A NUTRITION EDUCATION PROGRAM FOR PROMOTING HEALTHY BEVERAGE CONSUMPTION IN HIGH SCHOOLS

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ABSTRACT

The rise of unhealthy beverage consumption, such as soft drinks, in children and youth for the last 25 years has increased the risk of low bone mass density by replacing milk (a major source of calcium intake), compromised dental health, and possibly contributed obesity. A school-based nutrition education intervention was developed to promote a change in this behavior. This study examined the effectiveness of this nutrition education program, called *FUEL (Fluids Used Effectively in Living*), in promoting healthy beverage consumption among high school students.

The *FUEL* nutrition education manual consisted of six classroom sessions; it was delivered in four classes of grade nine students using different approaches, either multiple or single strategies. The nutrition intervention used multiple teaching methods which included six lessons delivered as visual, group interaction, tactile, individual, and auditory teaching styles. The multiple strategies approach was delivered through peer educators (led by a dietitian) in one class and dietitian-only in another class. In the single strategy approach, also called "self-taught", two classes received only the handouts in the *FUEL* manual. This latter approach was considered the control to the nutrition intervention. The two classes that received either peer education or self-taught approach were in two high schools in Saskatoon. The two classes with either dietitian-taught or self-taught approaches were in a high school in Prince Albert. The beverage intake, knowledge, and attitude of students were assessed by a self-administered questionnaire before the intervention, a week after the intervention, and three months after the intervention. In Saskatoon only, a one year follow-up beverage intake assessment was performed.

None of the schools in the *FUEL* study provided healthy beverage choices for the students. Generally, students in our study consumed an adequate amount of milk, but they drank sugary beverages daily. There was a tendency to replace milk and 100% fruit juices with sugary drinks. After the intervention, students in multiple teaching strategies decreased their sugary beverage intake significantly. The findings indicated that a school-based nutrition education with multiple teaching strategies may lead to positive knowledge, attitude and behavioural change which will have beneficial effect on long-term health.

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1. INTRODUCTION

1.1. Rationale

Adolescents need greater amounts of nutrients than adults to support the growth and development, and to prevent chronic disease that may occur during adulthood (Spear, 2002; Story & Neumark-Sztainer, 1996). Unfortunately, adolescents often do not have enough knowledge and experience to make appropriate decisions and tend to develop unhealthy eating habits. These include skipping breakfast, replacing the lunch meal with snack food, and increasing soft drink intake, all of which can lead to inadequate nutrient intake (Spear, 2002). Furthermore, adolescents' decision making process was also influenced by the commercial activities, peers, and environment (O'Dea, 2003; McKinley et al., 2005). This places adolescents in a nutritionally vulnerable position. Healthy behaviors, including consuming nutritious beverages, are important for adolescents to improve their school performance, growth, and developmental tasks (e.g. developing identity) (Massey-Stokey, 2002). He, Kramer, Houser, Chomitz, and Hacker (2004) also observed a positive relationship between appropriate health behaviors and higher academic achievement. Healthy eating behaviours are learned during childhood and adolescence and maintained through adulthood (Lytle, 2002). Eating behaviours may have an impact on later nutritionally related chronic diseases, such as cardiovascular disease, obesity, and osteoporosis.

Adolescents gain their nutrients not only from solid foods but also from beverage intake. Drinking is not only for eliminating thirst and maintaining body fluid requirement, but also for providing calories, protein, vitamins, and minerals. Adolescents consume a high amount of milk, fruit juice, and soft drinks (Forshey & Storey, 2003; Rampersaud et al., 2003), which are in the top ten contributing sources for several nutrients, such as energy, protein, fat, calcium, iron, vitamin C, vitamin A, and fiber. Milk contributes to energy, protein, fat, calcium, vitamin C, and vitamin A intake, while fruit juice contributes energy, calcium, iron, vitamin C, vitamin A, and fibre intake. Carbonated beverages supply energy, and fruit drinks contribute to vitamin C intake (Philips, Starkey, and Gray-Donald, 2004).

Over the past 25 years, adolescents have changed their beverage intake patterns by doubling their soft drink intake and decreasing their milk intake (Bowman, 2002; Cavadini, Siega-Riz, & Popkin, 2000; French, Lin, & Guthrie, 2003). This shift has had a negative impact on health by lowering nutritional quality and decreasing micronutrient intake. High soft drink intake may increase the risk of bone fractures (Petridou et al., 1997; Wyshak, 2000; Wyshak & Firsch, 1994), replace milk intake (McGartland et al., 2003; Whiting, et al., 2001), contribute to obesity (Mrdjenovic & Levitsky, 2003; St-Onge et al., 2003), and lead to dental caries and erosion (Heller, Burt, & Eklund, 2001; Dinçer, Hazar, & Sen, 2002).

High-fructose corn syrup is the main ingredient in a sweetened soft drink (American Academy of Pediatrics, 2004). When soft drinks are consumed once in a while, it appears not to be a problem; however, each 12 oz (355 mL) serving of a carbonated sweetened soft drink contains the equivalent of 10 teaspoons (40 g) of sugar and 142 calories. Therefore, adolescents should change their beverage intake habits by decreasing sugary beverage intake.

Several interventions using a school-based approach have successfully led to significant or moderate changes in adolescents' dietary habits (Himes et al., 2003; James, Thomas, Cavan, & Kerr, 2004). My thesis emphasizes a school-based approach to promotion of healthy beverage intake patterns for adolescents using multiple strategies of teaching because beverage intake affects the composition and quality of the adolescent's and children's daily dietary intake (Lee, Gerrior, & Smith, 1998; Stubbs & Whybrow, 2004; Troiano, Briefel, Carroll, & Bialostosky, 2000; Frary, Johnson, & Wang, 2004; Marshall, Gilmore, Broffitt, Stumbo, & Levy, 2005). The multiple strategies used in the *FUEL* study were peer educator approach and dietitian-taught approach, and the single strategy was self-taught approach.

1.2. Purpose of the Study

The purpose of this study was to examine the effectiveness of a nutrition education program in promoting healthy beverage consumption among high school students.

The study consisted of the evaluation component of a larger study which also included the development and presentation of a nutrition education program *FUEL* (Fluids Used Effectively for Living), to be described later, to grade nine high school students in two high schools in Saskatoon (fall of 2003) and a high school in Prince Albert (Fall 2004). To evaluate the nutrition education program, quantitative data on beverage knowledge and behaviour pre and post intervention were collected.

1.3. Objectives

The specific objectives of the study before the intervention were to

1. Examine the beverage consumption habits of grade 9 high school students,
2. Contrast the beverage consumption habits of girls and boys,
3. Explore students' knowledge and attitude towards healthy beverage consumption,

After the intervention, the specific objectives were to

1. Compare a self-taught model of program delivery with a peer educator model,
2. Compare a self-taught model of program with a dietitian-taught model,
3. Contrasting a peer educator model of program delivery with a dietitian-taught model,
4. Evaluate the effectiveness of each program delivery approach in altering beverage consumption after the intervention.

1.4. Hypothesis

The hypothesis of the study is that the multiple strategies (peer educator and dietitian-taught) approach will be more effective in positively changing the beverage consumption behaviors of adolescents than a single strategy (self-taught) approach. The alternative hypothesis is that all of the approaches are the same in positively changing the beverage consumption behaviours of adolescents.

1.5. The Significance of the Study

Schools provide a variety of choices of beverages for students through vending machines and cafeteria. The allocations of the vending machines in strategic high-traffic areas, such as outside the school cafeteria, in the lobby, in main hallways provide opportunities for children and adolescents to consume beverages at school (Consumer Union, 1995). This situation can create confusion in students because schools are supposed to convey a healthy message. The Alberta Public Health Association (APHA, 2003) and Public Health Nutritionists of Saskatchewan (2004) reported that food and beverage vending machines, most of which offer high-fat, high-added sugar choices, are widely available in high schools in Canada and are becoming more visible in junior high schools. Most students will drink milk when they are offered milk (Pilant & Skinner, 2004), but studies show that they are more likely to choose soft drinks over milk (Forshee & Storey, 2003).

Adolescents increase their independence in making decisions as they get older. Adolescents also begin to buy and prepare food themselves either because they have to or they want to (Spear, 2002; Hern & Gates, 1998). Unfortunately, adolescents lack knowledge and skills to make healthy food choices. A nutrition education program can make adolescents gain knowledge and skills from nutrition education and increase their self-efficacy (Long & Stevens, 2004), so they are able and choose to make healthy decisions. Furthermore, nutrition education interventions for youths are cost effective because it can decrease the risk of chronic diseases in adulthood (Hoelscher, Evans, Parcel, Kelder, 2002).

McManis and Sorensen (2000) acknowledged the importance of school health education programs. Being healthy can optimize students' learning ability, and adequate nutrition and physical activity support students' performance. The skills gained by participants in a nutrition education study can help students maintain their health and increase their academic performance. Moreover, an intervention focused on healthy beverages is important because beverages contribute to the overall diet quality of the adolescent's dietary intake. To design effective strategies in improving children's and adolescents' health, health educators need to understand the effect of beverage consumption on nutrition, in particular the relationship between types of beverages consumed and health (Park, Meier, Bianchi & Song, 2002).

Findings from the *FUEL* study would support development of any potential comprehensive policies supporting the sales and consumption of healthy food and beverages at school. The Saskatchewan School Trustee Association found that in 1993, only 18% of school boards had a written policy regarding the sale of food in schools.

1.6. Definitions

Adolescence: a transition time from childhood to adulthood, which is started by puberty at the age of 10 years and ended by the acceptance of adult lifestyle at the age of 19 years (Sturdevant & Spear, 2002; Sacks, 2003).

Nutrition education intervention: an instructional method of healthy eating promotion aimed at facilitating the voluntary adoption of nutrition related behaviours beneficial to health and well being (CDC, 1996; Boyle, 2003).

Multiple strategies: the combination of several teaching methods and styles, including lecture, role-playing, discussion and interaction, visual (using illustration), and tactile methods (using hands-on activities) (Soliven, 2003).

Single strategies: the usage of one teaching method, such as lecture method only or visual method only (Soliven, 2003).

Peer: a person who is considered a member of a particular group, both by themselves and by other group members (McDonald & Grove, 2001).

Same age peers: peers that have the same age as target population and usually come from the same neighborhood or share the same class (Telch, Miller, Killen, 1990). Same age peers were chosen among the target population themselves.

Cross age peers: peers who are slightly older (several years, 1-4 years) than the target population (Van Keer, 2004). The *FUEL* study chose as the cross age peers those who had recently left high school.

Older peers: peers, who were much older than the target population, but share the same situation and place to live (Taylor, Serrano, & Anderson, 2001).

FUEL **or** *Fluid Used Effectively for Living is* an interactive nutrition education resource package that focuses on promoting healthy beverage intake and increase physical activity among high school students. The resource is described in detail in section 3.2.

Soft Drinks: non-alcoholic beverages mostly containing water, carbon dioxide, flavors, colors, caffeine, acidulants, preservatives, potassium, sodium and sweeteners (Jorge, 2003).

Carbonated Soft Drinks (CSD): soft drinks with carbon dioxide that give an effervescent taste to the beverages **(**Ashurst, 1998), which include cola and non-cola beverages.

Non-Carbonated Soft Drinks (NCD): soft drinks without carbon dioxide and sparkling taste (Taylor, 1998), which include fruit punch, fruit drinks, ice tea, coffee with sugar, and sport drinks.

Sugary Beverages: the combination of carbonated soft drinks and non-carbonated soft drinks.

1.7. Summary

The rise of unhealthy beverage consumption, such as soft drinks, for the last 25 years has increased the risk of low bone mass density, replaced milk and calcium intake, compromised dental health, and contributed to obesity. A school-based nutrition education intervention may change the behavior of adolescents. This study examined the effectiveness of a nutrition education program in promoting healthy beverage consumption among high school students.

2. LITERATURE REVIEW

2.1. Introduction

To support the study of adolescents and the effectiveness of a nutrition intervention which focused on beverages, the literature review will discuss the need for fluids in the body, types of beverages, beverage intake of adolescents, including current and past beverage intake of adolescents. The increasing trend of beverage consumption suggests a need to understand the impact of soft drink consumption on adolescent health, especially bone health, dental health, and obesity.

The review will also describe the extent of availability of soft drinks in school, approaches used to conduct school based interventions such as teacher-led interventions, parental involvement interventions, and peer educator interventions.

Most of the research in Canada on the impact of soft drink consumption on adolescent health has placed emphasis on bone health. Two of the most influential studies were conducted on Saskatchewan children (Iiliano-Burns, Whiting, Faulkner, & Bailey, 1999; Whiting, Healey, Psiak, Mirwald, Kowalski, & Bailey, 2001). Each has provided insights on aspects of adolescent's beverage intake (Iuliano-Burns et al., 1999), and the relationship between carbonated drinks and bone health (Whiting et al., 2001). There is no paper with national on Canadian adolescents until 2005, so all papers discussed here were done either in United States or European countries.

2.2. Beverages

2.2.1 Need for Fluids

Thirst drives humans and animals to drink fluid in order to preserve body fluid homeostasis and survive (McKinley & Johnson, 2004). Water composes 75% of an infant body, 60% of a young adult body and 50% of an elderly body (Sheng, 2000; Institute of Medicine, 2004). The roles of water in the body include the following: as a reactant; as a medium for dissolving nutrients, gases, and enzymes; and as a body heat regulator (Whitmire, 2004). Water helps to remove toxins and waste products, and develops macromolecule structures, such as protein and glycogen (Kleiner, 1999; Sheng, 2000; Altieri, Vecchia, & Negri, 2003). The body keeps water in a balanced state by controlling intake and excretion. However, the body can suffer from either a negative or a positive water balance.

Negative water balance, dehydration, is defined as a reduction of water and salt in varying proportions compared with the normal state, which may be caused by failure to replace obligatory water losses or failure of the regulatory mechanism (Lorenz & Kleinman, 2003; Fiordalisi & Finberg, 2003). Dehydration leads to hypernatremia, which can be caused by one or more of the following: water loss in excess of sodium chloride, inadequate water intake, addition of sodium chloride (salt poisoning), osmotic diuresis (with glucosuria), and diuretic therapy when free water intake is inadequate (Fiordalisi & Finberg, 2003; Lorenz & Kleinman, 2003). When the body loses salt to a greater extent than that of water, hyponatremic dehydration occurs (Fiordalisi & Finberg, 2003). There is no universally accepted or defined measurement of hyponatremia. For example, Senkfor, Berl, and Liu (2003) defined hyponatremia as a serum sodium concentration <135 mEq/L, but hyponatremia is diagnosed when a serum sodium concentration ≤ 130 mEq/L by Han and Cho (2002). Hyponatremia can occur in different states: low total body sodium known as hypovolemia, normal total body sodium known as euvolemia, or excess total body sodium known as hypervolemia.

The signs of dehydration include thirst, headache, fatigue, loss of appetite, heat intolerance, dry mucous membranes, increased skin turgor, reduction in urine output, elevated urine osmolarity (except when caused by failure of the kidney to conserve free water), increased blood urea nitrogen, and increased hematocrit. The outcomes of dehydration are weakness, lethargy, hypotension, and shock (Lorenz & Kleinman, 2003; Kleiner, 1999). After being restricted from water intake to induce body mass deficits by 1-2%, 15 healthy adults felt tired and headachy, and suffered a decrease in self ratings of alertness and ability to concentrate (Maughan, 2003). When excessive loss of water and electrolytes in adults and elderly subjects was not compensated by adequate water intake, water content of the stools was reduced, and constipation occurred (Arnaud, 2003). Hypernatremia also causes malaise, thirst, and fever as clinical symptoms; generalized weakness, lethargy, confusion, irritably, and delirium as neurologic symptoms; nausea and vomiting as gastrointestinal symptoms (Kruse, 2003). Dehydration can reduce children's ability to manage their body temperature, which can lead to heat disorders during physical activity, such as heat cramps, heat exhaustion, and heat stroke (Squire, 1990).

Humans maintain their water balance by consuming an equal amount of water to that which is excreted. Water is excreted in four ways: the respiratory tract, skin (as sweat), gastrointestinal tract, and kidneys. Insensible water loss from skin is affected by ambient temperature, and activity, and inversely with ambient humidity (Lorenz & Kleinman, 2003). Humans need to drink since the water in the food and the water produced by oxidation of food (metabolic water) is inadequate to replace the loss and a minimum 1.44 L of water is needed to cover the lost and to maintain the water balance (Sheng, 2000). Valtin (2002) could not find any proof that at least 1.92 L of fluid a day is needed. In the age range 14-18 years, boys' AI (Adequate Intake) is 3.3 L/day and girls' AI is 2.3 L/day (Institute of Medicine, 2004).

A positive water balance will increase water volume and decrease osmolarity of both the intracellular and extracellular fluids. This is followed by acute water intoxication (Sheng, 2000). The elevation of total body water, when sodium level is normal, has caused water intoxication (Lorenz & Kleinman, 2003). However, excessive water consumption is rarely the reason for water intoxication, which more often results when renal damage impairs free water excretion. Water intoxication causes a decrease in serum sodium, and severe states causes nausea, vomiting, seizures, headache, muscle twitching, convulsion, and coma can occur (Lorenz & Kleinman, 2003; Sheng, 2000). The accumulation of the excess fluid in the body, edema, happens when an imbalance of forces results the diffusion of the water across either the cell membrane or the capillary endothelium (Sheng, 2000).

2.2.2. Types of Beverages

Drinking water may be obtained through several common beverages: plain water, bottled water, fruit and vegetable juices, fruit drinks, soft drinks, syrup, stimulant beverages, and milk. Plain water includes tap water or mineral water and bottled water. All of them are tasteless and contain some minerals. Plain water is the primary source of water intake (The Swiss Association for Nutrition, 2003). However, children aged 11-12 years drank beverages other than water as 68% of their fluid intake (Zohouri et al., 2004). The 68% consisted of 26% carbonated soft drinks, 4% noncarbonated soft drink, 9% fruit juice, 17% milk, 9% tea, and 3% coffee and others. NHANES III (1988-1994) showed that children aged 10 drank 15% milk, 13% juice, and 10% carbonated drinks (Sohn, Heller, & Burt, 2001). Types of beverages consumed affect the composition of modern diet (Stubbs & Whybrow, 2004). Troiano, Briefel, Caroll, and Bialostosky (2000) found that 20-24% of energy intake came from beverages. Lee, Gerrior, and Smith (1998) showed that energy intake in teenagers was affected by the types of milk they consumed.

Milk, soft drinks, and fruit juice are important beverages for adolescents because they consumed high amount of these beverages (Forshey & Storey, 2003; Rampersaud et al., 2003). Furthermore, Philips, Starkey, and Gray-Donald (2004) reported these beverages were in the top ten contributing foods for several nutrients, such as energy, protein, fat, calcium, iron, vitamin C, vitamin A, and fibre. Milk contributes to energy, protein, fat, calcium, vitamin C, and vitamin A intake, while fruit juice contributes energy, calcium, iron, vitamin C, vitamin A, and fibre intake, and soft drinks contributes in energy and vitamin C (in fortified fruit drinks) intake. The beverages to be discussed are milk, soft drinks, and fruit juice, which are the main ones for adolescents.

2.2.2.1. Milk

According to Dairy Producers Regulations (1995), milk refers to "the natural lacteal secretion obtained from one or more lactating females of the bovine species, and includes cream, skim milk and any other portion of milk" (p.4). Canadian Food Inspection System Implementation Group (2002) in the National Dairy Regulation and Code defined milk as "a normal lacteal secretion obtained from a mammary gland of a dairy animal." However, whenever the consumers speak about milk, they think about liquid cow's milk products.

Raw milk consists of 87.1% water, 4.6% lactose, 4% fat, 3.25% protein, 0.7% mineral substances, 0.17% organic acid, and 0.15% miscellaneous. Lactose is a reducing sugar, composed by glucose and galactose. The fats of milk are mostly triglycerides and also include phospholipids, cholesterol, free fatty acids, and diglycerides. The minerals in milk are potassium, sodium calcium, magnesium, chloride, and phosphate. The organic acids in milk can be found in the form of ions or salts (Walstra, Geurts, Noomen, Jellema, & van Boekel, 1999).

The main proteins in milk are caseins, β-lactoglobulin, and α-lactalbumin. Casein or caseinogens is the acid precipitated protein (Fox, 2003). The casein functions as the amino acid, calcium, and phosphate provider upon digestion. B-lactoglobulin and α-lactalbumin are the major proteins in whey. Whey remains as liquid after isoelectric precipitation of casein from skimmed or whole milk. Whey includes dissolve solution of proteins, lactose, inorganic salts, vitamins and several components at trace level. This protein can bind and improve retinol uptake in jejunum, which indicates possible tasks in retinol transport and absorption. It also binds vitamin D_2 stronger than retinol (Sawyer, 2003). Unfortunately, there are not enough studies to explain the general functions of β-lactoglobulin. α-lactalbumin serves as the regulatory protein of the lactose synthase enzyme that catalyzes and regulates the synthesis of lactose in milk. α-lactalbumin also binds calcium and zinc (Brew, 2003).

