partake if you feel in any way uncomfortable. Even if you agree to do the test, you can withdraw at any time.

POTENTIAL BENEFITS TO PARTICIPANTS
There are no direct benefits to you for participating in this project, however, you will receive a data printout of your body composition, feedback of your diet analysis, and resources regarding healthy eating and how calcium and dairy play a role.

POTENTIAL RISKS AND DISCOMFORTS
There are minimal risks by taking part in this study. However, the researchers wish to be inclusive in their recruitment process. This project requires interaction one on one with a female technician/researcher and requires tight fitting clothing or swimwear to be worn. If for any reason you may feel uncomfortable to take part in this study, please contact the researcher to discuss modifications to the procedure to address your concerns.

The risk of claustrophobia is very low as there is a large, clear Plexiglas window at the front of the instrument. Should you nonetheless feel uncomfortable, there is “stop test” button located under your left knee. You can press this button at any time to automatically stop the test and disengage.
the door. Alternatively, you can simply tell the graduate student investigator through the Plexiglas window that you would like the test stopped. While the whole test takes approximately 15 minutes, you will sit in the BOD POD™ for only about 5 minutes. Participants must also fast for a short period prior to this test. This involves no eating or drinking (other than water) for 2 hours prior. We will provide you with a juice box and granola bar after the test.

You may also feel that there are some personal questions that we ask of you, such as questions about your body image, which may make you feel uncomfortable. If this is the case you may choose not to complete the questionnaires. We will also provide you with a list of resources in case you have further questions or concerns based on your participation in the study.

PAYMENT FOR PARTICIPATION
As an appreciation for your time you will receive a $10 Zehrs gift card and will receive a "grab bag" containing informational pamphlets regarding healthy eating, coupons to local businesses, and small items donated from local businesses (i.e., fridge magnets, pens, etc). In-kind funding for the "grab bags" are provided for by Organic Meadows, the Dairy Farmers of Canada, and the Dairy Farmers of Ontario.

CONFIDENTIALITY
Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study. The only individuals that will have access to your data will be the faculty investigator (Dr. Andrea Buchholz), co-investigators (Dr. Janis Randall Simpson and Dr. Susan Whiting), and the graduate student investigator (Michelle Marcinow). Data will be coded and stored in password-protected computer files. Thus your individual data will not be identifiable with your name. Any results published or presented will be done using group data and/or coded (unidentifiable) individual results. Data (including the master list that connects your study number with your name) will be stored in the lab until publication, after which it will be shredded and discarded in confidential waste. You may choose to withdraw your data up to one month after your completed study visit. The results of this study will be part of a doctoral student thesis project and research publications. We will not use any of your data for anything other than what we have specified.

PARTICIPATION AND WITHDRAWAL
You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without penalty, and will still be compensated. You may exercise the option of removing your data from the study up to one month after your study visit. You may also refuse to answer any questions you do not want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

RIGHTS OF RESEARCH PARTICIPANTS
You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through the University of Guelph Research Ethics Board. If you have questions regarding your rights as a research participant, contact:
Sandy Auld, Research Ethics Coordinator
University of Guelph
437 University Centre
SIGNATURE OF RESEARCH PARTICIPANT
I have read the information provided for the CADIA study as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I also agree to allow the investigators to use my anonymized data in a research publication(s). I have been given a copy of this form.

PARTICIPANT

_________________________________________  ____________________________________________
(Printed name)  (Signature)

_________________________________________
(Date)

WITNESS

_________________________________________  ____________________________________________
(Printed name)  (Signature)

_________________________________________
(Date)
Appendix C: CADIA Study Demographic Questionnaire

The Calcium and Dairy Intake Assessment (CADIA) Study

Demographic and Milk Product Belief Questionnaire

Section One: Demographics

1. Date of birth: ___/____(mm/yyyy)

2. Gender:
   □ male

3. How do you define yourself? (Check all that apply)
   □ White, Caucasian
   □ Black, African Canadian, African American
   □ Middle Eastern, Arabic
   □ South Asian (i.e., Indian, Pakistan)
   □ East Asian (i.e., China, Japan)
   □ Southeast Asian (i.e., Thailand, Philippines, Malaysia)
   □ Hispanic
   □ Native
   □ Other (specify):______________________

4. Employment Status:
   □ Employed
   □ Self-employed
   □ Student
   □ Stay at home mom/dad
   □ Unemployed

5. Highest level of education:
   □ High School
   □ College
   □ Undergraduate degree
   □ Graduate degree
   □ Other (Please specify):______________________
6. Income:
   □ < 15,000
   □ < $15,000 - $34,999
   □ $35,000 - $74,999
   □ $75,000 or more
   □ Prefer not to answer

7. Marital Status:
   □ Single
   □ Married/Common law
   □ Separated/Divorced
   □ Widowed
   □ Prefer not to answer

Section Two: Health Conditions

1. Do you have any of the following health conditions?
   □ Cardiovascular Disease
   □ Diabetes
   □ Hypertension
   □ Hypercholesterolemia
   □ Crohn's Disease
   □ Celiac Disease
   □ Other (specify): ____________________________________________________________

2. Are you currently taking any prescription medications? If so, please list:
   __________________________________________________________________________
   __________________________________________________________________________