Milk contains 137 kcal energy, 0.4 mg riboflavin, 0.8 mg pantothenic acid, 0.9 μg vitamin B_{12} in a 250 mL (8 oz) volume. The vitamin D is added to milk (2.5 μg per 250 mL) (Department of Health, 1995), so the reasonable daily milk intake can provide 300-400 international units of the vitamin. Based on fat content, milks are categorized into whole milk (3.4 % fat w/v), 1% milk (1.03 % fat w/v), 2% milk (2.06 % w/v), and skim milk (<0.03 % fat w/v) (Department of Health, 1995).

For adults and adolescents, 500 mL of 1% milk supplies 9% and 12% of daily recommended energy intake (respectively), but in the same amount it contains 50% or more of the recommended phosphorus, calcium, vitamin D, riboflavin, and vitamin B_{12} (McBean, Miller, & Heaney, 2004; Institute of Medicine, 2002) . Milk intake is positively related to a decline in risk of cardiovascular disease, hypertension, osteoporosis, breast cancer, kidney stones, and overweight (McBean, Miller, & Heaney, 2004).

2.2.2.2 Soft Drinks

Soft drinks are defined as non-alcoholic beverages mostly containing water, carbon dioxide, flavors, colors, caffeine, acidulants, preservatives, potassium, sodium and sweeteners (Jorge, 2003). Based on their ingredients, soft drinks are divided into carbonated and non-carbonated soft drinks. Carbonated soft drinks are further divided into colas and non-colas, as well as diet and regular soft drinks. Other categories of soft drinks are ready-to-drink soft drinks and dilute-to-taste soft drinks which are concentrated or in powder form (Ashurst, 1998).

Carbon dioxide is used to carbonate soft drinks. It conveys an effervescent taste, and the acid form of the carbon dioxide (carbonic acid) enhances the sharpness of taste. Carbon dioxide is also beneficial in microbiological control of soft drink products (Taylor, 1998). Non-carbonated soft drinks do not undergo carbonation process and do not have any sparkling flavor.

The sugar used to sweeten the regular soft drinks is either sucrose or high fructose corn syrup. Regular soft drinks have approximately the same amount of sugar as a glass of pineapple or orange juice, 7-14 g/100 mL. Diet soft drinks use aspartame, saccharine, acesulfam K, or sucralose as their sweeteners (National Soft Drink Association, 2003). Aspartame sweetness intensity is very high (160-220 times sweeter than sucrose), and it is often used in small amount per serving, so the calories provided per serving is close to zero. Saccaharine, acesulfam K and sucralose do not contain any calories at all (Nelson, 2000).

A soft drink is slightly acidic in order to give pleasant tartness to the product and preserve it. The most common acidulants in soft drinks are citric acid and phosphoric acid (National Soft Drink Association, 2003). Cola-flavored carbonated beverages use phosphoric acid as acidulant because it can strengthen the acidity and cola flavor in very low cost. Phosphoric acid has the same characteristics as the cola flavors, which are dry and sometimes balsamic (Taylor, 1998; Jorge, 2003). Cola soft drinks use cola nut from *Cola nitida* and *Cola acuminata* trees of Africa as their flavor agent (Grivetti & Wilson, 2004). Non-cola soft drinks usually use citric acid.

2.2.2.3. Fruit Juice

Fruit juice was adopted as important part of North American diet in 1950s (Varnam & Sutherland, 1999). Fruit juice is defined as unfermented liquid obtained from the crushing, comminuting, and pressing sound ripe fresh fruit, including in the fresh, heat treated, and chilled preserved form (Department of Health, 1997; Bates, Morris, & Crandall, 2001; Council of European Union, 2001). The appearance of juice can be translucent, opalescent or pulpy.

Fruit juice may contain sweeteners, a preservative, amylase, cellulase, and pectinase (Department of Health, 1997). Sugars can be added to fruit juice for several purposes, including controlling the acidic taste and sweetening the taste. To control the acidic taste, the sugar content may not be higher than 15 g each liter of juice. To sweeten the juice, the sugar content should not be over 150 g each liter of juice. A maximum of 150 g sugar per liter juice can be used to sweeten and controlling the acidic taste (Council of European Union, 2001).

Fruit juice production is based on several practical reasons. Fruits can be preserved longer in juice form than in fresh form. Fruit juice is more convenient to consume than whole fruits. Fruit juice has relatively the same nutrient content as fresh fruits; the loss of the nutrient content in fruit juice can be replaced by fortification. The processing, heating, chilling, freezing, standardizing, and transportation of fruit juice are easier to be controlled and handled than those of the fresh fruit. The seasonal variability of the fruit availability can be reduced by providing fruit juice which can be stored for a quite long time (Bates et al., 2001).

Based on its consistency, juice can be classified as puree and pulp. A puree has lower consistency than pulp (Bates, Morris, & Crandall, 2001). Fruit juice can also be categorized as concentrated fruit juice, reconstituted fruit juice, fruit juice from concentrate, and dehydrated or powdered fruit juice (Department of Health, 1997; Council of European Union, 2001).

The water in concentrated juice is removed to at least 50% of its volume (Department of Health, 1997; Council of European Union, 2001). Department of Health (1997) allows concentrated fruit juice to contain vitamin C, food color, stannous chloride, a sweetening ingredient, and a preservative. The manufacturers can add these ingredients to fruit juice to reach good manufacturing practice.

Reconstituted fruit juice or juice from concentrate is fruit juice that is made by adding water, natural pulp and cells, a sweetener, and flavors to the concentrated juice. The ingredients added may be recovered from the process of producing concentrated fruit juice, and the finished products should have the same characteristics with the original fruit juice (Council of European Union, 2001). However, reconstituted lemon or lime juice can be added dimethylpoplysiloxane not more than 10 ppm (Department of Health, 1997). Dehydrated or powdered fruit juice is produced by removing all of the water content of the juice. Fruit nectar is the unfermented but fermentable juice, puree, or to another mixture of juice that has been added by water and sugars and/or honey. The sugar and/or honey content may reach 20% maximum of the product total weight (Department of Health, 1997).

The acidic taste in fruit juice is caused by tartaric, malic, citric, acetic, and ascorbic acids at the amount of trace until above 3%. Sometimes a trace amount of phenolic acid can be found in fruit juice; however, some fruit may contain abundant phenolic compounds, such as anthocyanin, carotenoid, and tannin, which cause astringency taste (Bates et al., 2001). Fruit juice contains less than 5% lipid except avocado, olive, ackee, and oil palm juice. Protein, lipids, amino acids, mineral, and vitamin construct fruit flavor and aroma.

Most of commercial fruit juices contain high potassium, especially orange, pineapple, and prune juice that contain 1000-3000 mg/L (Densupsoontorn et al., 2002). Several fruit juices, pears, lemons, oranges, wild berries, and some temperate climate mountain fruits have more than a 1:1 calcium:phosphorus ratio (Dauthy, 1995). However, according to Clydesdale, Kolasa, and Ikeda (1994), reconstituted 100% orange and grapefruit, canned 100% prune, apricot nectar, and grape juice contain calcium:phosphorus ratio lower than one. Denspsoontorn et al. (2002) also found that orange, apple, litchi, and longan commercial fruit juice have calcium:phosphorus ratio lower than one.

2.2.2.4. Others

According to Department of Health (1988) and World Heath Organization (2001), bottled water (prepackaged water) is potable water from underground source or 'pristine' sources ('natural mineral water') or from processed waters but not obtained from a public water supply. The water should not contain any coliform bacteria but its condition is suitable for a specific growth of microbial flora. In the processing method, the composition of water should not be modified by any chemical substances. However, it can have added carbon dioxide, ozone, and fluoride. The fluoride content should not exceed 1 ppm. The bottled water should be safe to be stored to elevated (room) temperatures over a period of days to weeks before consumption.

The International Bottled Water Association (2004) categorized bottled water into spring water, purified water, mineral water, sparkling bottled water, artesian water, and well water. Spring water is the water that flows naturally to the surface of the water from an underground source. Purified water is the water that has undergone distillation, deionization, reverse osmosis or other suitable methods to meet the requirement set by the United States Pharmacopeia. Mineral water naturally contains constant level and relative proportions of mineral and trace elements. Total dissolve solids in mineral water should not be less than 250 ppm. Sparkling bottled water has added carbon dioxide until the carbon dioxide content reach the initial amount before processing. The commonly sparkling prepackaged water which has added carbon dioxide is labeled differently, such as sparkling spring water. Artesian water is obtained from a confined aquifer well (water that is held by underground layer of rock or sand), and the water level is as high as or above the top of the aquifer. Well water is obtained from a hole drilled in the ground that taps the water aquifer.

Coffee and tea can be classified into stimulant beverages because they contain stimulating substances such as caffeine, theobromine, and theophylline. Theobromine and theophylline in dried tea leaves are approximately 0.15% and 0.05% respectively in dried leaves, and dried coffee beans have only a trace amount of both substances. Although dried tea leaves contain higher caffeine (3-4%) than dried coffee beans (1.5%), caffeine in a cup of tea is lower than that in a cup of coffee. This could be caused by the fact that the amount of tea leaves was lower than that of coffee in the cup (Wilson, 1999).

Coffee beans are derived from two kinds of coffee plants, which are *Coffea arabica* and *Coffea canephora* (Robusta coffee). Robusta dried beans contain higher all amino acids (alanine, glycine, valine, proline, leucine, isoleucine, aspartic acid, methionine, phenylalanine, lysine, ornithine, tyrosine, and tryptophan) than arabica dried beans, except $_L$-glutamic acid. Robusta dried beans consists of higher $_D$-amino acids (46.6 mg/kg) than Arabica dried beans (30.7 mg/kg). However, the mean concentrations of total amino acids between the two coffee beans are not significantly different (Casal, Alves, Oliveira, & Ferreira, 2003). The total polysaccharide of Robusta beans are the same with that of Arabica beans, but arabinogalactans in robusta beans may help the polysaccharide of the Robusta easier to be extracted (Fischer, Reimann, Trovato, & Redgwell, 2001). Robusta coffee provides bitter and full flavors when it is brewed, but Arabica coffee gives an acidic taste (London International Coffee Organization, 2004).

Coffee contains not only caffeine, amino acids, and polysaccharides but also acrylamide, a chemical substance in plastic manufacture that possibly contribute to cancer and have neurotoxic properties (Andrzejewski, Roach, Gay, & Musser, 2004; Health Canada-Food Program, 2003). Andrzejewski et al. (2004) found the ranges of acrylamide levels were 172 to 539 ng/g in instant coffee crystals and 6 to 16 ng/mL in brewed coffee.

Canada Food and Drugs Act (1990) defined green coffee or raw coffee or unroasted coffee as the seed of *Coffee arabica L., C. liberica* Hiern, or *C. robusta* Chev, which has been processed to its spermoderm (p. 79). This seed will undergo a roasting mechanism until at least 10% fat content and 6% total ash. Canada Food and Drugs Act also permits coffee to be decaffeinated until maximum 0.1% caffeine in decaffeinated raw coffee and decaffeinated coffee, decaffeinated instant coffee is allowed to have caffeine not more than 0.3%.

Tea is a beverage made from a mixture of the processed and dried leaves of the tea plant, *Camellia sinensis* or *Thea sinensis* (Varnam & Sutherland, 1999). Food and Drugs Act (1991) managed that tea "shall be the dried leaves and buds of *Thea sinensis* (L.) Sims prepared by the usual trade processes" (p. 349). The processing methods of tea determined the types of the tea that are green tea, oolong tea, and black and red tea. When the processing of the fresh tea leaves stops until the drying and steaming, the product will be green tea. When tea leaves are partially fermented before drying, oolong tea will be produced. Black and red teas are fully fermented before drying and steaming, but black tea is fermented by oxidation, and red tea uses microorganisms (Zuo, Chen, & Deng, 2002).

Water soluble extractive on a dry basis is at least 30% in blended black tea product and 25% in unblended black tea. At least 33% water soluble extractive should be in green tea. Blended black tea, unblended black tea, and green tea contain total ash ranged from 4 to 7% on the dry basis (Department of Health, 1991). Tea leaves consist of high concentration of some minerals, such as iron, nickel, manganese, sodium, potassium, magnesium, calcium, aluminium, and low concentration of zinc, copper, and chromium (Ferrara, Montesano, & Senatore, 2001). The quantity of magnesium and potassium in tea is higher than that of calcium and sodium, respectively. Tea can be a potential provider of manganese; however, the lack information about the tea mineral contents leads to the unclear understanding of the contribution of tea in mineral intake (Cabrera, Gimeä Nez, & Loä Pez, 2003). The bioactive compound in tea is polyphenols, particularly catechins including epigallocatechin, galic acid, and bioflavonoids (Ferrara et al., 2001).

2.3. Beverage Intake Assessment

In assessing beverage intake of adolescents, several considerations are important in choosing dietary intake measurement methods to achieve the purposes of the study. These include the requirements for details and accuracy, population specification, the time period of interest, the availability of the trained interviewer, and the cost (Subar, 2004; Johnson & Hankin, 2003). Other matters that characterized dietary methods are their capability to capture usual intake, variability, and errors. Usual intake is the pattern of someone's intake, which is likely not the same everyday. Lack of precision happens when a dietary method accounts for only a small number of days; precision can be increased by increasing the number of days in recording the intake. Error in dietary methods decreases the validity of the data. Data that are valid accurately describe the intake of participants without any underreporting and overreporting (Black, 2001).

2.3.1. Food Frequency Questionnaires (FFQs)

Generally, in completing FFQs, the respondents were asked to indicate how often they eat each food listed in the questionnaires. The advantages of using FFQs are that they give moderate burden to subjects, can be self-administered in a relatively short time, assess usual diet, and are low cost. FFQs also have several weaknesses: poor precision, memory dependence, and complex cognitive skill requirement. Intake data can be compromised when multiple foods are grouped within single listing (Black, 2001; Lee & Nieman, 2003). The quality of FFQs is improved by using a detailed food list to avoid food groupings and asking interviewers to administer the questionnaires (Kumanyika, Tell, Shemanski, Martel, & Chincili, 1997).

In two studies, FFQs provided accuracy and reproducibility for adolescents and 6^{th} grade students (Rockett & Colditz, 1997; Andersen, Bere, Kolbjornsen, & Klepp, 2004). Rockett, Wolf, and Colditz (1995) showed that FFQs have 0.57 Pearson correlation for reproducibility of 0.57 for soda intake, and that girls presented a higher reproducibility in questionnaires than boys.

However, Andersen, Bere, Kolbjornsen, and Klepp (2004) observed a high number of students who misclassified in administering food frequency questionnaires. This indicates that more detailed questionnaires are needed in working with children. A longer list of foods in assessing fruit and vegetable intake provides higher validity with 24-hour recall in African-American adults (Resnicow et al., 2000). In assessing women’s dietary pattern, FFQs showed a good agreement with 4 times 7-day weighted dietary record (Khani, Ye, Terry, & Wolk, 2004).

Although FFQs cannot provide detailed information and depend on long-term memory, a combination of a 24-hour recall and food frequency questionnaires can be more effective to assess the intake of a person (Stang, 2002). Using this technique, subjects make a list of food and beverages consumed in the previous 24 hours, so more detailed information can be obtained. This recall only depends on short-term memory and is easy to administer.

2.3.2. Twenty-four Hour Recalls (24 Hour Recalls)

The participants recall their intake in the past on specified days usually in the immediate past 24 hours, called 24-h recall. While a 24-h recall is not able to describe a usual intake of a person, repeated 24-h recalls can increase the precision in determine individual usual intake (Black, 2001). The advantages of using 24-h recalls are that these recalls require a short time to be administered, put a small burden on subjects, provide more detailed information, depend on shorter term memory (Lee & Nieman, 2003), and can be conducted through telephone (Messerer, Johansson, & Wolk, 2004).

In one study, the 24-h recalls gave a good reproducibility when they were used for grade 6 students with mean age 11.6 years old. In the same participants, the recalls gave higher estimates for the average intake of fruit and juice compared to the 7-day food record (Andersen, Bere, & Klepp, 2004).

2.4. Beverage Intakes of Adolescents

Factors such as hunger or food cravings, taste enjoyment, time, and convenience have been shown to influence food and beverage intake habits. Taste enjoyment was considered an important factor in choosing beverages by girls aged 13-18 years (Kassem, Lee, Modeste, & Johnston, 2003) and those aged 12-15 years (Lee & Reicks, 2003). Adolescents often neglect health consequences as factor in choosing beverage to consume, and this shows that adolescents do not have enough knowledge and experience in incorporated nutrition knowledge in making decision. Studies show that beverage intake behaviour of adolescents changed over time. Table 2.1 shows the beverage intakes of American adolescents for milk, juice, carbonated soft drink (CSD), and non-carbonated soft drink (NSD). Non-carbonated soft drinks include fruit drinks, fruit ades, and fruit punch. Three studies in Table 2.1 were consistent in showing that for the past 27 years, soft drink intake has increased (Cavadini, Siega-Riz, & Popkin, 2000; Bowman, 2002; French, Lin, & Guthrie, 2003). Furthermore, Cavadini et al. (2000) found that the increase of soft drink intake was followed by the increase of carbohydrate as a proportion of total energy intake, replacing fat and protein intake.

Conversely, a study funded by the National Soft Drink Association and conducted by Yi, Meier, Bianchi, and Won (2002) observed that there was a decline in soft drink consumption from 1988 to 1998. However, across all age groups, carbonated soft drinks were drunk at the highest amount among all beverages. It could also be seen that the different between the amount of daily soft drink and milk consumptions was approximately twice as high. The study has several limitations. There may have been a misclassification between fruit juice and fruit drinks, and the use of a two-week food diary has disadvantages when it is used for adolescents. The proportion of eating out in adolescents was greater, so adolescents tend to forget to include their drinks when they are away from home. Furthermore, the participants could have altered their diets to please the researchers (Bandini, Cyr, Must, & Dietz, 1997). On several occasions, participants may just more aware of what they eat during the study, which can lead to alteration of usual diet.

Popkin and Nielsen (2003) pointed out an increase of calorie contribution from soft drinks to energy intake in participants aged 2 years and older. Soft drinks contributed 2.9% (52 cal) of total energy in 1977/78 and 5.3% (105 cal) in 1994/96. Soft drinks were the highest source of sweeteners that provide calories in 1994/96. Calorie input from fruit drinks doubled from 1977/78 (18 cal) to 1994/96 (31 cal). The absolute numbers were low because they included 2 year old participants in the calculations.

The rise in soft drink intake was concurrent with the trend toward larger portion sizes as observed by Popkin and Nielsen (2003) from 1977 until 1996. The increasing of portion sizes occurred at home and outside. Soft drink servings underwent a change in portion sizes as well. One serving used to be 72 mL in 1977 and rose to 96 mL in 1996, in the home. Restaurants increased their serving size from 630 mL in 1977 to 900 mL in 1996, and fast food restaurants increased from 630 mL in 1977 to 990 mL in 1996. Sweetened beverages, including soft drinks and fruit drinks, were consumed during beverage breaks (50% of total sweetened beverage intake), lunch, and dinner. The access to soft drink at home contributed 55% to the consumption of the beverages; 25% of soft drink intake came from fast food and other restaurants, and 9% derived from school and vending machines. Homes were still the largest source of soft drink access in 1994-1998; however, soft drink access from fast food restaurants, vending machines, school cafeterias has increased (French et al., 2003).

Table 2.1. Beverage Intake of Adolescents in Selected Studies

Study	Age (y)	N	Data sources	Intake (g/day) Type of Drinks	Year							
Cavadini, *et al* (2000)	11-18	12,498	NFCS, CSFII. 2 food diary and 24-hour recall		1965		1977		1989		1996	
					Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
				Milk	1181	848	1067	738	741	594	746	481
				Juice	287	286	294	260	320	292	347	308
				CSD	379	319	405	391	763	518	1102	773
				NSD	187	160	200	153	207	174	396	264
Bowman (2002)	12-19	837 girls	NFCS, CSFII		1977/78		1987/88		1989/91		1994/96	
				Milk	647		564		510		408	
				Juices	65		77		87		102	
				CSD	183		215		264		350	
				NSD	72		109		87		134	
Lee and Nieman (2003)	> 2	US population	Food disappearance		1955				1995			
				Milk	474				253			
				CSD	114				550			
French, *et al* (2003)	14-17	8,908 in NFCS (1977/78) 3,177 in CFSII (1994/98)	NFCS, CSFII 2 food diary and 24-hour recall		1977/78				1994/98			
					Boys		Girls		Boys		Girls	
				Soft Drink	199		198		624		397	
Yi, *et al* (2002)	15-19	87/88=4143 92/93=2748 97/98=2397	NFOR(2 wks food diary)		1988		1993		1998			
					Boys	Girls	Boys	Girls	Boys	Girls		
				Milk	417	275	360	252	332	303		
				Juice	122	105	125	113	122	94		
				CSD	624	561	607	490	649	456		
				NSD	82	82	68	99	108	105		

Note. y: year
Data is presented in the mean intake
CSFII: Continuing Survey of Food Intake by Individuals.
NFCS: Nationwide Food Consumption Surveys.
NFOR: National Family Opinion Research.

French et al. (2003) identified boys and girls aged 14-17 years as the greatest soft drink consumers in the population of 6-17 year olds. Using the same data, Bowman (2002), Storey, Forshee, and Anderson (2004), and Rampersaud, Bailey, and Kauwell (2003) also confirmed these findings. However, Heller, Burt, and Eklund (2001) analyzed the data from the Third National Health and Nutrition Examination Survey (NHANES III, 1988-1994) and noted that the highest soft drink consumption was in the participants aged 17-24 years.