3. Do you believe you are lactose intolerant?
   □ Yes
   □ No (If no, skip to #7)
   □ I do not know

4. Why do you think that you are lactose intolerant? (check as many responses as apply to you)
   □ I have discomfort after eating milk products (gas, bloating, cramps, diarrhea)
   □ A health professional told me I was lactose intolerant
   □ Based on information from the media or other source
   □ Based on family history
   □ Word of mouth, talking with friends
   □ Don't know
   □ Other (please specify): _____________________________________________________
5. What changes did you make to your diet as a result of being lactose intolerant? (choose one response that best describes what you did) I

□ I didn't make any changes
□ I switched to lactose-free products and did not change the overall amount of milk products I use
□ I slightly reduced the amount of milk products I use but I still use them frequently
□ I greatly reduced the amount of milk products I use, but I still use them once in a while
□ I eliminated some milk products from my diet (e.g., milk) but still use others (e.g., cheese or yogurt)
□ I eliminated all milk products from my diet
□ Other (please specify):________________________________________

6. If you could avoid the symptoms of lactose intolerance, would you be willing to add more milk and milk products to your diet?

□ Yes
□ No
□ I do not know

7. Do you believe you have a milk allergy?

□ Yes
□ No (If no, skip to section three)
□ I do not know

8. Why do you think you have a milk allergy? (choose one response that best describes what you did)

□ Abdominal symptoms (pain, cramps, gas, bloating)
□ Skin symptoms (hives, eczema, rash)
□ Sneezing, itchy/watery eyes, runny nose, wheezing
□ A doctor or other health professional told me I was allergic
□ Based on information from the media or other source
□ Based on family history
□ Talking with friends, word of mouth
□ Don't know
□ Other (please specify):________________________________________

9. What changes did you make to your diet as a result of having a milk allergy? (choose one response that best describes what you did)

□ I didn't make any changes
□ I slightly reduced the amount of milk products I use but I still use them frequently
□ I greatly reduced the amount of milk products I use, but I still use them once in a while
□ I eliminated some milk products from my diet (e.g., milk) but still use others (e.g., cheese or yogurt)
□ I eliminated all milk products from my diet
□ Other (please specify):________________________________________
Section Three: Milk Products and Health

The following section focuses on milk products, which we are primarily referring to cow's milk, cheese and yogurt (not soy milk or other plant-based alternatives).

1. People have different beliefs and opinions about milk products (milk, cheese, yogurt), and how they affect health. Please read each statement carefully and indicate whether you disagree, are neutral, or agree with it.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Disagree strongly</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>It’s easy to get the nutrients you need without using any milk products in your diet.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>I would feel I was looking after myself if I had more milk products every day.</td>
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<tr>
<td>Increasing my milk product intake would help me maintain stronger bones.</td>
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<tr>
<td>Overall, I think I would be healthier if I kept my milk product intake to a minimum.</td>
<td></td>
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</tr>
<tr>
<td>In my opinion, a diet that includes milk products is healthier than one without milk products.</td>
<td></td>
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</tr>
<tr>
<td>Milk products are NOT important to the health of adults of my age.</td>
<td></td>
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</tr>
<tr>
<td>I’d rather get the calcium and vitamin D I need from supplements than from milk products.</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
2. For each of the statements below, please indicate whether you disagree with it, are neutral, or agree with it.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Disagree strongly</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think that milk products contain antibiotics and unnatural hormones.</td>
<td></td>
<td></td>
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<tr>
<td>Milk is expensive compared to other beverages.</td>
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<tr>
<td>I enjoy the taste of cheese and/or yogurt.</td>
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<tr>
<td>I don’t like the taste of milk.</td>
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<tr>
<td>There are so many different things being said about milk products that it’s hard to know what I should believe.</td>
<td></td>
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</tr>
<tr>
<td>Milk products are important to include when people are trying to control their weight.</td>
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<tr>
<td>Having more milk products would provide extra calories I’d rather not have.</td>
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<td></td>
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<tr>
<td>Overall, I think organic milk products are better for me than conventional milk products.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Milk products are hard for me to digest</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
3. What effect, if any, would each of the following have on your intake of milk and milk products?

<table>
<thead>
<tr>
<th>Effect</th>
<th>Definitely no effect</th>
<th>Probably no effect</th>
<th>Might or might not change</th>
<th>Probably would increase</th>
<th>Definitely would increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better taste in general</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less expensive organic milk and milk products</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>More attractive packaging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longer shelf-life (less likely to spoil)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommendation by a health professional I trust</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Being confident they do not contain antibiotics or unnatural hormones</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being confident that the cows are humanely treated</td>
<td></td>
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<tr>
<td>Available in more places (e.g., vending machines)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower cost of milk products in general</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More studies showing they are good for my health</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Better taste of low-fat or fat-free choices</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Appendix D: Anthropometric, Body Composition, Physical Activity and Body Image Measurements of Body Composition, Body Image, Physical Activity of Calcium and Dairy Intake Assessment Study (CADIA) Participants

Anthropometric and body composition measurements were collected by trained research assistants (M.L.M, H.A.S). Height was measured using a wall-mounted stadiometer (Seca Corp., Ontario, CA) to the nearest 0.1 cm. Weight and percent body fat was measured using the BOD POD® (Cosmed, Concord, CA) to the nearest 0.1 kg and as a %, respectively. Body mass index (BMI) was calculated as kg/m$^2$. The BOD POD™ itself consists of two chambers, the test chamber (front) and the reference chamber (rear). Participants were asked to sit within the front chamber on the seat for the duration of the test. Participants were asked to wear minimal, form-fitting clothing such as lycra, Spandex swimsuit, and single-layer compression shorts and/or lightweight jog bras, as the BOD POD™ takes very accurate measurements of weight and volume therefore any excess material or objects can produce inaccurate results. Participants were also asked to wear a swim cap to compress any air pockets within the hair. There is no fasting required for this test however, participants were asked not to eat or drink immediately prior to the BOD POD™ test. The test took approximately 15 minutes.

Physical activity was assessed using the long form version of the 31-item International Physical Activity Questionnaire (IPAQ) that collects detailed information about the following domains: Leisure time and physical activity, domestic and gardening (yard) activities, work-related physical activity, and transport-related physical activity. Data collected will be reported as a continuous measure by weighting the reported minutes per week within each activity category but a MET energy expenditure estimate assigned to each category (Ainsworth).

Body image was assessed using the 23-item Body-Esteem Scale for Adolescents and Adults (BESAA). Each item includes a five point Likert scale ranging from 0 (never) to 4 (always); scoring is based on participants' agreement or disagreement with the positively or negatively worded statements. Negative items, which are marked with an asterisk, must be reversed by re-coding the scale (i.e., 0=4, 1=3, 2=2, 3=1, 4=0). The total score places the participant on a continuum of body esteem (scores ranging from 0 to 92), with higher scores reflecting a poorer body image.


<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Male</th>
<th>Female</th>
<th>p-value&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=79</td>
<td>n=40</td>
<td>n=39</td>
<td></td>
</tr>
<tr>
<td>Body Fat, %</td>
<td>24.2 ± 11.9</td>
<td>17.1 ± 9.3</td>
<td>31.5 ± 9.8</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>WC, cm</td>
<td>87.3 ± 11.2</td>
<td>90.0 ± 11.1</td>
<td>84.4 ± 10.6</td>
<td>.91</td>
</tr>
<tr>
<td>Height, cm</td>
<td>171.4 ± 12.8</td>
<td>179.3 ± 9.9</td>
<td>163.3 ± 10.0</td>
<td>.73</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>77.4 ± 18.5</td>
<td>86.5 ± 16.5</td>
<td>68.9 ± 16.6</td>
<td>0.74</td>
</tr>
<tr>
<td>BMI, kg/m&lt;sup&gt;2&lt;/sup&gt;</td>
<td>26.4 ± 6.0</td>
<td>26.85 ± 5.5</td>
<td>26.1 ± 7.0</td>
<td>.12</td>
</tr>
<tr>
<td>IPAQ, MET-min/week&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5000.9 ± 4769.9</td>
<td>6268.9 ± 5703.4</td>
<td>3700.4 ± 3144.8</td>
<td>.02</td>
</tr>
<tr>
<td>BESAA score&lt;sup&gt;b&lt;/sup&gt;</td>
<td>52.9 ± 14.3</td>
<td>56.1 ± 14.6</td>
<td>49.6 ± 13.4</td>
<td>.04</td>
</tr>
</tbody>
</table>

Mean Values for Anthropometric, Body Composition, Physical Activity and Body Image Measurements of Body Composition, Body Image, Physical Activity of Calcium and Dairy Intake Assessment Study (CADIA) Participants

<sup>a</sup> >3000 MET-minutes/wk considered to be high active

<sup>b</sup> BESAA score is a continuous score ranging from 0-91 (Higher score=Increased body image)

<sup>c</sup> Independent t-test used for statistical analyses
Appendix E: CADIA Study 3-day Food Record

Three-Day Food Record

Participant ID#: ________________________________
Dates of recorded intake: _________________________
Interviewer: ____________________________________
Interviewer Contact Information: __________________

Instructions for Keeping Your Three-Day Food Record

- Please keep your three-day food record for three consecutive days.
- The days should include two weekdays and one weekend day.
- Select days that closely resemble your usual eating habits.
- Each time you eat or drink anything (meals, snacks, etc.) during the three days, write down what and how much you ate.
- Indicate what you consumed not what you had on your plate.
- Include any supplements you are taking. Record the brand name (e.g., Centrum® Women under 50) or type (e.g., 400 IU Vitamin D) and amount taken (e.g., 1 tablet every day).
- To measure how much was eaten, use a set of measuring cups and spoons to help estimate amounts. Also see the examples below to estimate portion sizes.
- Note if food choices are homemade or purchased. Please include brand names whenever possible.