Over time, low fat milk was consumed more than whole milk, and raw fruit consumption was substituted by fruit juice (Cavadini et al., 2000; Yi et al., 2002). Lee and Nieman (2003) observed a decline of milk intake in the last 40 years. These findings were confirmed by Cavadini et al. (2000), French et al. (2003), and Bowman (2002).

The decrease in milk intake was followed by the decrease of calcium intake (Cavadini et al., 2000; Frary, Johnson, & Min, 2004). On the other hand, Yi et al. (2002) did not detect any differences in milk intake between 1988 and 1998. This may be caused by the differences of the dietary method used to assess usual beverage intake.

Several behaviors that improve milk and calcium intakes of children are eating breakfast (Bowman, 2002) and consuming flavored milk, flavored yogurt, ice cream, and pudding (Frary et al., 2004). However, mean calcium intakes remained below the Adequate Intake (AI) of 1300 mg/day (Cavadini et al., 2000; Frary et al., 2004). The participants in the study by Frary et al. (2004) were 3038 children aged 6-17 year old, and Bowman observed adolescents aged 12 to 19 year old.

There are many factors that could explain the differences in beverage intake among the studies. These include differences in the calculation of the mean intake, dietary assessment methods, and the age range of subjects. Three studies (Cavadini et al., 2000; Bowman, 2002; French et al., 2003) used NFCS (Nationwide Food Consumption Surveys) and CSFII (Continuing Survey of Food Intake by Individuals) data. However, the amount of the soft drink intakes in 1990s in Cavadini et al.'s finding was not the same as the others found. Cavadini et al. (2000) could have calculated the mean of carbonated soft drink intake in the teenagers who consumed the drinks, but they did not include all of the teenagers. The dietary methods in 1994-1996 CSFII were two 24-hour recalls on 2 nonconsecutive days (Lee & Nieman, 2003, p. 118), and NHANES

III used self-administered food frequency questionnaires (FFQ) and a 24-hour recall. One or two recalls may fail to capture usual beverage intake due to the variation of intake among days. Children and adolescents tend to make mistakes in completing FFQ (Andersen, Bere, Kolbjornsen, & Klepp, 2004) especially for the categorized food and drinks. Misclassification could happen in differentiating fruit drinks and fruit juice.

Age had inverse relationship with fluid milk intake, and positive relationship with carbonated soft drink intake (Forshee & Storey, 2003; Bowman, 2002). Bowman (2002) found that at the age of 13 years, female adolescents reduced their intakes of milk and fruit drinks (including fruit ades and fruit punches) sharply and elevated their soft drink and tea intakes. Consumptions of fruit juices, fruit drinks, and tea went down rapidly when the participants were 18 year old; however, their soft drink intake remained the same. At the age of 19 years, the participants increased all beverage consumptions except water and milk. Participants aged 12 years consumed the highest amount of milk while 19 year old subjects had the lowest milk consumption. Forshee and Storey (2003) also noted that race influenced beverage intakes. African-Americans drank less fluid milk and carbonated soft drinks but more fruit drinks than Caucasian-Americans.

Lytle, Seifert, and Greenstein (2000) analyzed longitudinal cohort data as part of the CATCH (Child and Adolescent Trial for Cardiovascular Health) intervention study. The aims of CATCH were lowering students' fat intake and making students more active, in order for them to be heart healthy. The participants were followed from grade 3 to 8. They found that as the students grew, they decreased their consumptions of breakfast, fruits, vegetables, and milk. On the other hand, their soft drink intake increased three times in grade 8, compared to their soft drink intake in grade 3.

French et al. (2003) noted that soft drink consumption had a negative influence on milk consumption and on many essential micronutrient intakes. Forshee and Storey (2003) and Rampersaud, Bailey, and Kauwell (2003) analyzed the 1994-1996 and 1998 data from CSFII and described that the intake of soft drinks was higher than the intake of milk in adolescents. Rampersaud et al. (2003) saw that 14-18 year adolescents consumed a higher amount of carbonated soft drinks than the American Academic

Pediatrics (AAP) recommended amount of 100% fruit juice (340 g/day), while the intake of 100% fruit juice itself did not reach AAP recommendation.

Most of the studies observed the trend that soft drink intake was increasing sharply over the years while the milk intake was decreasing. On the other hand, Yi et al. (2002) did not see the same tendency between 1988 and 1998, but they confirmed all the other studies, which showed that the intake of sugary drinks, including carbonated soft drink, fruit drinks, and ice tea, exceeded the intakes of milk and 100% fruit juice.

German adolescents also added their nutrient intakes by drinking fortified beverages. Between 1986 and 2000, 398 males and 408 females aged 2 to 14 years completed 3-day weighed dietary records. In 16 years, energy intake from fortified beverages as percentage of total energy intake increased significantly (from 2 to 3%). Fortified juice was the most important beverage with a maximum 24% vitamin C and B_6 to total micronutrient intake, followed by soft drinks with a maximum 10% vitamin C, and instant drinks maximum 10% vitamin B_6 (Sichert-Hellert & Kersting, 2001).

2.5. Effects of Soft Drinks on Adolescent Health

2.5.1. Soft Drinks and Bone

2.5.1.1. Bone Metabolism

Bone is composed of two types of structural tissues, cortical (or compact) tissue and trabecular (or cancellous) tissue. Dense cortical tissue (80% of skeleton) covers trabercular tissue (20% of skeleton) (Lee and Nieman, 2003; Anderson, 2004). The active metabolism of bone, which involves two types of cells: osteoblasts and osteoclasts, is called bone modeling, bone turnover and bone remodeling. Osteoblasts secrete a collagen protein matrix, which forms the support structure of the bone, and bone mineral, which strengthens the bone. This mineral consists of calcium and phosphorus, called hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$). Osteoclasts continually break down bone in areas where bone is not needed. This activity leads to bone turnover and causing bone loss, while osteoblasts conduct bone remodeling (Wardlaw, Hampl, & DiSilvestro, 2004).

Bone mineral density and bone quality are used to measure bone strength. Bone quality relates to bone architecture, bone turnover, mineralization, and the accumulation of bone damage. Bone mineral density (BMD) accounts for approximately 70% of bone strength (Lee and Nieman, 2003). BMD, expressed as grams per centimeter squared (g/cm^2), shows the relative value of mineral content in bone for the measured area. Bone mass (called bone mineral content, BMC) refers to the absolute amount of hydroxyapatite measured in grams, and is also used to describe bone strength.

The three periods in skeletal development over the life span are rapid growth, stabilization, and bone mass decline. The rapid growth period is the time during early childhood and adolescence. The stabilization period is achieved in young adults, i.e. age 20 to 35 years, after which time bone mass will decline. Having a high BMD at age 50 lowers the risk of age-related bone fractures in women and men (Kanis et al., 2001).

Women lose their bone mass faster than men. The bone mass loss in women is caused by the alteration of calcium absorption due to the change of hormones at menopause when estrogen is no longer formed. Estrogen can possibly stimulate bone loss by several possible mechanisms, such as changes in serum levels of parathyroid hormone, calcitonin, and vitamin D metabolites (Kaptoge et al., 2003; Anderson, 2004).

Physical activity improves the peak bone mass, which is reached during the growth. Evidence shows that physical activity is beneficial for BMD during childhood, but excess exercise during puberty can result in lower BMD. Physical activity is effective at high calcium intake, at least 1000 mg/day (Gilsanz, 1999). Region-specific interaction between calcium intake and physical activity in pre-pubescent girls was found by Iuliano-Burns, Naughton, Gibbons, Bass, and Saxon (2003).

Calcium makes up 39-40% of the entire mineral in the body. More than 99% of calcium in the body is located in bones and teeth (Wardlaw et al., 2004; Matkovic, Crncevic-Orlic, & Landoll, 2003). Calcium is critical to the structural integrity of both trabecular and cortical bone. Another 1% of calcium is in the cellular and extracellular fluid. The other roles of calcium are participating in blood clotting, transmission of nerve impulses to target cells, muscle contraction, and regulating the activity of several enzymes, including those that synthesize glycogen. The task of calcium in cellular and extracellular fluid is very important. When dietary intake is low, calcium is withdrawn from the skeleton to maintain normal calcium concentrations in blood. Adequate calcium consumption throughout life optimizes peak bone mass and minimizes age-related bone loss later in life (Wardlaw et al., 2004).

When blood calcium and vitamin D are low, the parathyroid gland releases parathyroid hormone, which then stimulates the synthesis of 1,25 dihyroxyvitamin D (calcitriol) in kidneys. Calcitriol then interacts with specific cells in the small intestine, bone, and kidney. In the small intestines, calcitriol promotes calcium absorption. In bone, calcitriol and parathyroid hormone stimulate osteoclasts to release calcium from bone to the blood. In kidney cells, both of them also prevent calcium loss in urine excretion (Wardlaw, 2004; Dawson-Hughes, 2003).

High blood levels of phosphate suppress the conversion of vitamin D to its active form in the kidneys. Since phosphorus level maintenance is not as tight as calcium, serum phosphate levels can rise slightly with a high phosphorous diet, especially after meals. High blood phosphate levels reduce the formation of the active form of vitamin D (calcitriol) in the kidneys, reduce blood calcium, and lead to increased PTH release. However, high serum phosphorus levels also lead to decreased urinary calcium excretion. If sustained, elevated PTH levels could have an adverse effect on bone mineral content, but this effect has only been observed in humans in diets that were high in phosphorus and low in calcium (Knochel, 2003).

Milk, which contains 300 mg calcium in a 250 mL serving, is a good source of absorbable calcium. Dairy foods provide 75% calcium in the North American diet generally (Weaver, 2003; Wardlaw et al., 2004) and more than 55% calcium in the adolescents' diet especially (Iuliano-Burns, Whiting, Faulkner, & Bailey, 1999). From all milk products, fluid milk alone contributed at least 40% as calcium source in teenagers' diet. The calcium rich plants in the kale family (broccoli, bok choy, cabbage, mustard, and turnip greens) contain calcium that is as bioavailable as that in milk (Weaver, 2003; Wardlaw et al., 2004).

Some food components have been found to inhibit the absorption of calcium. Oxalic acid (oxalate) is the most potent inhibitor of calcium absorption, and is found in high concentrations in spinach and rhubarb and somewhat lower concentrations in sweet potato and dried beans. Phytic acid is a less potent inhibitor of calcium absorption than oxalate. Yeasts possess an enzyme (phytase) which breaks down phytic acid in grains during fermentation, lowering the phytic acid content of breads and other fermented foods. Only concentrated sources of phytate such as wheat bran or dried beans substantially reduce calcium absorption (Weaver, 2003).

2.5.1.2. Effects of Soft Drink Intake on Bone Health

As shown in Table 2.2, cola soft drink intake increased the risk of getting bone fractures (Wyshak et al., 1989; Wyshak & Fischer, 1994; Wyshak, 2000; Petridou et al., 1997; Guerrero-Romero, Rodriguez-Moran, & Reyes, 1999; Mazariegos-Ramos et al., 1995). The phosphorus content in cola type carbonated beverages could have reduced levels of the active form of vitamin D (1,25-dihydroxyvitamin D) and led to a decline in calcium absorption and to bone decalcification, increasing bone fracture risk. All cola beverages contain 40 to 70 mg phosphorus per 12 oz serving (Massey & Strang, 1982). The calcium: phosphorus ratio is a significant risk factor for bone fractures while a higher calcium: phosphorus ratio is protective. Guerrero-Romero et al. (1999) detected significantly higher serum PTH level, a higher urinary phosphate excretion, and a lower calcium serum in women who drank significantly more cola soft drinks than other women who did not drink cola soft beverages. Mazariegos-Ramos et al. (1995) found a similar phenomenon in children and a significant negative correlation between the serum calcium level and the number of soft drink consumed each week. After the 14-18 year subjects stop drinking cola soft drinks, the serum calcium level increase, followed by the decrease of serum phosphorus level. High blood levels of phosphate suppress the conversion of vitamin D to its active form in the kidneys. Since phosphorus level maintenance is not as tight as calcium, serum phosphate levels can rise slightly with a high phosphorus diet, especially after meals. High blood phosphate levels reduce the formation of the active form of vitamin D (calcitriol) in the kidneys, reduce blood calcium, and lead to increased PTH release. However, high serum phosphorus levels also lead to decreased urinary calcium excretion. If sustained, elevated PTH levels could have an adverse effect on bone mineral content, but this effect has only been observed in humans in diets that were high in phosphorus and low in calcium (Knochel, 2003). Furthermore, cola beverage effects were more pronounced in more active girls and children (Wyshak, 1989; Wyshak, 2000; Petridou et al., 1997). However, Whysak

(2000) showed more evidence that all kinds of soft drink intake enhanced the bone fracture risk. The mechanism of the phenomenon is not known yet. Heaney and Rafferty (2001) did not observe excess urinary calcium excretion after their participants drank non-caffeinated cola soft drinks. They detected higher calcium in urine after the subjects drank caffeinated cola beverages, indicating that the rise in calcium excretion was due to the caffeine. The authors postulated that this excretion would be compensated by reducing calcium excretion later. Their results proved that the mechanism of how phosphorus in soft drinks may impact on calcium metabolism is not through urinary calcium losses.

It seems that drinking fruit juice can lead to bone fracture due to an altered calcium:phosphorus ratio (Petridou et al., 1997). It has been discussed before that several kinds of fruit juice contain more phosphorus than calcium, which can lead to unbalanced calcium:phosphorus in the bone. However, this result is not in accordance with Whiting et al. (2001) and Marangella et al. (2004). High potassium citrate in fruit juice lowers bone resorption in women age 58±8 years and girls 8-13 years (Tylavsky et al., 2004; Marangella et al., 2004). Further study will be needed to conclude the effect of fruit juice on bone.

All the studies in Table 2.2 agree that the intake of milk could play a protective role in bone health. Milk is an important calcium source in the diet. According to Fischer, Mitchell, Smiciklas-Wright, Mannino, and Birch (2004), the calcium intakes of 5-9 year old girls describes relative amount of their milk and soft drink intake. These girls could meet their calcium recommendation intake by being served milk more often than other girls who failed meeting the recommendation. Furthermore, Goulding et al. (2004) demonstrated that children who had low milk intake suffered slighter trauma bone fractures, which indicated that weakness of the skeleton or imbalance of body weight to skeletal strength. The replacement of milk intake could weaken bone; several studies that detected evidences of the occurrence of milk intake replacement by other beverages would be described (Whiting et al., 2001; McGartland et al., 2003).
There was negative correlation between consumption of low nutrient dense beverages and both total body bone mineral content as well as BMC accrual during the two years surrounding age of peak bone mineral accrual in girls. There was no relationship

between consumption of cola or non cola beverages with bone (fracture or BMC) in boys. The girls consumed less CSD than boys but they also had lower BMD in heel than boys. However, at the same time, boys also drank more milk and participated in more physical activity, behavior that can enhance bone mass, than did girls. The study suggested a threshold effect for calcium and physical activity. The threshold of protective calcium dose could have an important role since boys were above the threshold in calcium intake and physical activity, yet the consumption of CSD did not affect their bone health.

Milne and Nielsen (2000) and Nguyen, Dumoulin, Henriet, and Regnard (1998) detected a negative impact of sugar on bone. Soft drinks contain a lot of sugar, especially fructose in the products, but diet soft drinks use primarily aspartame Nguyen et al. (1998) described the increase of calcium in the urine within 3 hours after a glucose load or aspartame. Glucose intakes provoked a decrease in phosphatemia (high concentration of inorganic phosphates in blood) since phosphate followed glucose uptake into cells as required for glucose phosphorylation. The reduction of serum phosphate could stimulate mineral bone release, causing a rise in calcemia (excess calcium in blood). However, the decrease in phosphatemia was substantially smaller after aspartame ingestion than after glucose and was unlikely to have been triggered by the entry of glucose into cells. The hydrolysis of aspartame into phenylalanine and aspartic acid in the gastrointestinal tract and the phosphate activation of these amino acids in cells could cause a decrease in blood phosphate, which was likely to trigger acute bone mineral release. Most regular soft drinks do not use sucrose or glucose nowadays, but high fructose corn syrup. In the body, fructose can enter the metabolism in two ways; either it will be changed into fructose-6-phosphate by enzyme hexokinase and then follow the regular glycolysis pathway, or it will form fructose 1-phosphate and become glyceraldehydes 3-phosphate before following the regular glycolysis pathway (McGrane, 2000). However, both glucose and fructose are monosaccharides. The effect of glucose to bone could be similar with the effect of fructose to bone.

Another potential mechanism of fructose is to affect phosphorus balance in the body. It is found that a high fructose diet (20% of total calories) causes an increase in urinary loss of phosphorus and a negative phosphorus balance (i.e., daily loss of

Table 2.2. Studies of the effects of soft drink intake on bone

Study	Subjects	Methods	Results
Wyshak et al. (1989)	5,398 female 2,622 former athletes and 2,776 nonathletes (>50 y)	Mailed questionnaires	CSD consumers who were former athletes were at high risk for the occurrence of bone fractures than non-consumers.
Wyshak and Fischer (1994)	12-16 y teens 76 girls and 51 boys from a swimming club and physicians' offices	FFQ and medical history	An association between cola beverage consumption and bone fractures in girls (the adjusted OR = 3.59). High intake of calcium was protective (adjusted OR = 0.284). No association between the non-cola drinks and fractures.
Wyshak (2000)	Grade 9 and 10 n=460	Self-administer questionnaires	CSD consumption and bone fractures are associated: OR=3.14. Among physically active girls, the cola beverages are associated with bone fractures: OR=4.94, and all soft drinks and bone fractures with OR=7.00
Guerrero-Romero et al. (1999)	49-67 years 85 females	serum Ca, P, Albumin, estradiol, and FSH from blood. Questionnaires	Cola soft drink consumption had a strong and independent association with hypocalcemia (OR 1.28) for those women who drank one or more bottles per day (375 ml per bottle).
Mazariegos-Ramos et al. (1995)	18 months-14 years n=228 children	Blood sampling, interviews, and physical examination.	Negative correlation between the serum calcium level and the number of soft drink intake each week.
Petridou et al. (1997)	7-14 year old 74 boys and 26 girls	Questionnaires	Cola and NCD consumers increased the fracture risk by 1.7 and 1.6 (respectively). No relationship between non-cola and bone fractures.
Whiting et al. (2001)	Age= 14± 0.96 year old 59 boys and 53 girls	DXA and 24 hour recalls	Boys and girls replaced their milk intake with NCD and LND. Negative correlations were seen between the consumptions of LND and total BMC in girls, cola drinks and BMC, and non-cola drinks and BMC.
McGartland (2003)	12 and15 year old N=1335	DXA and diet history	Inverse relationship between diet drinks and heel BMD in girls. No relationship was observed in boys' intake.

Abbreviations: CSD, carbonated soft drinks; NCD, non-carbonated soft drinks; DXA, dual-energy X-ray absorptiometry; LND, low nutrient dense drinks;FFQ, food frequency questionnaire; FSH, follicle stimulating hormone; OR, odd ratio; Ca, calcium; BMD, bone mineral density; BMC, bone mineral content phosphorus was higher than daily intake). This effect was more pronounced if the diet was also low in magnesium. A potential mechanism for this effect is the lack of feedback inhibition of the conversion of fructose to fructose-1-phosphate in the liver. In other words, increased accumulation of fructose-1-phosphate in the cell does not inhibit the enzyme that phosphorylates fructose, using up large amounts of phosphate, which is known as phosphate trapping (Knochel, 2003; Milne & Nielsen, 2000).

2.5.2. Soft Drinks and Dental Health

2.5.2.1. Teeth

Teeth are constructed by crown, root portions, dentin, and neurovascular pulp. The crown is protected by enamel surrounding it, and the root is covered by cementum (Matthews & Al-Bayaty, 2002). Mature enamel contains 96% inorganic material, which is hydroxyapatite crystal same as for bone. Another crystal form in the teeth is fluoroapatite [$Ca_{10}(PO_4)F_2$] (Forcella, Mata, Mesquita, & Spoto, 2002). Carbonates and trace elements, including fluoride, boron, barium, lithium, magnesium, molybdenum, strontium, and vanadium also support the structure of teeth. During the period of tooth development, the exposure to these trace elements is important. They will become incorporated and remain in the mineralized substance of teeth since there is no enamel turnover. Carbonate, cadmium, chloride, iron, lead, manganese, tin, zinc, and magnesium make teeth more vulnerable to caries (Piesco, 2002). When carbonate substitutes phosphates, it will disorganize the lattice construction and make it more prone to acid dissolution. The mature enamel operates like a massive crystals mass in a chemical balance with the surrounding media. The acid stomach, food, drinks, or bacteria tend to alter the balance towards mineral loss (Forcella et al., 2002).

Dentin forms the body of teeth and contains metabolically active cells (Forcella et al., 2002). Dentin is an essential tissue because it contains the cell processes of odontoblasts and neurons. Odentoblasts carry out a structural role in the development of the dentinal matrix, and neurons pass on sensory information. Dentin covers and protects pulp and supports the overlying enamel. Mature dentin consists of 70% mineral, 20% organic matrix, and 10% water on a weight basis and 50% mineral, 30% organic, and 20% water on volume basis. The main inorganic matrix in dentin is hydroxyapatite.

Dentin is harder than cementum or bone because of its high mineral content, but it is softer than enamel. The bulk of the organic matrix of dentin consists of collagen. Unlike bone, dentin does not undergo continuous remodeling, so it has limited repaired capability (Piesco, 2002).