Amounts and Conversions
1/4 cup = 50 ml or 4 Tablespoons
1/3 cup = 75 ml or 5 1/2 Tablespoons
1/2 cup = 125 ml or 8 Tablespoons
2/3 cup = 150 ml or 10 1/2 Tablespoons
3/4 cup = 175 ml or 12 Tablespoons
1 cup = 250 ml or 16 Tablespoons
1 oz = 1 slice of processed cheese or lunchmeat
### How to Estimate Your Portion Size

<table>
<thead>
<tr>
<th>Meat</th>
<th>Three (3) ounces of meat are about the size and thickness of a deck of playing cards or an audiotape cassette.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td>A medium apple or peach is about the size of a tennis ball.</td>
</tr>
<tr>
<td>Grains</td>
<td>One cup of rice or pasta is about the size of your fist.</td>
</tr>
<tr>
<td>Cheese</td>
<td>One ounce of cheese is about the size of four dice.</td>
</tr>
</tbody>
</table>

### Three-Day Food Record Checklist

<table>
<thead>
<tr>
<th>Beverages</th>
<th>What kind of milk? Homo, 2%, 1%, skim, other. Was it fruit juice or fruit beverage or drink?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breads</td>
<td>Did you spread on butter or margarine?</td>
</tr>
<tr>
<td>Cereal</td>
<td>Did you add milk? Did you add sugar or fruit?</td>
</tr>
<tr>
<td>Dairy</td>
<td>What brand or kind of yogurt? What brand or kind of cheese?</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Was it raw or cooked? Was it fresh, frozen or canned? Did you add any butter, margarine or sauce?</td>
</tr>
<tr>
<td>Fruit</td>
<td>Was it a small, medium or large fruit? Was it fresh, frozen or canned?</td>
</tr>
<tr>
<td>Grains</td>
<td>Did you add any butter, margarine, peanut butter, jam or honey? Was it a half or whole sandwich? Was it a small or large muffin or bagel?</td>
</tr>
<tr>
<td>Fish</td>
<td>Was your canned fish packed in water or oil How did you cook your fish?</td>
</tr>
<tr>
<td>Meats</td>
<td>How did you cook your meat? What kind of cut was it e.g. chicken leg or chicken breast?</td>
</tr>
<tr>
<td>Soups</td>
<td>Was your soup prepared with milk, water or cream?</td>
</tr>
<tr>
<td>Restaurants</td>
<td>What restaurant was it?</td>
</tr>
<tr>
<td>Packaged food</td>
<td>What brand was it?</td>
</tr>
</tbody>
</table>
## Sample Menu

Day 1: Tuesday, May 10, 2011

<table>
<thead>
<tr>
<th>Time of Meal or Snack</th>
<th>Type of Food or Beverage Offered</th>
<th>Amount Eaten</th>
<th>Method of Preparation or Brand</th>
<th>Comments (e.g. amount of food served, too tired to eat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>Cereal</td>
<td>½ cup</td>
<td>Honey Nut Cheerios</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Milk 2%</td>
<td>½ cup</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Banana</td>
<td>½ med</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM Snack</td>
<td>Animal Crackers</td>
<td>10</td>
<td>Christie</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apple juice</td>
<td>4 oz</td>
<td>Allen’s pure apple juice-canned</td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td>Grilled cheese sandwich</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Whole wheat bread</td>
<td>1 slice</td>
<td>Dempsters</td>
<td>No crusts</td>
</tr>
<tr>
<td></td>
<td>Cheese slice</td>
<td>1 slice</td>
<td>Kraft slices</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Butter on bread</td>
<td>1 Tbsp</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yogurt – strawberry</td>
<td>75 ml</td>
<td>Mini-go</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Milk</td>
<td>½ cup</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>PM Snack</td>
<td>Granola bar</td>
<td>1 bar – 35 g</td>
<td>Quaker Chewy, Trail Mix – tropical fruit</td>
<td>Ate half of it</td>
</tr>
<tr>
<td>Dinner</td>
<td>Chicken fingers</td>
<td>1 ½</td>
<td>President’s Choice</td>
<td></td>
</tr>
<tr>
<td></td>
<td>French fries</td>
<td>10</td>
<td>McCain regular</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Honey</td>
<td>2 Tbsp</td>
<td></td>
<td>For dipping</td>
</tr>
<tr>
<td></td>
<td>Ketchup</td>
<td>2 Tbsp</td>
<td>Heinz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carrots</td>
<td>½ medium</td>
<td>Raw, cut in sticks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Milk</td>
<td>½ cup</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Evening Snack</td>
<td>Ice cream</td>
<td>1 cup</td>
<td>Chocolate Nestle</td>
<td></td>
</tr>
<tr>
<td>Day 1</td>
<td>Date:</td>
<td>Time of Meal or Snack</td>
<td>Type of Food or Beverage Offered</td>
<td>Amount Eaten</td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
<td></td>
<td>Breakfast</td>
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<tr>
<td></td>
<td></td>
<td>AM Snack</td>
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<td></td>
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<td></td>
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<td>Lunch</td>
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<tr>
<td>PM Snack</td>
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<tr>
<td>Dinner</td>
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<td></td>
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<tr>
<td>Evening Snack</td>
<td></td>
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</tbody>
</table>

Does this represent a typical day? [ ] Yes [ ] No
<table>
<thead>
<tr>
<th>Day 2</th>
<th>Time of Meal or Snack</th>
<th>Type of Food or Beverage Offered</th>
<th>Amount Eaten</th>
<th>Method of Preparation or Brand</th>
<th>Comments (e.g. amount of food served, too tired to eat)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Breakfast</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AM Snack</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Lunch</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>PM Snack</td>
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</tr>
<tr>
<td>Dinner</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evening Snack</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Does this represent a typical day? [ ] Yes [ ] No
<table>
<thead>
<tr>
<th>Time of Meal or Snack</th>
<th>Type of Food or Beverage Offered</th>
<th>Amount Eaten</th>
<th>Method of Preparation or Brand</th>
<th>Comments (e.g. amount of food served, too tired to eat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM Snack</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Time</td>
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<tr>
<td>-----------------------------</td>
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<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>PM Snack</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dinner</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evening Snack</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Does this represent a typical day?: [ ] Yes [ ] No
Appendix F: Framework of Statistical Methods for Estimating Usual Intake of Nutrients

Calculating the proportion of individuals at risk for nutrient inadequacy:

To determine the proportion of individuals at risk for nutrient inadequacy estimates of usual intakes of participants are required. Food consumption must be measured over more than one day (e.g., repeated 24-hr recalls or estimated 1-day food records) on at least 30 participants (Gibson, 2005). To remove the variability introduced by day-to-day variation in nutrient intakes (i.e., within-subject variation), an adjustment can be made to the observed distribution of intakes by using the PC-SIDE program developed at Iowa State University. The adjusted distribution of usual intakes can then be used to predict the percentage of participants that are at risk by using the Estimated Average Requirement (EAR) cut point method (Gibson, 2005).

Common Framework of Statistical Models:

Statistical models can account for the limitations of the food records by estimating and removing the effects of within-person variation by following these steps (Dodd et al., 2006):

Step 1: Describe the assumed relationship between individual food record measurements and individual usual intake.

- The usual assumption is that the food intake is an unbiased estimator of usual intake. Food records may over- or underestimate an individual’s true usual intake, but with repeated measures the estimation errors will cancel each other out.

Step 2: Partition the total variation in food record measurements into within- and between-person components.

- Individual usual intakes may be expressed as the sum of the group’s mean usual intake and person-specific deviations from the group mean:

  Individual usual intake = group mean usual intake + (individual usual intake - group mean usual intake)

Each food record may be expressed as:
Food record intake = group mean usual intake + (individual usual intake - group mean usual intake) + (food record intake - individual usual intake)

*Estimation of within-person variance is dependent on repeated measures.

**Step 3:** Estimate the usual intake distribution account for within-person variation.

If the within-person variance is $\sigma^2_w$, then the variance of the average of $n$ independent food record intakes for an individual is $\sigma^2_w / n$. If the variance of the usual intake distribution (i.e., between-person variation) is $\sigma^2_b$, it follows that the empirical distribution of within-person means has variance $\sigma^2_b + \sigma^2_w / n$. A set of intermediary values with the desired variance $\sigma^2_b$ are developed by shrinking each individual mean towards the overall mean (i.e., shrinkage factor, $w$):

intermediary value = $(1 - w) \times$ (overall mean) + $w \times$ (individual mean), where the shrinkage factor, $w$ is determined using the following equation:

$$w = \sqrt{\frac{\sigma^2_b}{\sigma^2_b + \sigma^2_w / n}}.$$

**The Iowa State University (ISU) Method:**

This method is based on a model that uses a two-stage transformation to obtain food records intakes that are almost exactly normally distributed. Transformations are required because often times observed intake distributions tend to be right-skewed and do not reflect a normal distribution. An initial transformation is done, often a transformation to a log scale, to account for the non-normal data, and then a back transformation is done to relate the values in the transformed scale to usual intake in the original data. The following are the ISU steps for estimating distributions of usual intake (Dodd et al., 2006):
Step 0: Initial Data Adjustments

- Data is transformed to make the distribution of the transformed adjusted food record intakes be as close to normal as possible

*Step 1*: Describe the assumed relationship between individual food record measurements and individual usual intake.

- The food record is unbiased for usual intake in the untransformed scale

*Step 2*: Partition the total variation in food record measurements into within- and between-person components.

- Within-person variance can vary among individuals

*Step 3*: Estimate the usual intake distribution account for within-person variation.

- Construct a set of intermediary values that retain mean and average between-person variance of transformed food records
- Conduct back transformations by using the inverse of the initial two-stage normality transformation in conjunction with a bias-adjustment (i.e., adjust each normal-scale intermediary value to obtain the original counterpart.
- The empirical distribution of original scale intermediary values is the estimated usual intake distribution
Appendix G: Estimated Average Requirements