The general functions of pulp are as nutrition providers, defense actor, and barrier. Pulp blood vessels bring nutrient to pulp and dentin, pulp nociceptive receptors sense thermal, mechanical, and chemical stimuli, and pulp has the ability to assemble immune defenses (Forcella et al., 2002). Pulp includes cells that supply mature pulp with odontogenic, nutritive, sensory, and protective functions and allow for preservation of vitality during normal homeostatic maintenance and during wound repair after injury. The two sections in mature dental pulp are odontogenic zone and pulp proper. Odentogenic zone includes odontoblasts, the cells in charge for the construction and maintenance of dentin. Pulp proper includes the majority of the remaining areas of the pulp and contains fibroblasts and extracellular matrix, blood vessels, and nerves (Chiego, 2002). Root dentin is wrapped by acellular cementum, which is enclosed by cellular cementum.

Tooth decay can be classified into two major categories, caries and tooth wear. According to Ten-Cate, Larsen, Pearce, and Fejerskov (2003), caries is defined as "chemical dissolution of the dental hard tissues by acidic bacterial product from degradation of low molecular weight sugars." There are three general theories about the caries mechanism: the proteolysis theory, proteolytic-chelation theory, and chemicoparasitic theory. The proteolysis theory suggests that proteolysis may occur in caries process when teeth have lesions that develop on exposed root surfaces. The proteolytic-chelation theory hypothesizes that oral microorganisms produce material with chelating ability from decomposing the organic components of the enamel. These products would then dissolve tooth minerals. The chemicoparasitic theory is widely accepted nowadays. This theory postulates that the mechanism of the caries is through decalcification, the loss of calcium from teeth. This theory believes that microorganisms' action on carbohydrate would create acid substance which leads to the decalcification of the inorganic portion of teeth. The dissolution of tooth organic compounds would take place thereafter (McDonald, Avery, & Stookey, 2000).

Caries can be prevented by individuals through practicing several habits, such as plaque control, use of fluoride, and dietary modification. In order to control the plaque, a person should brush his or her teeth at least once a day. In brushing teeth, one should use fluoride toothpaste. The brushing will detain the growth of the biofilm, and fluoride retards lesion progression. Fluoride has beneficial effects in preventing caries. The useful dietary pattern in avoiding caries are confining sugar to main meals, replacing a salty snack for a sweet one, changing the sugar to the artificial sweetener in tea and coffee; water and milk would be safe and better to drink between meals (Kidd & Nyvad, 2003).

Tooth wear leads to the dissolved of dental hard tissue on the surface and is caused by others except the developmental, dental caries and trauma (May & Waterhouse, 2003). The tooth wear can be categorized into erosion, abrasion, and attrition. According to Bratlett and Smith (2000), erosion is caused by acid, attrition happens when tooth strikes against tooth, and abrasion is caused by physical means other than teeth.

2.5.2.2. Effects of Soft Drink Intake on Dental Health

Soft drinks influence dental health by providing sugar and acid. The sugar components of soft drinks lead to caries. It can be seen in Table 2.3, that Heller, Burt, and Eklund (2001) revealed that no caries observed in the younger age group could be due to the accumulative outcome from the younger age related to the continued regular soft drink intake; however, cola consumption more than three times a week increased the risk of the erosion to three times (Jensdottir et al., 2004).

Acid in soft drinks may contribute to the erosion of teeth. Two characteristics in soft drinks that determine their erosive potential are the initial pH and the buffering capacity (Larsen & Richards, 2002). The amount of mineral dissolved during the erosion depends on the pH, the buffering effect, and the length of the exposure time. The buffering effect is the concentration of acids in the beverages or the ability of an acidic solution to keep its pH unaffected in dissolving enamel apatite and diluting with saliva. The stronger the buffering effect, the more mineral will be dissolved before the equilibrium pH can be reached and stop the dissolution. However, the presence of a certain quantity of calcium, phosphate and fluoride in the drinks may have protective effect against the dissolution (Larsen & Nyvad, 1999). As shown in Table 2.3, the orange juice demonstrated a high buffering effect while the lemonade-like soft drinks (Schweppes^{TM}, Coca-cola^{TM}, and Pepsi^{TM}) performed a considerable buffering effect, but the pH of the soft drinks was lower than the orange juice pH (Larsen & Nyvad, 1999; Larsen & Richards, 2002). The protective characteristic of fluoride against erosion was not detected when a person consumed soft drinks.

Saliva could protect and add mineral to enamel when it was not exposed to acidic soft drinks; however, this effect was not detected in the group that consumed soft drinks (Dinçer, Hazar, & Sen, 2002). The greatest pH decrease of saliva was detected after the control group and case group drank Ades N^{TM}, followed by Sprite^{TM}, Coca Cola^{TM}, and chocolate milk (Sánchez & Preliasco, 2003). As the pH of saliva went lower, the more mineral in teeth would dissolve. The ability of the regular Coke^{TM} to cause erosion was greater than the Diet Coke^{TM} (Roos & Donly, 2002).

While some studies agreed that soft drink consumption may lead to tooth decay, caries and erosion, others such as Heller, Burt & Elkund (2001) reported no correlation between soft drink intake and dental caries in population under age 25. Forshee & Storey (2001) supports this view in their findings that regular soft drink consumption was not associated with dental cavities among people under the age of 25. The study also showed that age and income are better predictors of cavities than food or beverage consumption. Part of the discrepancy among results from the investigations could be attributable to the grouping of sweetened beverages (e.g., as soft drinks or sweetened beverages), methods used to assess beverage intake, inability to control for known confounders, and the time period of beverage intake assessment relative to the disease process. Furthermore, the manner in which beverages are consumed (snack vs. meal, prolonged sipping vs. quick drinking, daytime vs. nocturnal feedings) likely influences the disease process but is extremely difficult to assess in a community setting (Marshall et al., 2003). Although dairy products may contain lactose and added sugar, they have generally been considered protective against dental caries more likely because of theirs mineral content. Acid in fruit juice can cause erosion, but the fortification with calcium, phosphate, and fluoride may counteract the effect. Thus it seems logical to recommend

Table 2.3. Studies of the effects of soft drink intake on dental health

Study	Subjects	Methods	Results
Heller et al. (2001)	12- above 75 y. n=30,818	NHANES III (FFQ, 24-hour recall, and dental examination	No caries was observed in younger group, but it increased significantly in the higher age group.
Jensdottir et al. (2004)	19-22 y, n:57 23 patients	Self-administered Questionnaires and erosion score	A significant correlation between the cola intake and dental erosion, and between overall soft drink intake and dental erosion.
Larsen & Richards (2002)	Calcium fluoride, 4 molars	Solid calcium fluoride was suspended in NCD and CSD. Teeth were exposed in the beverages.	Carbonated and non-carbonated soft drinks are acidic and erosive.
Larsen & Nyvad (1999)	54 human premolars and molars	The exposure of the teeth on soft drinks and juices.	Orange juice has a high buffering effect, soft drinks had a considerable buffering effect, but soft drinks pH was lower than orange juice pH.
Dinçer et al. (2002)	Artificial saliva and 60 test teeth	Control group and exposed group toward cola beverages, non-cola carbonated beverages, and sparkling mineral water.	Enamel demineralised after exposing in acidic soft drinks. Protective effects of saliva towards teeth disappeared in soft drink consumers.
Roos and Donly (2002)	12-15 year old, n=17	Exposure to regular Coke™ and Diet Coke™. Plaque pH was measured after 5,10,& 20 mn	The ability of regular CSD to cause erosion on enamel was greater than the ability of diet CSD
Sánchez and De Preliasco (2003)	4-10 year old n= 30	Dental examination by a dentist, salivary pH, salivary flow rates, and salivary buffering capacity. Test products: CSD, orange juice, and chocolate milk.	The pH saliva decreased (from the greatest) after drinking orange juice, CSD, cola drinks, and chocolate milk. As the pH saliva went lower, the more mineral in teeth would dissolve.

Note: Y: year
n: the number of participants
NCD: non-carbonated soft drinks
CSD: carbonated soft drinks
NHANES: National Health and Nutrition Examination Survey.
FFQ: food frequency questionnaire

refraining from consuming soft drinks more than fruit juice because of the former's effect on teeth; further, soft drinks do not contain any important nutrients apart from water and energy (sugar) for the body, while fruit juice is an important vitamin C provider in North American diet.

2.5.3. Soft Drinks and Obesity

2.5.3.1. Obesity

Obesity is excess adiposity, and in order to measure it, there must be a suitable noninvasive measure of body fat and a suitable cut-off with which to compare (Cole & Rolland-Cachera, 2002). Adiposity is the amount of body fat expressed either as the absolute fat mass (kg) or as the percentage of total body mass. The Center for Disease Control and Prevention (CDC) incorporated the 2000 growth charts in determined Body Mass Index (BMI, kg/m^2) cutoffs to assess populations aged 2 to 20 years. Overweight is defined as a BMI-for-age at or above the 95^{th} percentile on the charts, and those who are at risk of overweight have BMI-for-age between the 85^{th} and the 95^{th} percentile (CDC, 2002).

Changes in the size of adipose tissue result from alterations in energy balance (Wabitsch, 2002). Energy balance is the equivalent of energy intake and energy expenditure. Positive energy balance, the excess of energy intake from energy expenditure, results in weight gain (Wardlaw et al., 2004). Energy in the body is used for basal metabolism, physical activity, and the thermic effect of the food. Basal metabolism, 60% to 70% of total energy, is the minimum energy needed to keep a resting and awake body alive. The amount of physical activity energy depends on the types of activity; more active action requires more energy than sedentary movement. Thermic effect of food is the energy needed to digest, absorb, and further process the food nutrient (Laquatra, 2004; Wardlaw et al., 2004).

During the pubertal development, obese adolescents often have early sexual maturity and eventually experience menarche at a younger age than non-obese girls. The long term effects of obesity in adolescents include becoming obese adults, increasing mortality risks, increasing risks for coronary heart disease, increasing hypertension risks during pregnancy, and diabetes type 2 (Zwiauer, Caroli, Malecka-Tendera, & Poskitt., 2002). Approximately 50% of severely obese youngsters suffered from metabolic syndrome, which linked insulin resistance and hypertension, dyslipidemia, type 2 diabetes, and other metabolic abnormalities (Weiss et al., 2004). Adolescents with BMI over 40 had considerable cardiorespiratory morbidity and severe physical deconditioning (Gidding et al., 2004).

Several factors are involved in the development of obesity, including genetic factors. The way genes affect the obesity must be through their effects on food intake or energy expenditure. The identification of genes that affect obesity is not very clear until now because human obesity engages many genes (Hill, Kriketos, & Peter, 2000). Schwartz (2003) stated that the prevalence of obesity has changed over the last decade; however, the gene pool has not changed. The change could be affected by the alteration of our environment. Physical activity has been replaced by inactivity, including watching television, and playing video or computer games. The increase of portion sizes served at home and restaurants elevate the energy intake and lead to positive energy balance.

Nestle (2002, pp. 173) states that "the increasing prevalence of obesity results from complex interaction of societal, economic, demographic, and environmental changes that not only encourage people to eat more food than needed to meet their energy requirements but also encourage people to make less healthful food choices and act as barriers to physical activity." As income rises and populations become more urban, diet becomes high in fat, saturated fat and sugar. At the same time, large shifts towards physically inactive work occurs (WHO, 2003). Moreover, at the present day, the prevalence of two working parents has been increasing in families and time is pressing, so many people and children alter their food choice to fast food which offers the high fat and high sugar diet. Consequently, a small increase in energy intake and a decrease in physical activity results in significant changes in body weight (St-Onge, Keller, & Heymsfield, 2003).

Giammattei, Blix, Marshak, Wollitzer, and Pettitt (2003) conducted an obesity study in 11 to 13 year old schoolchildren and identified television watching, non-active activity, as a contributing factor to obesity. The BMI increased as the hours of television watching raised. However, the study detected a weaker correlation between computer use and video games playing with the BMI and the percent fat.

It is estimated that around 17.6 million children under five are overweight worldwide. Obesity incidence in adolescents aged 12-17 has elevated dramatically from 5% to 13% in boys and from 5% to 9% in girls between 1966-70 and 1988-91 in the USA. In Canada, the prevalence of overweight in children aged 7 to 13 years old during 1981 to 1996 expanded from 11% to 33% in boys and 13% to 27% in girls. In the same time, the prevalence of obesity in boys rose from 2% to 10% and in girls 2% to 9% (Tremblay, Katzmarzyk, & Willms, 2002).

2.5.3.2. Contributions of Soft Drink Intake to Obesity

Table 2.4 shows studies that found a relationship between soft drink consumptions and obesity or weight gain. Soft drink intake was identified as one of the contributory factors to obesity. Boys aged 9-14 years who consumed sugar-added beverages and diet soda significantly increased their weight. The increase of sugar-added beverage intake over time was associated linearly with weight gain, and increasing milk and diet soda intakes were weakly associated with weight gain. Girls who consumed one daily (0.5 to 1.5) serving or more of sugar added beverages gained significantly more BMI (Berkey, Rockett, Field, Gillman, & Colditz, 2004). The findings from Ludwig, Peterson, and Gortmaker (2001) were against the findings of Giammattei et al. (2003), who noted that the diet soft drink intake was an independent predictor for obesity in the subjects. Ludwig et al. (2001) observed a negative association between the diet soft drink intake and obesity. Obese children and adolescents aged 4 to 16 years had significantly higher total energy intake, total fat and saturated fatty acid intakes than non-obese subjects (Gillis, Kennedy, Gillis, & Bar-Or, 2002). A stronger relationship between total energy eaten and juvenile adiposity than with fat or the type of fat consumed was detected in the study. Soft drinks contained high fructose corn syrup and glucose that could enhance the energy overconsumption (Bray, Nielsen, & Popkin, 2004). Table 2.2 shows the calorie amount in the beverages served by Canada Fast Food Restaurants. The high fructose corn syrup (HFCS) intake enhancement was related temporally to the obesity epidemic, and too much HFCS in soft drinks might have a role in the obesity epidemic (Bray et al, 2004).

Table 2.4. Studies of the relationship of soft drink intake and obesity

Study	Subjects	Methods	Results
Giammattei et al. (2003)	Grade 6 and 7, 186 boys and 199 girls	Physical and fat measurement using bioelectrical impedance	Regular and diet soft drink consumption contributed to cause obesity in children aged 11 to 13 year old.
Mrdjenovic & Levistky (2003)	6-13 year old, n=30, Site: summer camp	4 to 8 week weighed food diaries	Soft drink consumers increased their weight after the study. They also replaced milk with soft drinks.
Ludwig et al. (2001)	11-12 year old n:571	Anthropometric measurement and YFFQ	The risk of becoming obese rose 1.6 times for each additional can or glass of soft drink.
St-Onge et al. (2004)	32-37 year old 12 men and 8 women	Beverage test (mix nutrients and sugar only), energy expenditure measurement, satiety questionnaire	Sugar only beverages were easier to digest due to their smaller thermic effect, subjects did not feel satisfied after drinking sugar only beverages.
Schulze et al. (2004)	24-44 year old, n: 91,249	Mailed questionnaire through, Nurses Health Study II, 133 items semi quantitative FFQ	Women who increased their consumption of soft drinks increased significantly their weight and BMI. Women who increased consumption of fruit punch gained more weight (3.69 kg) compared with women who decreased consumption (2.43 kg; $P<.001$). Greater sugar-sweetened soft drink consumption was strongly associated with progressively higher risk of type 2 diabetes age-adjusted RR was 1.98
Berkey et al. (2003)	9-14 year old n: 16,771	BMI measurement; FFQ; tanner stage, menarche, and age questionnaire	The increase of sugary beverage intake was associated linearly with weight gain. Sugar added beverage and diet soda male consumers increased their weight. Female soft drink consumers had higher BMI

Note: YFFQ: Youth Food Frequency Questionnaire
BMI: body mass index
FFQ: food frequency questionnaire
n: the number of participants

Energy given by a sugar content beverage was more preserved by the body than a mix nutrient beverage of the equal volume and energy content because these kinds of beverages had smaller thermic effect (St-Onge et al., 2004). Soft drinks can be categorized as sugar only beverages because the sweetener builds 10%-12% of their weight (Jorge, 2003). Furthermore, adults and young women did not feel satisfied after drinking the sugar only beverages (St-Onge et al., 2004; Schulze et al., 2004). There was also a positive relationship between sugar-sweetened drink intake and both greater weight gain and risk of type 2 diabetes.

Table 2.5 shows that the serving sizes of regular soft drinks were bigger than milk. McConaby, Smiciklas-Wright, Birch, Michell, and Picciano (2002) found there was a positive relationship between body weight and the energy intake and between body weight and the portion size. The increase of the portion size was followed by the increase of energy intake. Although the causes of obesity were complicated, the studies provided evidence about the relationship between soft drink consumption and obesity. Thus, soft drink intake could be identified as a contributing factor to obesity.

Table 2.5. Energy content in beverages served at Canadian fast food restaurants

Types of beverages		Serving size (mL)	Calorie (kcal)	Sugars (g)
1% milk		250	100	12
		200	80	10
1% chocolate milk		250	170	27
		200	140	22
2% partly skimmed milk		200	100	9
		250	130	12
Apple Juice		177	80	18
Orange Juice	(small)	315	150	32
	(medium)	440	210	44
	(large)	570	280	57
Coca Cola	(small)	345	150	39
Classic™	(medium)	495	220	56
	(large)	730	320	82
Sprite™	(small)	345	140	35
	(medium)	495	200	51
	(large)	730	290	75
Fruitopia™	(small)	345	170	41
	(medium)	495	240	59
	(large)	730	350	88
Iced Tea	(small)	345	110	59
	(medium)	495	160	40
	(large)	730	230	28
Hot chocolate		188	130	21

Source: McDonald's Quality and Nutrition Information (2004).

2.6. Soft Drinks in High School

Most of the surveys and surveillances conducted in North American have determined that the dietary habits and beverage intake are moving towards an unhealthy direction. One factor that affects food choice of children and adolescents is food marketing. Children, especially adolescents, are attractive customers because the amount of money they control has risen and parents have allowed them to choose their own food. So in the recent years, the companies concentrate to market their products to children. The advertising messages reach the youngest children and adolescents (Nestle, 2002). The US General Accounting Office (2000) of the US government observes that the marketing activities are greater in high schools than those in middle or elementary schools. It is hard to differentiate which activities are done solely for commercial purpose from the non-commercial. For example, soft drink companies fund teachers in making a teaching manual with their logos on it. This activity can be categorized as a marketing venture. However, other companies may fund an activity solely to support the school system.

Critics such as Nestle (2000) express concern since soft drink companies may be focusing on schools because they knew that most of their potential customers go to schools. The marketing activities include product selling, direct advertising, indirect advertising, and market research.

2.6.1. Product Selling

Some schools have an "exclusive arrangement" that prohibits the sale or advertising of products from competitive vendors, and generally provides an immediate transfer of funds to individual school boards with subsequent revenues or inclines tied to sale (Molnar & Reaves, 2001, Nestle, 2000). A second form of contract allows schools to enter into an arrangement with the soft drink company where the schools to sell the company's products such as soft drinks. This arrangement may or may not be exclusive. A soft drink company assured the school that it would get a minimum of $30 per student, which was 0.4% of the amount of the district budget (General Accounting Office/GAO, 2000). Nestle (2000) reported that by the year 2000, there were 130 schools in 33 states in United States of America involved with the soft drink companies' contracts. The "Pouring Rights" contracts gave one particular brand exclusive rights to set their vending machines in schools to build brand loyalty among students. The allocations of the vending machines were in strategic places with high-traffic areas, such as outside the school cafeteria, in the lobby, in a main hallway (Consumer Union, 1995).

Table 2.6 depicts several contracts between districts and the soft drink companies, with information about the money involved and the benefits for the companies. Hardy (1999) reported that Colorado Spring District 11 official sent letters to administrators encouraging them to raise Coke™ sales in their schools because of the contract between Coca Cola™ and the district. To fulfill the contract, the schools was encourages to push or at least promote the students to drink Coke™.

Table 2.6. Examples of contracts between soft drink companies and US schools districts

School	Company	Time	Money expected from the contract	Benefit for the companies
Colorado Spring district 11	Coca-Cola™	10 years	$8 million	Increase Coke sales in schools
Viroqua District, Wisconsin	Pepsi ™	8 yrs	$6,000 vending machines with milk, sandwiches, fruit. $64,900	Prolonged the right to sell in the schools, provided no-advertising scoreboard.
17 schools in Kent, Michigan	Coca-Cola™	20 yrs	$10/year/student 1% of sales, total $4-5 million/yr	Exclusive rights for schools to sell only their products
Charleston, South Carolina	Pepsi™	5 yrs	$8.1 million, $1 million for signing contract, $50,000/yr, 40-43% revenues from vending, $1,000 scholarship/y	Exclusive rights for schools to sell only their products
County Charleston	Pepsi™	5 yrs	$7.2 million	NA
Norfolk, Virginia	Coca-cola™	5 yrs	$3.2 million	Exclusive rights for schools to sell only their products
Hillsborough, Florida	Pepsi™	12 yrs	$ 50 million	Exclusive rights for schools to sell only their productsl
Sherwood District, Oregon	Coke™	12 yrs	$ 400,000	Exclusive rights for schools to sell only their products

Source: Hardy (1999) and Molnar (2003)

2.6.2. Direct Advertisement

In schools, advertising soft drinks can be observed in the form of direct advertisements on soft drink vending machines and scoreboards. Soft drink companies may also put the advertisements on school buses, billboards, wallboards in corridors and lavatories, as well as on telephone kiosks and book covers. Some schools ran the commercials on radio programs piped into school corridors and lunchrooms. In other schools, advertisements were distributed through the media, such as classroom magazines and television programs. Channel One, the daily classroom news programs aired two minutes of commercials aimed at school children every 12 minute news program (Consumer Union, 1995). One of the soft drink companies' contributions to schools was providing computer equipment. Soft drink companies also sponsored school sports, club and other activities, and provided schools with sports uniforms, sports supplies and facilities. In compensation they could put their logo on sports uniforms, sports supplies, and sports facilities. They gave free samples and coupons for fast food to the students (Nestle, 2000). Consumer Union (1995) also reported that in 1992-1993, the local Coca-Cola bottler donated $45,000 for several scoreboards, including a four-sided electronic scoreboard suspended from the ceiling for Northridge High School, Layton, Utah. The Coke™ logo was the only picture in the large scoreboard.

2.6.3. Indirect Advertising

The indirect advertisements were usually finite and subtle. One of the examples of this advertising was corporate-sponsored educational materials or teacher training (GAO, 2000). Sponsored educational materials were usually provided for free or inexpensively; these materials were in the forms of multimedia teaching kits, videos, software, books, posters, reproducible activity sheets, workbooks, or other teaching aids. These enhanced teachers' material supplies. However, these materials could have outright plugs for a company or its product, or worse, biased information (Consumer Union, 1995).

Analyzing the trends of commercialism in school, Molnar (2003) concluded that in 2003, there was no US student that has not been sold out by the school in exclusive contracts or other advertisement activities with soft drink, fast food, and other companies. All of the commercial activities in schools gave advantages for schools and companies. However, Alex Molnar in Hardy (1999) stated that the contracts made the schools promote a brand of soft drinks even when more nutritious beverages were offered. In the school advertisements, the soft drink companies delivered messages that were against schools' messages in health and nutrition classes.

All of these contracts were a temporary solution for funding problems in school districts. However, the solution would lead to other problems, which are the health of the students and the distortion of health messages carried by the school. The American Academic of Pediatric Dentistry (AAPD) (Originating Council on Clinical Affairs, 2002) issued a policy statement that argued against the contracts. The statement said that AAPD would encourage collaboration with other parties to attract public awareness of the health impact of soft drinks on health, discourage any agreements that reduce the access to healthy beverages, promote healthy beverages and health intervention, especially in oral hygiene. Furthermore, cans would be preferred over bottles because they cannot be closed and stored for convenient later consumption throughout the day. They also suggested that bottled water should always be available at the same place that soft drinks are offered.

The Pediatrics-Committee on School Health (2004) published recent recommendations about soft drinks in schools. The policy recommended that school districts invite public discussion before signing any contract with soft drink companies. In those situations where contracts are already signed, the committee recommends that the allocation of vending machines should be chosen by the schools not the soft drink companies. In addition, soft drink vending machines should be turned off during lunch time or school hours, incentives based on the amount of soft drinks sold per student from the contracts should be eliminated, the amount of machines should be limited, and soft drink consumption and advertisements in classrooms should be eliminated.

The Long Angeles Unified School District Board (LAUSD) voted to ban soft drink in all LAUSD schools started January 2004. The action was stimulated by several factors, including community, teacher, and parent input, coalition of healthy food and community food advocates' campaign, LAUSD board members' advice, support from

LAUSD staff, and the awareness of the public of the bad impact of soft drinks on health (Center for Food and Justice et al., 2002).

The Canadian Soft Drink Association has elected to voluntarily remove carbonated soft drinks from elementary and middle school as of fall 2004. That remains to be seen however, is the effects of such a move will have on school funding and children's intake of added sugar, given the likelihood of increased intake from fruit-based drinks and sport drinks. The extent of the role soft drink companies will play in elementary schools' beverage environment will also be of impedance (Henry, 2004).

2.7. School Based Intervention for Adolescents

School is a good place to develop nutrition education interventions for adolescents because it is the easiest place to reach a large amount of adolescents. School-based intervention provides several advantages, including maintaining continuous and concentrated contact with participants, conducting more cost-effective intervention, and presenting the intervention within the context of the children's natural environment (Hoelscher et al., 2002). Adolescents spend most of their time at school the 10-month academic year and eat at least one of the three major meals in school; therefore, the type of foods and beverages sold is important in supporting students' nutritional intake. Hofer (1999) stated for most students formal school hours is often arranged into a complex schedule of athletic events, social life, after-school activities, studying, and part-time jobs. The most likely time adolescents spend time with their families is the evening meals and weekend. However, spending time with family on weekends is not first on the list in an adolescent's schedule. Nutrition education in school is a good opportunity to help adolescents practice healthy behaviours. Schools also have an appropriate opportunity to address peer and social pressure that influence health behaviours.

Table 2.7 and Table 2.8 show school-based nutrition education interventions that are conducted from 1990 until 2004. The brief summary of the number of the participants in each study, the participants' ages, the evaluation methods, the intervention components, and the outcomes of the intervention are described in the table. According to the components used in the studies, this thesis classifies the studies into three categories, which are teacher or adult educator, parental involvement, and peer educator component.

2.7.1. Teacher- and adult-led in school based intervention studies

Table 2.7 describes studies using teacher or adult as educator. Teachers and other deliverers in these studies have been trained prior to the intervention. Studies have shown that teacher-led intervention may become more effective than family-based intervention or interventions involving parents only, since teachers can guide and support them during this intervention period. Teacher involvement can decrease the conflict between adolescents and parents (Rhodes, Grossman, & Resch, 2000). The effectiveness of teacher-led or adult-led intervention depends on how students perceive teacher support. For example, when the students in grades 6 to 8 think the teacher support is high, they may increase their self-esteem (Reddy, Rhodes, & Mulhall, 2003). Students may become more confident in their ability to change.

Using a variety of teaching methods has also been shown to be effective. Soliven (2003) categorized teaching methods into

1. Visual teaching method, the lessons were presented using pictures, sketches, graphs, diagram, and other illustrations.
2. Auditory teaching method, oral presentation was the mean in delivering the lessons.
3. Tactile teaching method, students were engaged in hands-on experiments.
4. Kinesthetic teaching method, teachers incorporate physical activity into the lessons.
5. Group teaching style, the integration of group discussion during the lessons.
6. Individual teaching style, students were given activities or assignment to work on individually.

Several studies used the combination of these methods, such as Killen et al. (1993) who effectively used a slide presentation, modified by the story telling, and Little et al. (2002) who successfully used general lecturing, group activity, and class discussion to increase the nutrition knowledge. Long and Stevens (2004) integrated the use of internet and behavioural-activity-based classroom components, while Anderson et al. (2001) used only a behavioural and activity based classroom component.

The way students were recruited did not influence the results of the studies. In the Long and Stevens (2004) study, students volunteered to join the study, while students were assigned to follow the Anderson et al. (2001) program. Both interventions were successful in increasing students' nutrition knowledge; however, they did not report the improvement of eating behaviour. Both studies were done in short duration (less than a year). This might indicate that while adolescents may learn about nutrition information; they may need a longer period to internalize practice for sustained behavior. It is difficult to determine the duration of an intervention to effectively influence students' behaviour without taking so much school time. For example, students in the "Exercise Your Options" study (Dairy Council, 2003) changed their intake behaviour after 16 weeks of intervention, but Himes et al. (2003) observed the changes in the participants after 1.5 years of implementation of soft drink intervention on younger students.

The "FOR (Food On the Run)" intervention was incorporated not only into classroom but also campus, and community related activities, such as working with foodservice to add healthful food options, school-wide taste tests, and lunchtime demonstration (Agron, et al., 2002). More learning and teaching activities beyond the classroom in health and nutrition education would enable students and teachers to utilize critical health literacy opportunities within the local communities (Leger, 2001) as was done in the "FOR" intervention.

One study, "Nutrition For Life" (Devine, Olson, & Frongillo, Jr, 1992) made modest but significant improvement in nutrition knowledge, attitudes, and behaviour scores despite its short term duration. In another study, participants changed their food choice into healthier foods after seven weeks with the "Exercise Your Options" intervention (Dairy Council of California, 2003). Although the duration of the study was considered short (16 weeks), the "New Moves" (Neumark-Sztainer, Story, Hannan, Rex, 2003) used social cognitive theory and multicomponents to improve participants' attitude towards physical activity; however, there was no significant different between the students' behaviour in the control schools and intervention schools. However, the likeliness of attitude and behaviour change increases when a theory-based and multi-component intervention is applied in a study.

Table 2.7. Adult taught approach in school-based nutrition education interventions for adolescents from 1990-2004

Study	Subjects	Evaluation methods	Duration	Components	Result
Nutrition For Life (Devine et al., 1992)	1863 students. Grade 7-8	Questionnaire	ranged: 1-50 hrs	Nutrition For Life manuals can be integrated into the curricula of Health and Home Economic class in New York State schools.	Increased nutrition attitude, behavior, and knowledge scores when the manuals were used for 3 hours.
Killen et al. (1993)	967 girls. 11-13 yrs	Anthropometric measures, interview, self-report assessment.	18 lessons	Slides presentations, workbooks	Increased students' knowledge, not their attitude and behavior.
Planet Health (Gortmaker et al., 1999)	1295 students. Grade 6-7	Body Mass Index, Triceps Skinfolds, Food and Activity Survey	2 school years	Classroom lessons, physical education materials, wellness sessions, and fitness funds.	Girls reduced the obesity prevalence and energy intake, and increased fruit and vegetable intake. The amount of television viewing decreased in all genders.
Anderson et al. (2001)	118 teens. 14-18 yrs	Knowledge test and food analysis chart.	4 wks	Guide to Good Food Manual.	Improved students' nutrition knowledge but not food choice
EYO (DCC, 2003)	3,300 students. 11-14 yrs	3 sets of Food record (pre-test, post-test, and 3 months follow up)	7 days	EYO manual focused on food choice	Increased all food group food consumption and decreased intake of extras and sodas.
Food on the Run (Agron, et al., 2002)	220 students. Grade 10, 16 y	Self-reported survey (42 close-ended questions)	9 months	Training for students, classroom sessions, and activities (working with food service)	Increased knowledge and positive attitude scores toward PA and nutrition. Improved healthy eating behavior.

Table 2.7. Adult taught approach in school-based nutrition education interventions for adolescents from 1990-2004

Study	Subjects	Evaluation methods	Duration	Components	Result
Little, Perry, Volpe (2002).	39 high school students	Questionnaire	5 wks	5x 1 hour nutrition lesson: 20-35 min lectures, 10-15 min activity, 5-10 min concluding the lesson.	Improved nutrition and sport knowledge and increased supplement taking.
New Moves (Neumark-Sztainer et al., 2003)	201 girls. Grade 9-10	Individual interviews, mailed surveys to parents, process evaluation by subjects	16 wks study, 8 wks follow up	PA sessions, nutrition sessions, social support sessions, a follow up component (weekly lunch meeting at school).	The intervention groups improved PA behaviour and the skill in choosing healthy food and self-perceived.
Long and Stevens (2004)	121 students. 12-16 y	Health Behaviour Questionnaire.	1 month	5 hours of WWW-based nutrition education and 10 hours classroom curriculum	Increased the students' self-efficacy for healthy eating, but not healthy food consumption.
PATH (Bayne-Smith et al., 2004)	442 girls. 14-19 y	Self-administered anonymous questionnaire	30 mn x 5 days/wk, 12 wks	Manuals with vigorous exercise, health and nutrition education, and behavior modification.	Improves knowledge, healthy eating habits, percentage of body fat, and blood pressure

Note: EYO: Exercise Your Options
PATH: Physical Activity and Teenage Health
PA: physical activity

Table 2.7 also shows that the longer the duration of the studies the more likely they were to influence attitude and behaviour. The use of more than one component in a study increases the exposure time of the intervention on students. Moreover, a multi-component study appears to address a variety of factors that shape eating habits.

2.7.2. Parental and Family Involvement

Parents influence children's eating habit by controlling the types of food purchased, prepared and served at home (Tseng, 2004), being role models in shaping health behaviours (Rosso & Rise, 1994), and shaping children's food preferences and eating habits (Birch & Fischer, 1998; Brown & Ogden, 2004). Several studies presented in this section identified parental influence as important in the choice of food and beverage consumed. For example, adolescents aged 16 years saw their parents as models for healthy behaviors, especially in type and amounts of fat consumed, smoking habit, and alcohol consumption. Rosso & Rise (1994) reported that parents still influenced their adolescent children's health behavior even as their age increased from 16 to 20 years. Neumark-Sztainer, Story, Perry, & Casey (1999) also found that adolescents aged 12-19 years identified parental influence as one of secondary importance in affecting their food choices. Taste enjoyment of food was shown to be shaped by the culture, custom, and meal pattern in the family where parents usually hold the highest control (Birch & Fischer, 1998; Brown & Ogden, 2004). Finally, Young and Fors (2001) found that two working parents in a family reduced the possibility for increasing parental supervision. Studies have shown that parents can improve the healthy behaviors of their children by 11% by showing support for their children when they engage in healthy behaviors (He, Kramer, Houser, Chomitz, & Hacker, 2004). The frequency of family meals also increases the quality of healthy dietary intake. As children grow and become teenagers, however, they gain more freedom to buy and prepare their own meals (Neumark-Sztainer, Story, Hannan, & Rex, 2003).

There were also school-based interventions for adolescents that tried to involve parents as seen in Table 2.8, such as the New Moves (Neumark-Sztainer et al., 2003), Gimme 5 intervention (Nicklas et al., 1998), and TEENS intervention (Lytle et al., 2004). In the Gimme 5, intervention parents were asked to help their children to eat five servings of vegetable and fruit everyday. The New Moves intervention incorporated minimal parent involvement in order to enhance parental support for students by sending 14 postcards containing information related to physical activity, social support, and nutrition. In the TEENS intervention, parents received a nutrition package from school, and some parents joined the nutrition advisory council at school (Birnbaum, 2002).

The New Moves intervention (Neumar-Sztainer et al., 2003) and TEENS intervention (Lytle et al., 2004) did not change the eating behaviour of the students while the Gimme 5 intervention (Nicklas et al., 1998) could not maintain the change for a long time. These findings might indicate that parental involvement works only for younger children (Reynolds et al., 2000; Nader et al., 1996; Himes et al., 2003) or early adolescents because during early adolescence, adolescents tend to trust and respect adults (Spear, 2004). The participants in the previously mentioned interventions were high school students who are in their middle adolescence when they are often mistrustful of adults and greatly influenced by peer group (Spear 2004). This could be the reason of the ineffective adult involvement component. Another possibility is the available design of parental involvement might not be sufficient in assuring the involvement.

Relationship with family members has been identified as one of the most valuable items by 6^{th} graders, but the importance of this relationship gradually diminished as students grow up (Prokhorov, Perry, Kelder, & Klepp, 1993). In late adolescence, generally teenagers have established a body image, are directed toward the future, are independent, and are consistent in their values and beliefs (Spear, 2004). The involvement of the nutritional expert might be useful during this time because teenagers are open to the rationale behind the given information explained by the dietitian

2.7.3. Peer Educator Intervention

Peer educator intervention has been shown to effectively influence adolescents' eating behaviours. During adolescence, teenagers form their identity through their opinions and decisions. Often their opinions are against those of their parents and teachers. During middle adolescence, peers become more dominant than parents when it comes to social activities, such as dietary habits (Cullen et al., 1998; Spear, 2004), dress styles, clubs, social events, and hobbies (Sigelman & Shaffer, 1991). In the study by

Herns and Gates (1998), adolescents showed a wide autonomy by buying their own food at the grocery store. However, they depended more on their parents in choosing courses, deciding to go to college, selecting a job, and spending money (Sigelman & Shaffer, 1991). Pugh and Hart (1999) noted that peer groups are important for identity development in adolescence since identity is built within relationship. Pugh and Hart followed (1999) 10^{th} and 11^{th} grade students for two years and observed that these students explored who they are by being involved in activities with their peers. Sloane & Zimmer (1993) explain that peer leaders are considered effective because adults and teenagers, would rather consider and personalize a message that may alter their attitudes and behaviors if they believe the messenger is comparable to them in lifestyle and faces the same concern and pressure. Jago (1998) and Siegel, Aten, Roghmann, and Enaharo (1998) stated that peer education is suitable for adolescents, especially grade 9, because they prefer to please their peers than adults. They found that peer educators were more effective than adult educators for students aged 13 to 18 years.

Role modeling, peer pressure, consistent support and educational resources make schools an ideal spot for health promotion study. Peer education had been applied widely and successfully in other health intervention studies. These include, reducing steroid utilization for high school athletes (Goldberg & Elliot, 1993), improving sexual knowledge and behavior in Turkish and Zambian adolescents (Özcebe & Akin, 2003; Agha & Van Rossem, 2004), HIV prevention (Smith & DiClemente, 2000), and nutrition education for adults and pregnant teenagers (Anliker et al., 1999). A peer educator approach was also incorporated in school-based nutrition education for adolescents as shown in Table 2.8. The Peterborough School Nutrition Project (Parker & Fox, 2001), TACOS (Fulkerson et al., 2004), and TEENS (Lytle et al., 2004) used different forms of peer educator involvement.

Botvin, Baker, Filazzola, and Botvin (1990) found that for grade 7 students, older peer educator intervention could produce significant behavior changes. The experimental schools were assigned to either prevention program implemented by older peers, prevention program implemented by regular classroom teachers, prevention and booster sessions by older peers, or prevention and booster sessions by classroom

Table 2.8. School-Based Nutrition Education Interventions for Adolescents from 1990-2004 using parental involvement and peer-leader components

Study	Subjects	Evaluation methods	Duration	Components	Result
HHP (Barthold et al., 1993)	19,073 students. Grade 6-12	-	5 yrs	Assemblies (introductory presentation), Classroom presentations, flyers for parents.	There is no evaluation for the outcomes.
Gimme 5 (Nicklas et al., 1998)	2213 students. Grade 9-12	Class-administered questionnaires	workshops 5x55 min. For 4 y.	Media campaign, workshops, supplementary activities, school meal modification, and parental involvement.	Increased knowledge scores, the intake of fruit and vegetables 14%.
TACOS (Fulkerson et al., 2004)	812-3157 secondary schools students.	Activity list and observation, and food sale list and student mailed survey.	2 yrs	Media campaign, taste-testing, public announcements, poster and T-shirt contest, raffle event, recipe creations, game, peer-leader promotion, and coupon kick-off.	An increase of percentage lower fat food sales. The duration of promotions and the percentage lower-fat food sales were unrelated in year l, but significantly related in year 2.
TEENS (Lytle et al., 2004)	2883 students. Grade 7-8	24-hour recalls, survey, observation, documentation.	2 yrs	Peer leaders involvement, TEENS curriculum, family component.	Increased food choice score, but did not improve food intake

Note: HHP: Healthy Heart Program
TACOS: Trying Alternative Cafeteria Options in Schools
TEENS: Teens Eating for Energy and Nutrients at Schools

teachers. However, the roles of peer educators were common as additional educator, which means that older peers assisted the classroom teacher in giving any sessions.

In the TEENS study, students chose the peer educators by writing the names of three boys and three girls in class that they respected and admired. The peer educators were involved in the delivery of the TEENS (Teens Eating for Energy and Nutrition at School) curriculum, which contained 10 classroom sessions for 40-45 minutes, and small group activities and discussion as the leaders. Students and teachers were satisfied with the peer educator component (Birnbaum, Lytle, & Story, 2003). Compared to students exposed to classroom and environmental component, students exposed to peer educator and classroom components made the greatest improvement in dietary habit (Birnbaum et al., 2002). The dietary behaviour improvement was not sustained until the second year follow-up (Lytle et al., 2004). In the Tacos study, students volunteered themselves to become peer promoters. They obtained incentives for the activities they conducted (Fulkerson et al., 2004). Students in the Peterborough School Nutrition Project worked with the drama teacher and presented a drama of healthy eating behaviour in the cafeteria (Parker & Fox, 2001).

Anliker et al., (1999) reported that working with peer educators benefits a program because peer educators can provide comments on program design, material, and implementation. In most occasions, the peer educators change their eating habits and become role models and supporters in overcoming barriers to dietary change. However, several challenges in building a peer educator program are also encountered, such as providing careful training, support, and monitoring for peer educators, and motivating peer educators to be more active in the program.

2.8. Summary

Humans need to drink fluid since the water in the food and the water produced by oxidation of food (metabolic water) are inadequate to replace the loss. The main beverages consumed by adolescents (except plain water) are milk, fruit juice, and soft drinks. Adolescents have shifted their beverage intake over the last 30 years into low milk intake, higher fruit juice intake, and high soft drink intake. This phenomenon was concurrent with the trend toward larger portion sizes, which occurred at home and outside meals. Soft drink access from fast food restaurants, vending machines, school cafeterias had increased. Age has an inverse relationship with fluid milk intake, and positive relationship with carbonated soft drink intake. Teens aged 14-17 years are the greatest soft drink consumers in the 6-17 year old population. Soft drinks are consumed during breaks (50% of total sweetened beverage intake), lunch, and dinner.