Dietary Reference Intakes (DRIs): Estimated Average Requirements
Food and Nutrition Board, Institute of Medicine, National Academies

| Life Stage Group | Calcium (mg/d) | CEO (g/kg) | Protein (g/kg) | Vit A (µg RE) | Vit C (mg) | Vit D (µg) | Vit E (mg) | Riboflavin (mg) | Niacin (mg) | Vit B6 (mg) | Folate (µg) | Zinc (mg) | Copper (mg) | Iron (mg) | Magnesium (mg) | Molybdenum (µg) | Phosphorus (mg) | Seleni- 
| 6 to 11 yrs | | | | | | | | | | | | | | | | | | um (µg) |
| Children 1-3 yrs | 100 | 100 | 0.97 | 219 | 13 | 10 | 7 | 0.4 | 0.4 | 1 | 0.4 | 120 | 0.7 | 260 | 65 | 20 | 65 | 13 | 280 | 17 | 2.5 |
| 4-8 yrs | 100 | 100 | 0.70 | 273 | 22 | 10 | 4 | 0.5 | 0.3 | 6 | 0.3 | 160 | 1.0 | 540 | 65 | 41 | 110 | 17 | 40 | 17 | 2.5 |
| Adults 18-50 yrs | 100 | 100 | 0.10 | 610 | 60 | 12 | 1.0 | 1.1 | 1.1 | 520 | 1.0 | 665 | 90 | 7.7 | 240 | 35 | 1,650 | 45 | 8.7 |
| 51-64 yrs | 100 | 100 | 0.06 | 223 | 73 | 10 | 1.0 | 1.1 | 1.1 | 520 | 2.0 | 700 | 93 | 6 | 350 | 34 | 300 | 40 | 9.4 |
| 65+ yrs | 100 | 100 | 0.06 | 223 | 73 | 10 | 1.0 | 1.1 | 1.1 | 520 | 2.0 | 700 | 93 | 6 | 350 | 34 | 300 | 40 | 9.4 |
| Females 18-50 yrs | 100 | 100 | 0.06 | 223 | 73 | 10 | 1.0 | 1.1 | 1.1 | 520 | 2.0 | 700 | 93 | 6 | 350 | 34 | 300 | 40 | 9.4 |
| 51-64 yrs | 100 | 100 | 0.06 | 223 | 73 | 10 | 1.0 | 1.1 | 1.1 | 520 | 2.0 | 700 | 93 | 6 | 350 | 34 | 300 | 40 | 9.4 |
| 65+ yrs | 100 | 100 | 0.06 | 223 | 73 | 10 | 1.0 | 1.1 | 1.1 | 520 | 2.0 | 700 | 93 | 6 | 350 | 34 | 300 | 40 | 9.4 |

## Appendix H: Probabilities of Inadequate Iron Intakes

### TABLE G-7 Probabilities of Inadequate Iron Intakes* (mg/d) and Associated Ranges of Usual Intake in Adult Men and Women Using and Not Using Oral Contraceptives (OC), CSFII, 1994–1996

<table>
<thead>
<tr>
<th>Probability of Inadequacy</th>
<th>Adult Men</th>
<th>Non-OC Users</th>
<th>OC Usersb</th>
<th>Mixed Populationc</th>
<th>Postmenopausal Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5f</td>
<td>&gt; 10.94</td>
<td>&gt; 13.26</td>
<td>&gt; 12.50</td>
<td>&gt; 14.92</td>
<td>&gt; 17.85</td>
</tr>
<tr>
<td>1.0d</td>
<td>&lt; 3.98</td>
<td>&lt; 4.42</td>
<td>&lt; 3.63</td>
<td>&lt; 4.18</td>
<td>&lt; 2.73</td>
</tr>
<tr>
<td>0.66</td>
<td>3.08–4.29</td>
<td>4.42–4.88</td>
<td>3.83–4.00</td>
<td>4.18–4.63</td>
<td>2.73–3.04</td>
</tr>
<tr>
<td>0.93</td>
<td>4.30–4.64</td>
<td>4.69–5.45</td>
<td>4.01–4.45</td>
<td>4.64–5.19</td>
<td>3.05–3.43</td>
</tr>
<tr>
<td>0.65</td>
<td>4.65–5.09</td>
<td>5.46–6.22</td>
<td>4.40–5.06</td>
<td>5.20–5.94</td>
<td>3.44–3.93</td>
</tr>
<tr>
<td>0.75</td>
<td>5.10–5.44</td>
<td>6.23–8.87</td>
<td>5.07–5.52</td>
<td>5.95–6.55</td>
<td>3.94–4.30</td>
</tr>
<tr>
<td>0.65</td>
<td>5.45–5.74</td>
<td>6.68–7.46</td>
<td>5.53–6.94</td>
<td>6.56–7.13</td>
<td>4.31–4.64</td>
</tr>
<tr>
<td>0.55</td>
<td>5.75–6.03</td>
<td>7.47–8.07</td>
<td>5.95–6.35</td>
<td>7.14–7.73</td>
<td>4.65–4.97</td>
</tr>
<tr>
<td>0.45</td>
<td>6.04–6.32</td>
<td>8.08–8.76</td>
<td>6.36–6.79</td>
<td>7.74–8.39</td>
<td>4.98–5.30</td>
</tr>
<tr>
<td>0.35</td>
<td>6.33–6.65</td>
<td>8.77–9.63</td>
<td>6.80–7.27</td>
<td>8.40–9.21</td>
<td>5.31–5.68</td>
</tr>
<tr>
<td>0.15</td>
<td>7.05–7.69</td>
<td>10.63–13.05</td>
<td>7.92–8.91</td>
<td>10.37–12.49</td>
<td>6.15–6.80</td>
</tr>
<tr>
<td>0.08</td>
<td>7.70–8.00</td>
<td>13.00–15.49</td>
<td>8.92–9.90</td>
<td>12.50–14.85</td>
<td>6.81–7.30</td>
</tr>
<tr>
<td>0.04</td>
<td>8.07–8.49</td>
<td>15.50–18.23</td>
<td>9.91–10.94</td>
<td>14.86–17.51</td>
<td>7.37–7.88</td>
</tr>
</tbody>
</table>


b Assumed 50 percent reduction in menstrual iron loss.

c Mixed population represents 17 percent oral contraceptive users and 63 percent nonoral contraceptive users.

d For population assessment purposes, a probability of 1 has been assigned to all usual intakes falling below the two and one-half percentiles of requirement and a probability of 0 has been assigned to all usual intakes falling above the ninety-seven and one-half percentiles of requirement. This enables the assessment of population risk where precise estimates are impractical and effectively without impact.

PARTICIPANTS NEEDED FOR THE "CALCIUM AND DAIRY INTAKE ASSESSMENT (CADIA) III STUDY"

Attitudes and Beliefs of Young Adults Towards Dietary Calcium

We are recruiting a diverse group of men and women (18-34 years old).

**HOW WILL YOUR PARTICIPATION BENEFIT YOU?**

- Learn about dietary calcium and its health effects.
- Gain an increased awareness of your current calcium intake.
- Learn about the misconceptions surrounding dairy products.
- Find out where else you can get calcium in the diet.

Your participation would involve a **1.5-2 hr focus group session** either in the Guelph or Hamilton area.

Refreshments and snacks will be provided during the focus groups and you will also receive a $20 gift card as compensation for your time!

Please contact Michelle to see whether you are eligible:
t: 519-824-4120 ext. 56715 e: bodycomp@uoguelph.ca
Appendix J: Dietary Calcium: Young Adults’ Knowledge, Attitudes and Beliefs Study
Screening Questionnaire

Dietary Calcium: Young Adults’ Knowledge, Attitudes and Beliefs
Screening Questionnaire

#1. Age: ________________

#2 Gender: ☐ male ☐ female

#3 Ethnicity:
☐ White, Caucasian
☐ Black, African Canadian, African American
☐ Middle Eastern, Arabic
☐ South Asian (i.e., Indian, Pakistan)
☐ East Asian (i.e., China, Japan)
☐ Southeast Asian (i.e., Thailand, Philippines, Malaysia)
☐ Hispanic
☐ Native
☐ Other (specify): ________________

#4 Education:
☐ High School
☐ College
☐ Undergraduate degree
☐ Graduate degree
☐ Other (Please specify): ________________

#5 Employment status:
☐ Employed
☐ Self-employed
☐ Student
☐ Stay at home mom/dad
☐ Unemployed
☐ Other (Please specify): ________________
#6 Calcium Status (Determined by the calcium calculator):
______________ mg/d

#7 Dietary Restrictions (i.e., physician diagnosed lactose intolerance, vegan):
______________________________________________________________

#8 Regular Calcium Supplement Use:
□ yes  □ no
Appendix K: Dietary Calcium: Young Adults’ Knowledge, Attitudes and Beliefs Study
Letter of Information

LETTER OF INFORMATION ABOUT THE RESEARCH STUDY:

Dietary Calcium: Young Adults’ Knowledge, Attitudes and Beliefs

You are being asked to participate in a combined learning opportunity and research study conducted by Dr. Andrea Buchholz (Primary Investigator/Supervisor), Dr. Janis Randall Simpson (Co-investigator), and Michelle Marcinow, PhD candidate (Graduate student investigator) of the Dept. Family Relations and Applied Nutrition, University of Guelph; Dr. Susan Whiting (Co-investigator) of the Dept Nutrition and Dietetics, University of Saskatchewan; and Dr. Mary Jung (Co-investigator) of the Dept. Health and Exercise Sciences, University of British Columbia-Okanagan. The study is funded by Canadian Foundation for Dietetic Research.

The purpose of this document is to provide you with the information necessary to make an informed decision about your participation. If you have any concerns about this research, please feel free to contact:

- Dr. Andrea Buchholz, RD, PhD tel 519-824-4120 ext 52347, email abuchhol@uoguelph.ca
- Michelle Marcinow, PhD candidate, email mmarcino@uoguelph.ca

Purpose of the Study
The main goal of the study is to determine young adults’ knowledge, attitudes and beliefs about calcium, its dietary sources and roles in health; as well as what factors may influence calcium intake.

Procedures
If you volunteer to participate in this study, there are two actions you will be asked to complete: 1) Sign and date this consent form, and 2) Participate in a digitally-recorded focus group discussion lasting approximately 1.5-2 hours. The focus group will be held in room 206B of the J.T. Powell Building of the University of Guelph. You will be seated around this table with approximately 5 other people. We will begin by welcoming you to the group, introducing ourselves as a research team, and explaining the purpose of the study. We will do an ‘icebreaker’ activity, and which will be followed by a series of questions intended to explore your, and other focus group participants’, knowledge, attitudes and beliefs about dietary calcium (sources, influence on health), bone health, as well as what factors may influence your intake of dietary calcium. Focus group discussions will be audio recorded. Refreshments and snacks will be provided during the study visit.
**Potential Risks and Discomforts**
There are minimal risks by taking part in this study. During the focus groups, you may experience discomfort discussing your knowledge, attitudes and beliefs towards dietary calcium. You do not have to answer any questions that you do not feel comfortable answering, and you may withdraw from the study at any time without penalty.