Beverage intake in this study is assessed using a beverage frequency questionnaire, which is developed based on food frequency questionnaires. The advantages of using food frequency questionnaires are give moderate burden to subjects, can be self-administered, assess usual diet, and require low cost and short time. Food frequency questionnaires also have several weaknesses: poor precision, memory dependence, complex cognitive skill requirement. Food frequency questionnaires provide enough accuracy by presenting a good reproducibility in adolescents and 6th grade students. Food frequency questionnaires have 0.57 Pearson correlation in reproducibility for soda intake.

High soft drink intake compromises health, especially bone and dental health. The intake of soft drinks replaces the milk consumption, which lead to the inadequate calcium intake. Adequate calcium intake is important for bone mass density attainment which reaches its peak during adolescents. By consuming soft drinks, adolescents increase their phosphorus intake and make their calcium/phosphorus ratio imbalance, which can increase the release of calcium from bone. Soft drinks contain acid that can dilute the mineral from teeth while the protection effect of saliva on teeth cannot be observed in the presence of soft drinks. Sugar content in soft drinks also can cause teeth caries. This sugar may also add calorie intake in adolescents and increases their weight. Soft drink intake may have a role in causing obesity.

Adolescents spend most of their time in schools for their lessons and extra curriculum activities. The access to unhealthy beverages has become competitors for milk and fruit juice consumptions. Most students, in a school that provided milk only, consumed milk. Soft drinks companies conduct marketing activities in schools, including product selling, direct advertising, indirect advertising, and market research. In the product sale activities, the soft drink companies establish exclusive contracts with school under the goal of short-term fundraising. The contracts give one particular brand exclusive rights to set their vending machines in schools to build brand loyalty among students. These promotion activities convey a mixed message to adolescents. The message about healthy beverages seems not important to be practiced in the daily life because of the fact that school provides and promotes unhealthy beverages to students.

Nutrition education in school is a good opportunity to practice healthy eating and to address the peer and social pressure that influences health behaviours. School-based intervention provides several advantages, including maintaining continuous and concentrated contact with participants, conducting more cost-effective intervention, and presenting the intervention within the context of the students' natural environment. The long duration studies had a higher likeliness in influencing attitude and behaviour, but more than one component in a study increased the exposure time of the intervention on students. Moreover, a multicomponent study may address more factors that shape eating habits.

Parents and family influence children's eating habit by controlling the food availability at home, being role models, and shaping children's food preferences and eating habit. Having parents involved in nutrition education for adolescents can improve both children's and parents' eating habits. Parents also can support children in improving their eating habits. Adolescents have a wide autonomy by buying their own food at the grocery store out of need or choice. In late adolescence, teenagers have established a body image, are directed toward the future, are independent, and are consistent in their values and beliefs. The involvement of the nutritional expert might be useful during this time because teenagers are open to the rationale behind the given information. During middle adolescence, peers are more dominant than parents when it comes to social activities, such as dietary habit, dress styles, clubs, social events, and hobbies. Working with peer educators provides benefits because they can provide comments on program design, material, and implementation. Mostly, the peer educators change their eating habits and become role models and supporters in overcoming barriers to dietary change. Several challenges in building a peer educator program include providing careful training, support, and monitoring for peer educators, and motivating peer educators to be more active in the program.

3. METHODS

The study was done in two phases in two different cities, with the first phase conducted in Saskatoon (fall 2003) and the second phase in Prince Albert (fall 2004). This chapter describes the study participants, assessment methods, intervention and data analysis used in both phases of the study.

Ethical approval was obtained from the University of Saskatchewan's Ethics in Behavioral Science Research. The ethical approval for this study was received in March 10, 2003 (Appendix 1). Permission was also obtained from the appropriate school divisions.

3.1. Subjects

A total of 113 grade nine students from four high school classes (two from Saskatoon and two from Prince Albert participated in the study). Students from the two Saskatoon classes (57 students) were selected from Ethical Living classes and received the intervention in fall 2003. In this phase (called Phase 1) classes were assigned as peer educator class and self-taught class. Students (76 students) from two English classes in Prince Albert high school received the intervention in the fall, 2004; classes were assigned as dietitian taught and self-taught (Phase 2). The gender composition of the class can be seen in Table 3.1. Schools were selected from the Directory of Saskatchewan schools (Saskatchewan Learning, 2003) in consultation with the appropriate School divisions. All participants were from middle class neighborhoods, with close access to a variety of beverage outlets. For example, there were soft drink vending machines on all premises along with cafeteria where soft drink, milk and other beverages were served. Beverages were also available at malls within a five minute walk.

All participants were informed of the intent of the study. Appropriate permission was sought and obtained from the school divisions concerned before the letters to principals and teachers were mailed. Written consent was obtained from principals, teachers, parents and guardians of eligible participants (Appendix 2), and all student participants. Principals, teachers, consenting parents and students were sent an information package describing the study and protocols. The identity of the participants was not recorded or used in any way, except to characterize participants by class A, B, C, or D, and to allow sequential recalls and questionnaires to be tracked. The one student who did not participate in the intervention was given alternate activities.

Table 3.1. The gender composition of each class

Models of delivery	Females	Males	Total
Saskatoon (Phase 1)			
Multiple strategies:	10	23	33
Peer Educator (Class A)			
Single strategy:	10	14	24
Self Taught (Class B)			
Prince Albert (Phase 2)			
Multiple strategies:	12	8	20
Dietitian Taught (Class C)			
Single strategy:	16	8	24
Self Taught (Class D)			

3.2. Intervention Manual

A multifactorial and interactive nutrition education program *FUEL (Fluids Used Effectively for Living)* was designed as the intervention for the study. The program emphasizes the importance of nutritious food and beverage, healthy habits and active living behaviors among students, parents, and teachers. The program is linked to the Saskatchewan Learning's Evergreen health education curriculum guide for grades 6-9 which embraces a Comprehensive School Health model developed to positively influence knowledge, attitudes, and behaviour of students. The manual developed consists of a binder with six core lesson plans described in Table 3.2. All six lesson plans included a *Student Material* component (e.g. overheads, worksheets, and quiz).

Also included were fact sheets and recipes that students could take home and share with their families.

The development of F.U.E.L *for your future* was conducted as a collaborative effort between the research team, including a Registered Dietitian who was the research assistant and another register dietitian who assisted in progam delivery, with input from undergraduate and graduate nutrition students, recent nutrition graduates, and teachers within the Saskatoon school system. Students in the first phase study provided valuable input which was used to revise the manual. The revised *FUEL* manual was then used in the second phase study. The project was funded by Dairy Farmers of Canada.

Table 3.2. Lesson Plan Description for *FUEL*

No	Title	Description
1	The ABCs of Nutrition	Focus on increasing students' knowledge of human nutrition, by helping them make nutritious food choices using accurate, current information that emphasizes a positive relationship between overall health and healthy eating.
2	Understanding the Nutritional Value of Beverages	Focus on helping students gain an understanding of the nutritional content of various beverages, reflect on their own beverage intake and recognize the health impact of their choices.
3	Healthy Bones	Helping students develop an understanding of the calcium content of various foods/beverages, ways to incorporate calcium into their daily routine, the importance of calcium to their health, and the role of dairy products in meeting their calcium needs.
4	Making Fast Food Fit	Helping students gain knowledge and skills on how to consume healthier meals incorporating the basic nutrition principles of variety and moderation after learning ways to cut the sugar, fat, and salt in their fast food.
5	Vitality!	Helping students explore the importance of physical activity and incorporating nutritious food and beverage choices into their lifestyle to improve their overall health
6	Take a Peek…	Helping students develop the skills to read and understand "Nutrition Facts" on a food label and examine various advertising techniques to become smarter consumers.

3.3 Intervention Delivery

The peer educator class (Class A), located in one Saskatoon high school, received full presentations of the *FUEL* manual. Multiple strategies in teaching were incorporated, including visual, lecture, tactile, group interaction and discussion, and role-play. Cross-age peers (five nutrition students, College of Pharmacy and Nutrition, University of Saskatchewan), and six same-age peers (grade nine students) assisted the two dietitians who were recent nutrition graduates (older peers) in carrying out the intervention. The cross-age peers worked closely with the same-age peers. Both cross-age first year nutrition students and same-age high school peers received nutrition training prior to the beginning of the intervention by the research associate who coordinated the overall program delivery. There were approximately three training sessions about 30 minutes long with follow-up sessions during the intervention. The peer educator training was intended to build teamwork among them. In the training, the peer educators were informed about their roles in the classroom sessions and outside the classroom. Peer educators also received nutrition information that would be given in the classroom sessions. In the training, the peer educators built their skill in performing the experiments and demonstration.

The two classes in Prince Albert were located in the same high school. The size of the high school allowed the treatment and comparison classes to be in the same high school. Class C was taught by a local dietitian who presented all of the *FUEL* presentations throughout the intervention. The application of multiple strategies was similar; however, there was no recipe demonstration and beverage tasting in this class.

The self-taught classes (classes B and D) received the same handouts from the same package. This approach was considered as a single strategy because students only received illustration packages. Although these classes did not receive any presentations from the manual, teachers may have responded to their questions regarding the handouts. Teachers in these classes did not receive the FUEL manual until the study was completed.

3.4. Beverage Intake Assessments

The questionnaire used to assess students' beverage intake was a food frequency questionnaire called Beverage Frequency Questionnaire (BFQ), which asked 19 questions about specific beverages, 4 questions about beverage intake habits at school, 6 questions about attitude towards beverages, and 11 questions about knowledge regarding healthy foods and beverages. The BFQ questions regarding beverage intake were answered in the expressions: more than once/day, once/day, once/week, and seldom/never. A 24 hour recall was taken at each pre-, post-test, and three months follow up, and results of this are reported elsewhere (Vatanparast, Lo, Henry, Whiting, submitted). Knowledge, attitude and behavior/ dietary practices pertaining to the selection and consumption of beverages were collected using the same questionnaire (Appendix 3). The baseline and post-intervention questionnaires were identical. Sections of the questionnaire included: 1) nutrition knowledge about sources of calcium in the diet, 2) attitude pertaining to beverage consumption, and willingness to make changes (self-efficacy), 3) behavior, dietary practices pertaining to beverage consumption, and 4) demographic characteristics. The questionnaires were conducted as class exercises, and supervision and assistance were provided. Draft questionnaires were pre-tested by high school students not participating in the study and were revised accordingly.

Each participating student was asked to complete three sets of BFQ, one at the beginning of the study, one week following the delivery of the nutrition program, and three months after the intervention delivery. For classes A and B only, the final set of questionnaire was administered one year later, in September 2004. The longer-term assessment was conducted to determine the extent to which students were able to integrate and sustain changes to their beverage consumption habits. The timing of beverage intake assessment is described in Table 3.3.

Each administration of questionnaires was conducted as a class exercise within the 45 minutes class period. Completion of the actual questionnaire took 10-15 minutes, with the remaining time used for 2-hour recalls. To allow for consistent data collection, the research team including trained research assistant carried data collection. Data collection at both classes A and B, was carried out during the same time, at baseline-and following program delivery. To maintain consistency throughout the study, several nutrition graduate students and research team members were present during the assessments.

Figure 3.1. The timeline of the *FUEL* study

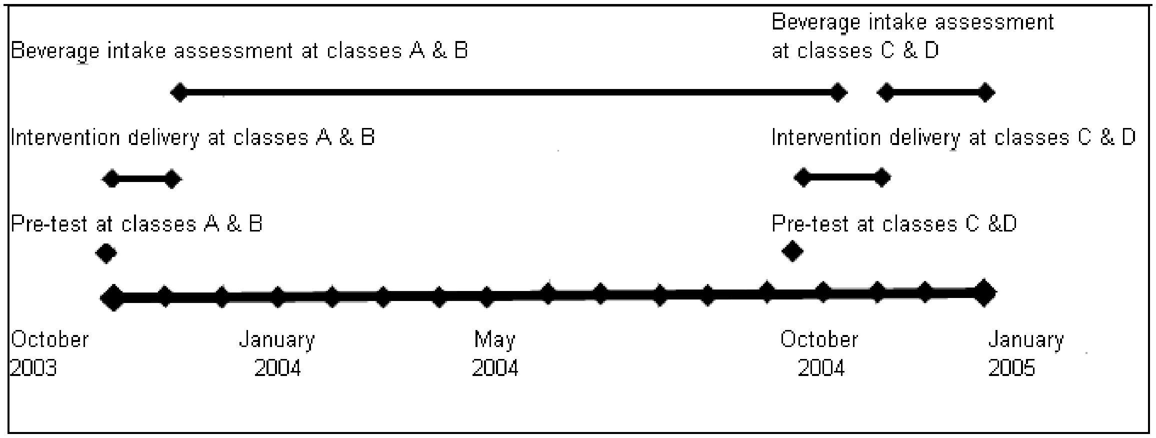

Table 3.3. Timing for beverage intake assessments (day.month.year).

Assessments	Peer educator (Class A)	Control-Self Taught (Class B)	Dietitian Taught (Class C)	Control-Self Taught (Class D)
Pre-test	01.10.2003	02.10.2003	15.10.2004	26.10.2004
Post-test	13.11.2003	14.11.2003	08.11.2004	25.11.2004
3 months follow up	12.01.2004	13.01.2004	10.01.2005	10.01.2005
1 year follow up	13.10.2004	14.10.2004	N/A	N/A

3.5. Statistical Analysis

The 19 questions on beverages in the BFQ were classified into six categories: 1) milk, 2) juice, 3) noncarbonated soft drinks, 4) carbonated soft drinks, 5) other drinks and 6) noncarbonated and carbonated soft drinks were totaled as sugary drinks. To obtain milk intake, the intakes of all types of fluid milk, milkshakes, and yogurt were added. The intake of juice included vegetable juice, 100% orange, cranberry, and grape juice, and orange-juice-calcium rich. The intake of noncarbonated soft drinks contained the intake of tea and coffee whenever added with sugar, ice tea, sport drinks, fruit drinks, and punch, such as Fruitopia™ and Sunny Delite™. Carbonated soft drink intake covered the intake of Coke™, Pepsi™, Sprite™ and Seven-Up™, as well as their generic equivalents. Total sugary drinks intake was the addition of noncarbonated soft drink and carbonated soft drink intakes. The other drinks consisted of bottled water, hot tea, and black coffee.

For coding purposes, the expression of seldom or never in the BFQ was considered as zero serving/week, about once/week was one serving/week, once/day was seven servings/week, and more than once/day was 14 servings/week.

Data were analyzed using SPSS (version 11.5, Chicago, Illinois). A normality test, Shapiro-Wilk's W test, to assess the data distribution was run first. The results indicated that the data were not normally distributed; thus a non-parametric test was used to analyze the data. Kruskal-Wallis ANOVA was used to compare all of the beverage assessments in a class. To determine significant differences among the beverage assessments, Friedman test was performed. Wilcoxon test was used as a multiple comparison test with the alpha level corrected according to the number of comparison done: 0.008 for Saskatoon high schools and 0.017 for Prince Albert high school. The correlation between beverage intakes was assessed using Spearman correlation.

3.6 Process Evaluations

The process of the intervention was evaluated after each presentation by asking students to write down what they liked most from the *FUEL* presentation that day. These data are not presented in this thesis. Another process evaluation was done, by asking the students the rate of their satisfaction towards the *FUEL* study in the scale of 1 to 5 (1 being poor and 5 being excellent). The level of satisfaction is discussed further in Chapter 4 (sections 4.3 and 4.4).

4. RESULTS

4.1. Introduction

This section begins with a description of each school's beverage environment followed by a summary of findings of beverage intake behaviour, nutrition knowledge and attitude toward healthy beverages assessments conducted at baseline, and post-intervention. Each school environment will be described under a separate heading (Saskatoon peer educator school, Saskatoon self-taught school, and Prince Albert school). Because the pre-test survey was used to describe the current beverage intake habits of grade 9 students, the intake of students from the same city were combined.

4.2. School environment

Participants were from primarily middle class neighborhoods according to Statistical Canada cut-off of income for family size more than 3 persons, which is ~$ 40,000/year, (Atlas of Canada, 2001). Participants had close access to a variety of beverage outlets. For example, there were soft drink vending machines on all premises along with cafeteria where soft drink, milk and other beverages were served. Beverages were also available at near by malls within five minutes walk.

4.2.1. Saskatoon Peer Educator School (Class A)

The peer educator high school consisted of 1600-1800 students from an area with income levels ranging from $33,000 to 130,000 per year (Muhajarine & Delanoy, 2003). Seven vending machines were in the school: four were located close to the main entrance and three to the cafeteria. Of the four machines that were located close to the main entrance, one sold mainly snack items such as chips, candies and gum while the remaining three sold an assortment of carbonated and non-carbonated beverages. Close to the cafeteria, one machine sold snack foods and two sold beverages. Coke™ was the main carbonated soft drink sold; non-carbonated soft drinks included sport drinks, fruit drinks, and iced tea. Each machine also carried an assortment of 100% fruit juice, and bottled water. Milk was provided in the school cafeteria only. Students could access beverages from the fast food restaurant in the mall that is located within 5 minutes walking distance.

At school, the price of milk and bottled water was relatively more expensive than the price of other vending machine beverages. The price for 591 mL soft drinks and 100% fruit juice was $ 1.75 while the price for 250 mL of milk was $ 1.00 ($ 1.50 for 500 mL milk).

4.2.2. Saskatoon Self-taught School (Class B)

The control school consisted of 986 students from an area with income levels ranging from $33,000 to 130,000 per year (Muhajarine & Delanoy, 2003). The control school had four vending machines: one was placed after the main entrance, one at the side entrance, and two at the cafeteria. The side entrance vending machine sold snack foods, and the others sold beverages. The types of beverages sold were carbonated soft drinks, non-carbonated soft drinks (iced tea and fruit drinks), 100% fruit juice, and bottled water. Milk was provided in the cafeteria, as well as several types of coffee. The price of carbonated and non-carbonated soft drinks was $ 2.00 for 591 mL, while the price of 250 mL milk was $ 0.75 ($ 1.40 for 500 mL milk) and 355 mL 100% fruit juice was $ 2.00. Across the street, there were two fast food restaurants and two convenience stores.

4.2.3. Prince Albert School (Class C and D)

The high school in Prince Albert consisted of approximately 2000 students in grades 9 to 12, who came from an area with income levels ranging from $37,000 to 80,000 per year (Saskatchewan River School Board, 2004). The vending machines were located in cafeteria and student lounge. Cafeteria vending machines sold soft drinks, bottled water, chips, and chocolate bars while the cafeteria also offered soft drinks, slushies, fruit drinks, water, and milk. Other vending machines in the student lounge sold soft drinks, bottled water, chips and chocolate bars. Each day the cafeteria offered a special of the day, which was a combination of lunch entrées and soft drinks. There was a pizza place, a bakery, a submarine sandwich, and a convenience store within a walking distance, where students could access beverages.

4.3. Students' beverage intake, knowledge, and attitude at the baseline

Figure 4.1 and 4.2 describe the beverage intake of grade 9 students before the intervention. Overall, students in all three schools drank similar amounts of beverages tested (milk, juice, carbonated soft drinks, non-carbonated soft drinks, and other beverages). However, grade 9 participating students in the two Saskatoon schools (class A and B) consumed a higher percentage of non-carbonated soft drinks (e.g. fruit drinks, fruit punch, ice tea, coffee with sugar, and ice tea), which led to a higher consumption of sugary beverages than participants in the Prince Albert school (class C and D). The percent contribution of juice intake between the three schools was marginally significantly different (p= 0.058) while the level of significant different was determined at 0.05. The caloric beverage intake (milk, 100% fruit juice, and sugary beverages) of participating students in all three schools was not significantly different.

Figure 4.3 shows that the intake of female participants in all classes before the intervention was not significantly different. However, female participants in the class A and B drank a higher percentage of non-carbonated drinks than those in class C and D. Figure 4.4 shows that boys in the class A and B drank more other beverages (coffee, tea, and bottled water) than those in class C and D. The percent contribution of caloric beverages between boys' intake in all three schools was not significantly different. Furthermore, participants (male and female) in all classes did not drink caloric beverages in significantly different amounts.

Baseline assessment showed no significant different between the knowledge of participants in all three schools. However, female students in class C and D had a significantly higher knowledge score than female students in class A and B. The attitude score of participants in class A and B towards healthy beverages was significantly higher than that of students in class C and D.