**Potential Benefits to Participants and/or to Society**
By participating in this study you may gain an increased awareness of your current calcium intake, how calcium relates to health, and of your knowledge about dietary calcium sources, including dairy products, and any misconceptions surrounding this food group. You may contact the researchers listed above to obtain a copy of the study results.

The information obtained from this study will be used to educate consumers and Registered Dietitians about young adults’ knowledge, attitudes and beliefs about dietary calcium.

**Payment for Participation**
After completing the focus group, you will receive a $20 gift card to a local business. We will ask you to sign to acknowledge receipt of the gift card. If you choose to withdraw partway through today’s group discussion, you will still receive the $20 gift card as compensation for your time.

**Confidentiality**
Every effort will be made to ensure the confidentiality of any information that is obtained in this study. All emails with personal identifiers will be accessed on a secured password-protected desktop and deleted once correspondence is completed. A pseudonym (fake name) will be used during transcription and analysis of the interview. Audio recordings of the focus group discussions will be downloaded off the digital recorders within 24 hours to a password-protected desktop, and then immediately deleted off the digital recorder. While we will do our best to maintain confidentiality the researchers cannot control disclosure of information by other participants. Therefore, we ask that you refrain from discussing who attended the focus groups and what was discussed during the focus group. If we find information we are required by law to disclose, we cannot guarantee confidentiality.

**Participation and Withdrawal**
You can choose whether or not to be in this study. If you volunteer to be in this study, you may withdraw at any time without penalty, and still be compensated. You may also refuse to answer any questions and still be included in the study. However, please note that it is difficult for the researchers to remove one person's contributions to a focus group conversation if you wish to have your contributions removed. The researchers may also remove you from the study if circumstances arise that warrant doing so.
**Rights of Research Participants**
You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through the University of Guelph Research Ethics Board. If you have questions regarding your rights as a research participant, contact:

Sandy Auld, Director, Research Ethics
Telephone: (519) 824-4120, ext. 56606
E-mail: sauld@uoguelph.ca

**Signature of Research Participant**

I have read the information provided for the study “Dietary Calcium: Young Adult's Knowledge, Attitudes and Beliefs” as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

Name of Participant (please print)

______________________________________  ______________________
Signature of Participant  Date

**SIGNATURE OF WITNESS**

Name of Witness (please print)

______________________________________  ______________________
Signature of Witness  Date
Appendix L: Dietary Calcium: Young Adults’ Knowledge, Attitudes and Beliefs Study
Semi-structured Interview Guide

Semi-structured Interview Guide for Focus Groups

Introduction
Provide a brief overview of the study making sure to include discussing consent and confidentiality. Participants will be reminded that they are able to withdraw at any time during the focus groups, and will still be compensated. We will also ask participants to refrain from discussing who was at the focus group and refrain from sharing any of the information that is discussed by fellow participants.

Ice Breaker
Welcome participants. Go around the room and ask:
- What is your name?
- What ice cream flavour best describes you and why?

General Calcium Knowledge
1. What do you know about calcium?
2. How do you think calcium influences overall health?
   - Are you aware of any health influences of calcium other than bone?
3. What comes to your mind of sources in the diet that provide calcium?
   - What are some non-dairy sources of calcium? What about milk alternatives? [e.g., plant-based beverages]
4. What food items would you consider as the best is the best source of calcium?
5. Do you think getting enough calcium in your diet is an important consideration for individuals in your age group?

Dairy Considerations
6. Dairy products offer one way to include calcium in the diet. Other than calcium, what else does dairy products contain?
   - Are there any negative or harmful ingredients in milk or other dairy products?
7. How do you feel about the way dairy cows are treated in Canada? What do you know about the treatment of Canadian dairy cows? Would this affect your intake of milk products?

Bone Health and Peak Bone Mass
1. Think back to our discussion re: bone health earlier in the focus group. What comes to mind when you think about what it means to have strong bones?
2. What do you think influences the health of our bones?
3. Do you think there is a time in our lives where our bones stop growing
After some discussion mention: There is technology available that can measure bone mass. Research is revealing that depending on the skeletal site being looked at, our bones can actually stop growing as early as adolescence and into our early 30's. In any case, all of us hit a plateau in or shortly, after our 30s before we begin to lose bone mass in our older age. This plateau is
referred to as peak bone mass. If you would like to explore this technology, or this concept, please talk to Michelle (PhD investigator) after our focus group.

**Facilitators of Calcium Consumption**

Is getting enough calcium in your diet a concern for you?

1. Are there any strategies that you use to help you make sure you are getting enough calcium in your diet?

2. What strategies would be helpful to motivate you to consume more calcium rich foods in your diet?

3. Do you think knowing that our bone mass reaches a peak in young adulthood would influence your dietary choices to include more calcium rich foods?

4. What would you consider to be the most effective way to convey messages about the importance of getting enough calcium in your diet to people in your age group?
   - Social media (which?), websites (which?), dietitians, doctors, dairy industry, etc.?