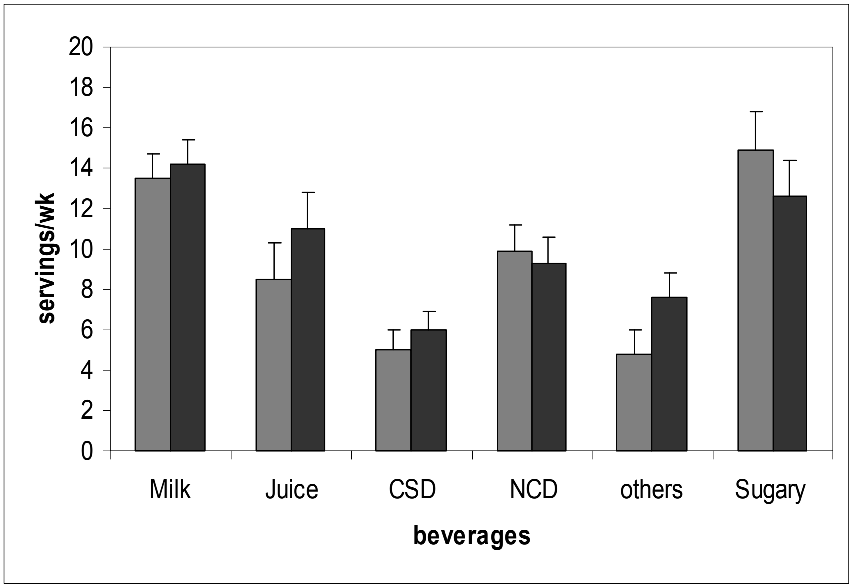

Figure 4.1. The beverage intake of students in four classes of grade 9 in Saskatchewan high schools

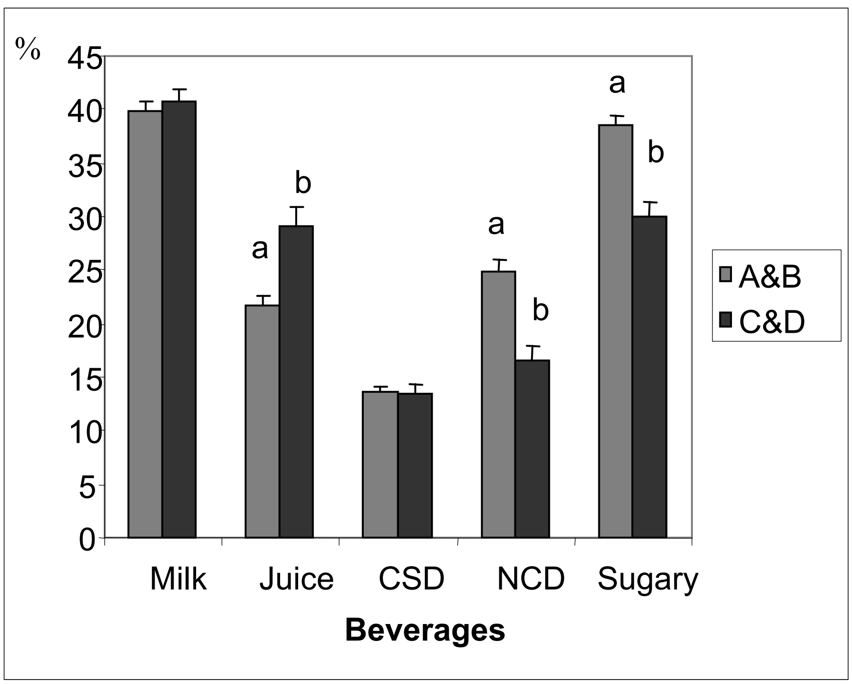

Figure 4.2. The percentage of beverage intake of students in four classes of grade 9 students in Saskatchewan

Note: A&B: the classes in Saskatoon high schools. C&D: the classes in Prince Albert High school. CSD: carbonated soft drink intake, NCD: non-carbonated soft drink intake, Sugary: the combination of CSD and NCD. The intake is presented in mean and standard error of mean. The different letter between the intake of both schools noted a significant difference ($P<0.05$). The number of students in class A=33, B=24, C=20, D=24.

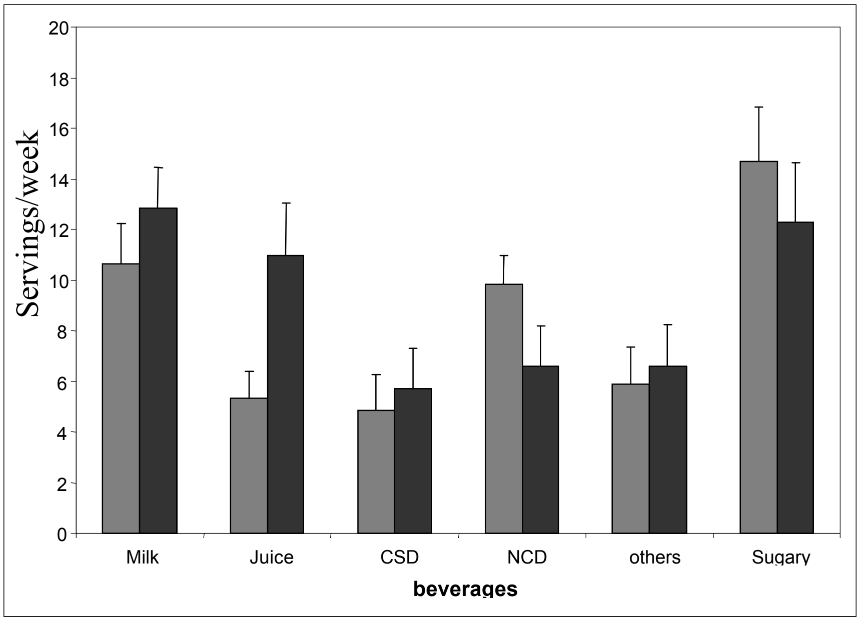

Figure 4.3. The beverage intake of girls in four classes of grade 9 in Saskatchewan high schools

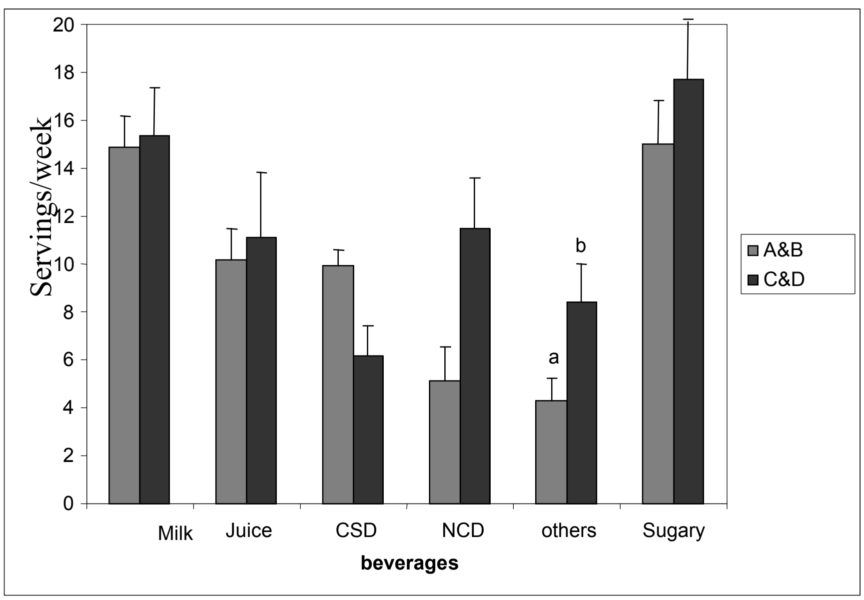

Figure 4.4. The percentage of beverage intake of boys in four classes of grade 9 students in Saskatchewan

Note: A&B: the classes in Saskatoon high schools. C&D: the classes in Prince Albert High school. CSD: carbonated soft drink intake, NCD: non-carbonated soft drink intake, Sugary: the combination of CSD and NCD. The intake is presented in mean and standard error of mean. The different letter between the intake of both schools noted a significant difference ($P<0.05$).
The number of students in class A=33, B=24, C=20, D=24.
The number of girls in class A=9, B=10, C=12, D=8.
The number of boys in class A=24, B=14, C=8, D=16.

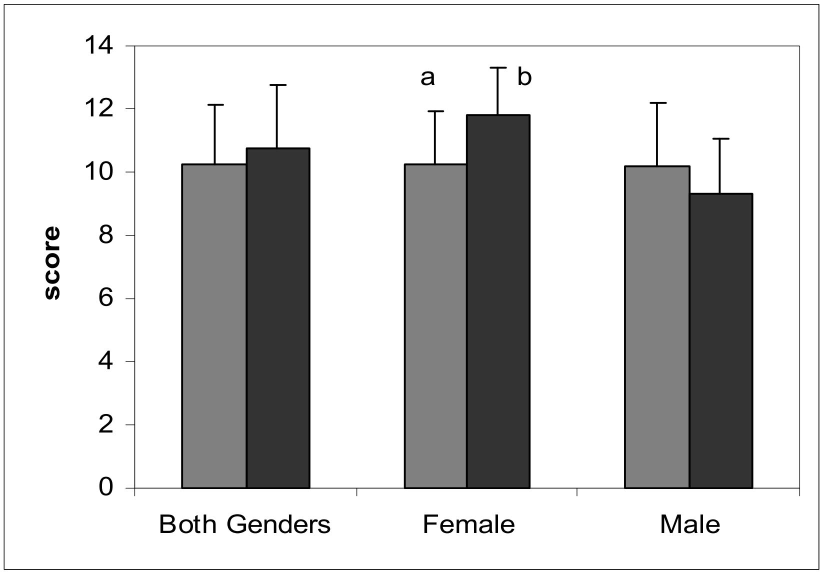

Figure 4.5. The knowledge score of students in four grade 9 classes in Saskatchewan high schools

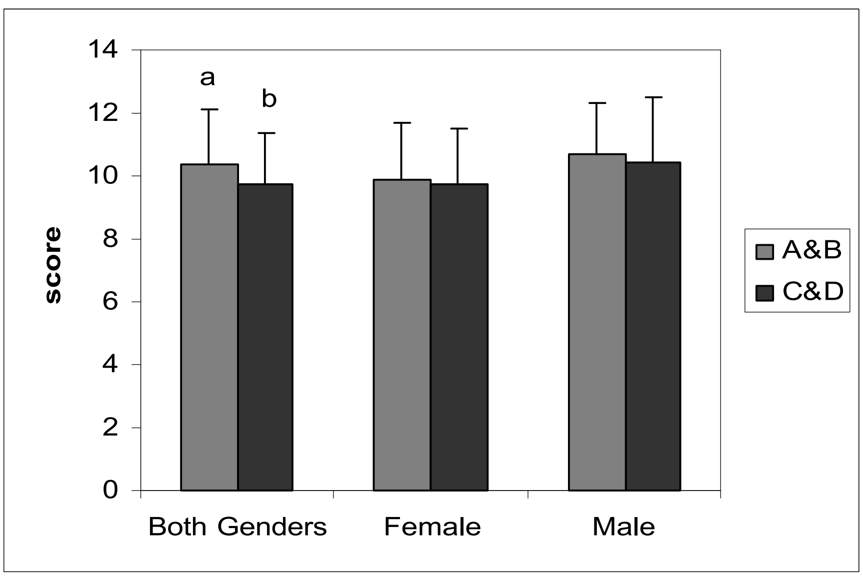

Figure 4.6. The attitude score of grade 9 students in four classes in Saskatchewan high schools

Note: A&B: the classes in Saskatoon high schools. C&D: the classes in Prince Albert High school. The highest score is 14 and the score is presented in mean and standard error of mean. The different letter between the score of both schools noted a significant difference ($P<0.05$). The number of students in class A=33, B=24, C=20, D=24.
The number of girls in class A=9, B=10, C=12, D=8.
The number of boys in class A=24, B=14, C=8, D=16.

Table 4.1 elaborates the questions of students' attitude towards healthy beverages. In class A and B, 60% students stated that they would choose pop when they were offered a choice of milk or pop, as well as 64% class C and D students. This situation was not triggered by the preference of pop taste or milk taste because 74% class A and B students and 62% class C and D students said that the taste of milk is acceptable. Moreover, 91% students in class A and B and 89% in class C and D believed that milk is not just for children. Most students also stated that they know easy ways to include milk in the diet (84% class A and B and 77% class C and D).

Table 4.1. Attitude of students in classes A, B, C, and D towards healthy beverages

Questions	Agree (%)		Somewhat Agree (%)		Disagree (%)	
	A&B	C&D	A&B	C&D	A&B	C&D
If you were offered a choice of milk or pop, you will usually chose pop	60	64	33	23	7	13
The taste of milk is acceptable to you	74	61	17	21	9	18
Milk is for everybody, not just for kids	91	89	7	7	2	4
There are easy ways to include milk in the diet	84	77	16	21	0	2
I like the way 100% fruit juice tastes	74	66	23	32	3	2
Drinking fruit juices will help you reduce the risk of cancer	22	18	60	64	18	18
If you improve the types of beverage you drink, you will be a healthier person	72	68	26	30	2	2

Note: A&B: the classes in Saskatoon high schools. C&D: the classes in Prince Albert High school. The number of students in class A=33, B=24, C=20, D=24.

Table 4.2 describes students' knowledge about healthy beverages. Most students knew that milk and 100% fruit juice are healthy beverages. Furthermore, they agreed that consuming milk gives several advantages, especially toward bone health. Only half of students recognized the differences of nutrient content between 100% fruit juices and fruit drinks.

Table 4.2. Attitude of grade 9 students towards healthy beverages

Questions	Agree (%)		Somewhat Agree (%)		Disagree (%)	
	A&B	C&D	A&B	C&D	A&B	C&D
Milk is cheaper than pop	37	32	47	52	16	16
Consuming one or more glasses of milk helps strengthen your bones and improve your overall health	93	86	7	14	0	0
Osteoporosis is a condition of weak bones that may break easily	70	66	30	30	0	4
Osteoporosis maybe prevented by getting enough calcium early in life	81	71	19	27	0	2
Dairy products are the richest sources of calcium	67	80	30	20	3	0
Fruit drink has the same nutrients as fruit juice	11	9	28	46	61	45

Note: A&B: the classes in Saskatoon high schools. C&D: the classes in Prince Albert High school. The number of students in class A=33, B=24, C=20, D=24.

Table 4.3 depicts students' beverage intake according to their answers towards several attitude and knowledge questions. The answers were categorized into three categories, which are agree, somewhat agree, and disagree. Students indicated they would consume a higher amount of milk if they like the taste. Students also are likely to consume a higher amount of milk whenever they think that there are easy ways to include milk in the diet (Kruskal-Wallis test resulted $p<0.05$); however, these are not significantly different among the categories since the p-values were greater than 0.017. There were no students disagreeing with the statement that consuming milk can improve your health and bone strength, so the mean intakes of all beverages in the disagree category were zero. Students who believed that consuming milk is healthy had a higher non-carbonated and sugary beverage intake than students who doubted the statement. Students who considered drinking fruit juices will help to reduce the risk of cancer had a significantly lower milk intake than others who somewhat agreed with the statement. On the other hand, there was no significant difference in milk intake between students who agreed with the statement and students who disagreed with the statement.

Table 4.3. Beverage intake of grade 9 students according to selected attitude questions

Questions	Q1	Q2	Q3	Q4	Q5
Milk intake					
Agree	16 ± 1*	15 ± 1	14 ± 1	15 ± 1	11 ± 1
Somewhat agree	11 ± 1	11 ± 1	10 ± 2	12 ± 1	16 ± 1*
Disagree	8 ± 3	0 ± 2	0	13 ± 3	10 ± 1
Juice intake					
Agree	11 ± 1	10 ± 1	10 ± 1	11 ± 1	10 ± 2
Somewhat agree	7 ± 2	9 ± 2	9 ± 2	7 ± 1	10 ± 1
Disagree	8 ± 2	21 ± 0	0	3 ± 2	10 ± 2
NCD intake					
Agree	9 ± 1	9 ± 1	10 ± 1*	10 ± 1	9 ± 2
Somewhat agree	12 ± 2	10 ± 2	3 ± 1	9 ± 1	10 ± 1
Disagree	11 ± 2	8 ± 0	0	2 ± 0	9 ± 2
CSD intake					
Agree	5 ± 1	6 ± 1	6 ± 1	6 ± 1	6 ± 1
Somewhat agree	7 ± 2	4 ± 1	4 ± 1	5 ± 1	5 ± 1
Disagree	5 ± 1	1 ± 0	0	5 ± 2	6 ± 2
Sugary intake					
Agree	14 ± 1	15 ± 1	16 ± 1*	16 ± 1	15 ± 3
Somewhat agree	19 ± 3	15 ± 2	7 ± 2	14 ± 2	15 ± 1
Disagree	16 ± 2	9 ± 0	0	7 ± 2	14 ± 3

Questions:
Q1: The taste of milk is acceptable to you
Q2: There are easy ways to include milk in the diet
Q3: Consuming milk will help strengthens your bones and improve you health
Q4: I like the way 100% fruit juice taste
Q5: Drinking fruit juices will help to reduce the risk of cancer
Data are presented in mean ± standard error of mean as servings/week
CSD: carbonated soft drinks
NCD: non-carbonated soft drinks
*there is significant difference in the same column, $p \leq 0.017$

Table 4.4 shows the correlations between percent contribution of healthy beverages (milk and juice) and unhealthy beverages (carbonated soft drinks, non-carbonated soft drinks, and sugary soft drinks). There is a negative correlation between milk intake and other caloric beverages in male and female student intake. Through the comparison of the correlation coefficient, the negative correlation was more pronounced in girls' percent contribution intake than boys'. Girls' percent contribution of juice intake did not have any negative correlation with sugary beverage intake, but boys' juice intake percentage shows negative correlation with sugary beverage percentage, especially carbonated soft drinks beverages.

Table 4.4. Correlation among percent contribution of beverages consumed by grade 9 students in four classes in Saskatchewan

Beverages		Males (n=62)		Females (n=39)		Total (n=101)	
		Milk	Juice	Milk	Juice	Milk	Juice
Juice	r	-0.371**		-0.433**		-0.451**	
	P	0.003		0.006		0.000	
Sugary	r	-0.575**	-0.409**	-0.613**	-0.300	-0.608**	-0.293**
beverages	P	0.000	0.001	0.000	0.064	0.000	0.003
CSD	r	-0.420**	-0.270*	-0.408**	-0.255	-0.486**	-0.168
	P	0.001	0.034	0.010	0.117	0.000	0.093
NCD	r	-0.319**	-0.193	-0.372*	-0.171	-0.328**	-0.259**
	P	0.012	0.133	0.020	0.299	0.001	0.009

CSD: carbonated soft drinks NCD: non-carbonated soft drinks
Sugary Beverages: the sums of CSD and NCD
r: Spearman Rho Correlation
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Table 4.5 describes the beverages that were usually drunk by students at schools. These results represented not only the preference of students but also the availability of beverages at schools. The most favorite beverage at school was water, followed by soft drinks. Students drank milk in the smallest amount than any other beverages. Furthermore, 76% students in class A and B and 96% students in class C and D never consumed milk at school.

Table 4.5. The percentage of students that drank soft drinks, fruit juice, milk, and water at schools

	> once/day (%)		Once/day (%)		<once/week (%)		Seldom/never (%)	
	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D
Soft Drinks	0	6.8	29.8	18.2	49.1	34.1	21.1	40.9
Fruit Juice	5.4	5.3	17.9	22.8	30.4	20.5	46.4	43.2
Milk	0	0	7.3	2.3	16.4	2.3	76.4	95.5
Water	42.9	27.3	35.7	43.2	17.9	20.5	3.6	9.1

A&B: the classes in Saskatoon high schools.
C&D: the classes in Prince Albert High school
The number of students in class A=33, B=24, C=20, D=24.
The number of girls in class A=9, B=10, C=12, D=8.
The number of boys in class A=24, B=14, C=8, D=16

4.4. Beverage intake of students in classes A and B

As shown in Figure 4.7; students in class A (peer educator class) decreased significantly their sugary beverage intake and sustained this though-out the study. Both students' CSD (carbonated soft drinks) and NCD (noncarbonated soft drinks) intakes in class A decreased, but it was not significant. The students in class B (self-taught class in Saskatoon) increased their juice intake at the end of the study (Figure 4.8). There is no significant change in students' milk intake in both classes after the intervention.

It can be seen in Figure 4.9 and 4.10 that the significant decrease of sugary beverage intake after the intervention in class A was contributed mostly by boys. However, girls also contributed to the significant decrease of peer educator class' sugary beverage intake by slightly decreasing their sugary beverage intake, but it was not sustained beyond the three months follow-up period indicating that girls may need greater reinforcement than boys. The carbonated soft drink intake in boys and girls was not as high as expected; however, both girls and boys drank a high amount of non-carbonated soft drinks.

Females in the self-taught class responded more positively to the intervention than males as indicated in Figures 4.11 and 4.12. Female students in this class increased their juice intake and decreased their sugary beverage intake. However, the decrease in sugary beverage intake could not be observed at the one-year follow up.

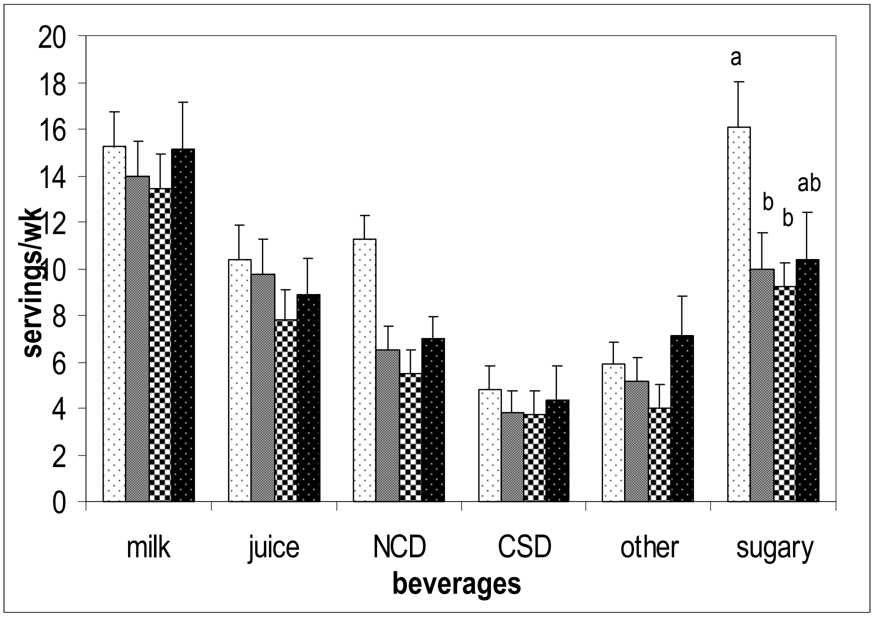

Figure 4.7. Beverage intake of students in class A

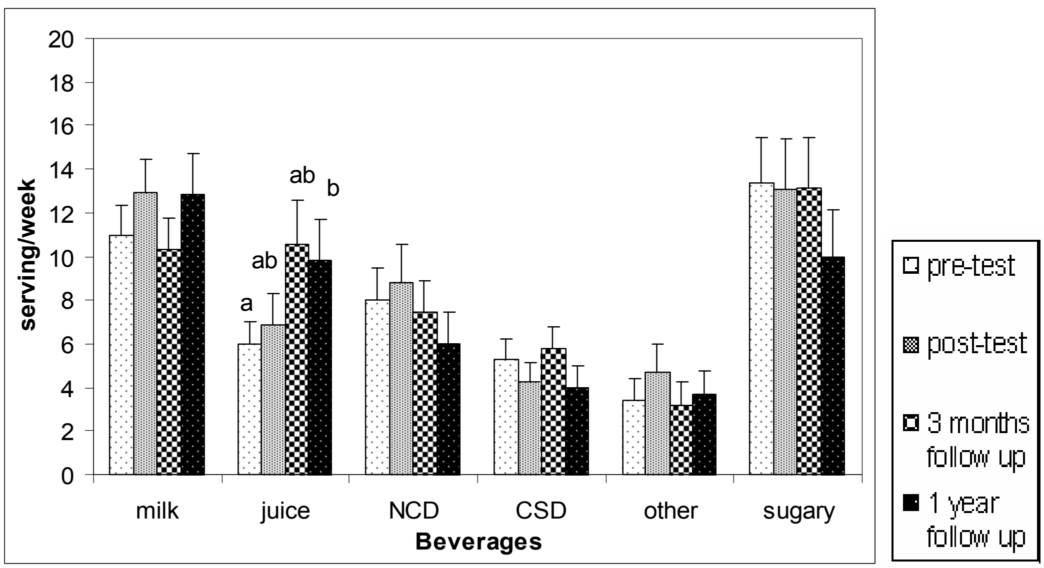

Figure 4.8. Beverage intake of students in class B

Note: Class A: Peer educator class in Saskatoon high school, Class B: Self-taught class in Saskatoon high school
CSD: carbonated soft drink intake, NCD: non-carbonated soft drink intake, Sugary: the combination of CSD and NCD. The intake is presented in mean and standard error of mean. The different letter noted a significant differences among beverage intake assessments ($P<0.008$).
The number of students in class A during the pre-test=33, post-test=30, 3 months follow-up=32, and one year follow-up= 23
The number of students in class B during the pre-test=24, post-test=24, 3 months follow-up=24, and one year follow-up=19

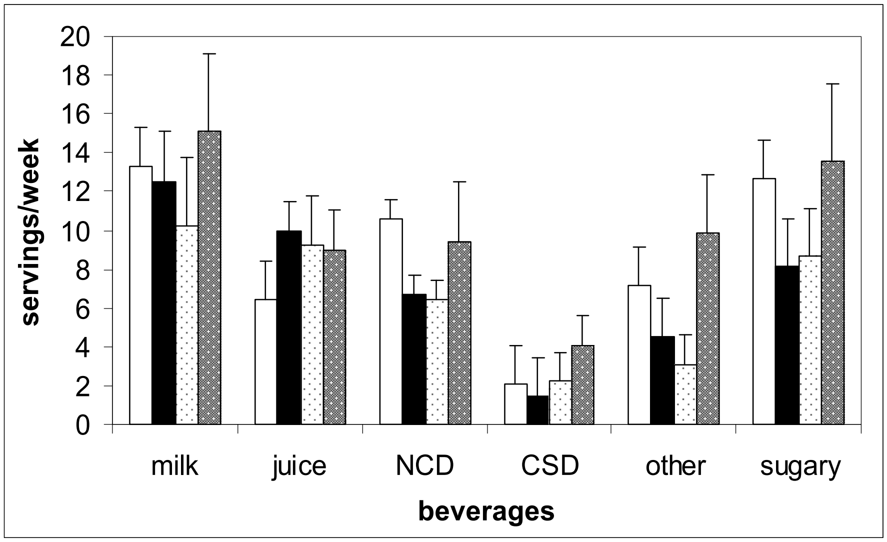

Figure 4.9. Beverage intake of girls in class A

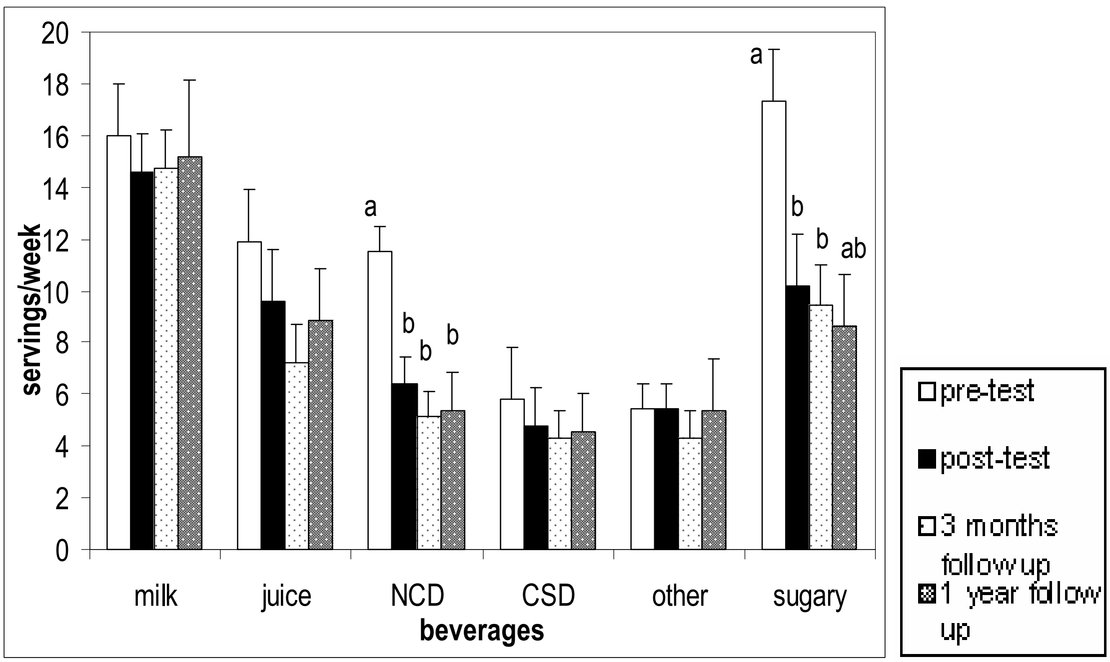

Figure 4.10. Beverage intake of boys in class A

Note: Class A: peer educator class in Saskatoon high school
CSD: carbonated soft drink intake, NCD: non-carbonated soft drink intake, Sugary: the combination of CSD and NCD.
The intake is presented in mean and standard error of mean.
The different letters noted a significant differences among beverage intake assessments ($P<0.008$).
The number of girls during the pre-test=8, post-test=9, 3 months follow-up=9, and one year follow-up= 9
The number of boys during the pre-test=24, post-test=21, 3 months follow-up=23, and one year follow-up=14

The correlation among percent contribution of students' caloric beverage intake is shown in Table 4.6. Negative correlations between percent contributions of milk and sugary beverage intakes, and milk and NCD intakes appeared in all beverage intake assessments (pre-test, post-test, 3 month follow-up, and 1 year follow up). The negative correlation between juice and milk intakes disappeared at one year follow-up. However, the small number of subjects at one year follow-up compromised the strength of the one year correlation analysis.

Table 4.6. Correlation among the beverage intake percentage of students in class A

Drinks		Milk				Juice			
		Pre-test n=33	Post-test n=30	3 m n=32	1 y n=23	Pre-test n=33	Post-test n=30	3 m n=32	1 y n=23
Juice	r	-0.521**	-0.427*	-0.558**	-0.026				
	P	0.002	0.019	0.001	0.905				
Sugary	r	-0.514**	-0.697**	-0.443*	-0.816**	-0.351*	-0.232	-0.384*	-0.446*
drinks	P	0.002	0.000	0.011	0.000	0.045	0.217	0.030	0.033
CSD	r	-0.079	-0.387*	-0.035	-0.613**	-0.341	-0.361*	-0.296	-0.445
	P	0.663	0.034	0.851	0.002	0.052*	0.050	0.100	0.033
NCD	r	-0.521**	-0.637**	-0.487**	-0.639**	-0.179	-0.045	-0.170	-0.239
	P	0.002	0.000	0.005	0.001	0.339	0.815	0.353	0.273
Attitud	r	-0.030	0.073	-0.275	0.075	0.334*	0.158	0.284	0.249
e	P	0.868	0.701	0.127	0.735	0.057	0.402	0.116	0.252
Knowl	r	0.179	0.131	0.420*	0.329	-0.108	0.188	-0.028	0.314
edge	P	0.319	0.491	0.017	0.125	0.550	0.320	0.880	0.145

Class A = Peer educator class in Saskatoon high school
CSD: carbonated soft drinks
NCD: non-carbonated soft drinks
Sugary Beverages: the sums of CSD and NCD
r: Spearman Rho Correlation
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

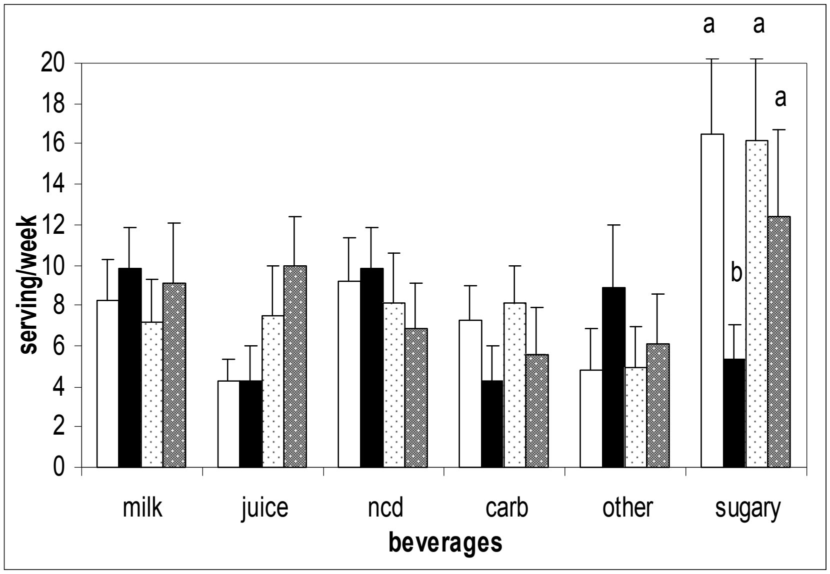

Figure 4.11. Beverage intake of girls in class B

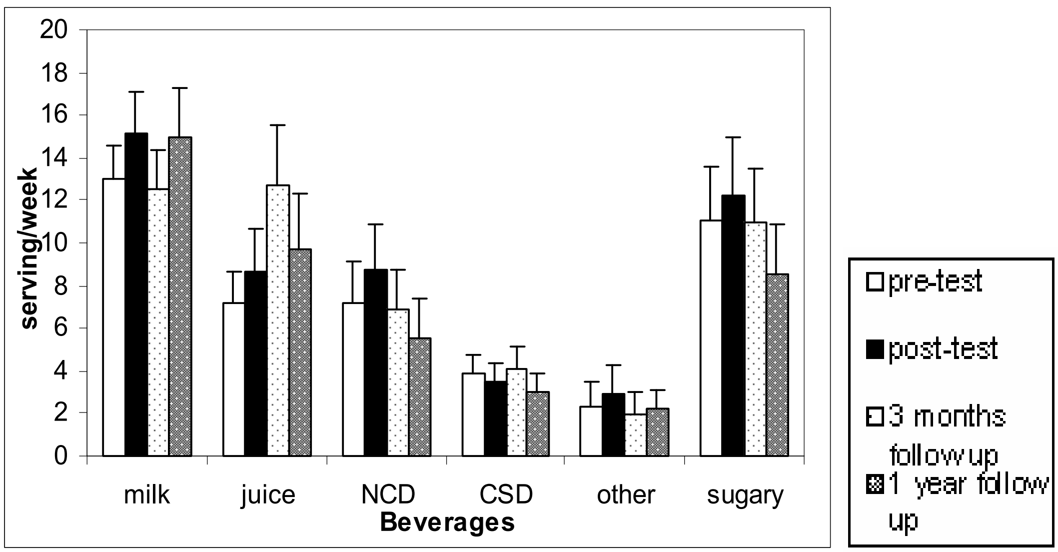

Figure 4.12. Beverage intake of boys in class B

Note: Class B: Self-taught class in Saskatoon high school
CSD: carbonated soft drink intake, NCD: non-carbonated soft drink intake, Sugary: the combination of CSD and NCD.
The intake is presented in mean and standard error of mean.
The different letters noted a significant differences among beverage intake assessments ($P<0.008$).
The number of girls during the pre-test=10, post-test=10, 3 months follow-up=10, and one year follow-up= 7
The number of boys during the pre-test=14, post-test=14, 3 months follow-up=14, and one year follow-up=12

Table 4.7 depicts the correlation among female students' beverage intake as a percentage of total caloric beverages (milk, 100% fruit juice, and sugary beverages). A negative correlation between percent contributions of juice intake and milk intake was found, as well as a negative correlation between percent contributions of milk intake and sugary beverage intake. As milk intake percentage increased, knowledge score decreased. All of these negative correlations became nonsignificant a week after the intervention; but they appeared again in one year follow up. After the intervention, there was a negative correlation between the percent contributions of milk and juice intakes.

Table 4.7. Correlation among the beverage intake percentages of girls in class A

Drinks		Milk				Juice			
		Pre-test n= 9	Post-test n=: 9	3 m n= 9	1 y n= 9	Pre-test n= 9	Post-test n=: 9	3 m n= 9	1 y n= 9
Juice	r	-0.367	-0.867**	-0.661*	-0.033				
	P	0.332	0.002	0.053	0.932				
Sugary drinks	r	-0.733*	-0.567	-0.226	-0.949**	-0.250	0.172	-0.283	-0.203
	P	0.025	0.112	0.559	0.000	0.516	0.460	0.460	0.600
CSD	r	0.066	-0.351	0.143	-0.881**	-0.393	0.393	0.159	-0.305
	P	0.866	0.354	0.714	0.002	0.295	0.295	0.683	0.425
NCD	r	-0.337*	-0.617	0.444	-0.915**	-0.233	0.433	-0.233	-0.170
	P	0.050	0.077	-0.293	0.001	0.546	0.244	0.546	0.663
Attitude	r	0.122	0.308	0.191	0.274	0.514	0.434	-0.518	-0.120
	P	0.755	0.420	0.623	0.476	0.157	-0.299	0.154	0.759
Knowledge	r	-0.743*	-0.392	0.562	-0.136	0.149	0.213	-0.303	0.383
	P	0.022	0.297	0.155	0.727	0.703	0.582	0.428	0.309

Class A: Peer educator class in Saskatoon high school
CSD: carbonated soft drinks
NCD: non-carbonated soft drinks
Sugary Beverages: the sums of CSD and NCD
r: Spearman Rho Correlation
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Before the intervention, there was negative correlation between the percent contributions of milk and juice intakes in boys, as well as between the percent contributions of milk and sugary beverage intakes, especially non-carbonated soft drink intake (Table 4.8). At the three months follow up, the negative correlations between milk and sugary beverage, carbonated soft drink, and non-carbonated soft drink intake percentages went weaker. At one year follow up, the negative correlation between percent contribution of juice and sugary drink intake grew stronger.

Table 4.8. Correlation among the beverage intake percentage of male students in class A

Drinks		Milk				Juice			
		Pre-test n= 24	Post-test n= 21	3 m n= 23	1 y n= 14	Pre-test n= 24	Post-test n= 21	3 m n= 23	1 y n= 14
Juice	r	-0.475*	-0.218	-0.444*	0.075				
	P	0.019	0.343	0.034	0.799				
Sugary drinks	r	-0.464*	-0.773**	-0.574**	-0.673**	-0.432**	-0.382	-0.402*	-0.683**
	P	0.022	0.000	0.004	0.008	0.035	0.087	0.057	0.007
CSD	r	-0.043	-0.558**	-0.236	-0.636*	-0.458**	-0.414	-0.341	-0.496
	P	0.842	0.009	0.278	0.014	0.025	0.062	0.112	0.071
NCD	r	-0.611**	-0.716**	-0.426*	-0.255	-0.124	-0.261	-0.240	-0.365
	P	0.002	0.000	0.043	0.379	0.564	0.252	0.269	0.200
Attitude	r	-0.021	-0.005	0.261	0.081	0.334	0.165	0.390	0.440
	P	0.922	0.984	0.229	0.784	0.111	0.475	0.066	0.115
Knowledge	r	0.431*	0.324	0.430*	0.793**	-0.175	0.279	0.128	0.232
	P	0.035	0.152	0.040	0.001	0.415	0.221	0.561	0.424

Class A: Peer educator class in Saskatoon high school
CSD: carbonated soft drinks
NCD: non-carbonated soft drinks
Sugary Beverages: the sums of CSD and NCD
r: Spearman Rho Correlation
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

After the intervention, the negative correlation between the percentage of juice and sugary beverage intakes (especially CSF) disappeared. However, this negative correlation appeared at 3 months follow up and became stronger at one year follow up. The knowledge score appeared to have positive correlation with the percentage of milk intake. Except at the post-test and three month follow-up, the negative correlation between the percent contributions of milk and sugary drink intakes was stronger in girls than on boys before and at one year follow up.

Table 4.9 shows the correlation among the beverage intake percentage of students in class B. A negative correlation between percent contribution of juice and milk intakes was discovered only at one year follow-up. The negative correlations between percent contribution of sugary beverage and milk intake disappeared at one year follow-up. Before the intervention, the negative correlation between CSD percentage and milk percentage was close to that between the percentage of NCD and milk intakes. After the intervention, the negative correlation between CSD and milk percentages became weaker and disappeared at 3 months follow up and one year follow-up. A negative correlation between percent contribution of juice and sugary beverage intakes was discovered only at three months follow-up, which is mainly caused by CSD percentage.

Table 4.9. Correlation among the beverage intake percentage of students in class B

Drinks		Milk				Juice			
		Pre-test n= 24	Post-test n= 24	3 m n= 24	1 y n= 19	Pre-test n= 24	Post-test n= 24	3 m n= 24	1 y n= 19
Juice	r	-0.311	-0.214	-0.328	-0.632**				
	P	0.140	0.316	0.118	0.004				
Sugary drinks	r	-0.873**	-0.819**	-0.483*	-0.341	-0.031	-0.329	-0.540**	-0.372
	P	0.000	0.000	0.017	0.153	0.884	0.116	0.006	0.117
CSD	r	-0.603**	-0.453*	-0.339	-0.117	-0.202	-0.476*	-0.559**	-0.474*
	P	0.002	0.026	0.106	0.634	0.344	0.019	0.004	0.040
NCD	r	-0.750**	-0.785**	-0.487*	-0.410	-0.059	-0.215	-0.367	-0.100
	P	0.000	0.000	0.016	0.081	0.785	0.312	0.078	0.685
Attitude	r	0.582**	0.018	0.200	-0.043	-0.299	0.259	-0.033	-0.186
	P	0.003	0.932	0.350	0.861	0.156	0.222	0.879	0.445
Knowledge	r	0.130	0.232	0.214	0.232	-0.172	0.417*	0.079	-0.290
	P	0.545	0.276	0.316	0.339	0.421	0.043	0.713	0.228

Class B: Self-taught class in Saskatoon high school
CSD: carbonated soft drinks , NCD: non-carbonated soft drinks
Sugary Beverages: the sums of CSD and NCD
r: Spearman Rho Correlation
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

In girls in class B, a negative correlation was found between the percent contributions of milk intake and sugary drink intakes (Table 4.10). This negative correlation changed over the year. A negative correlation between the percentages of juice and carbonated soft drink intakes could be found only at one year follow up.

Table 4.11 shows relationships among percent contribution of beverage intakes in boys in class B. The negative correlation between the percentage of milk and sugary beverage intake decreased gradually, and it could not be observed at three month and one year follow up. The negative correlation between the percentages of juice and carbonated soft drink intakes could be found only at one year follow up. The same phenomenon also happened for the percentage of girls' intake (Table 4.10). After the bonferroni correction, students' knowledge and attitude in both classes did not change significantly, so the graphs of students' knowledge and attitude are not presented.

As shown in Table 4.12, students in class A expressed a higher level of satisfaction ($p<0.05$) than class B. The satisfaction level started at 1 for poor, 2 for fair, 3 for good, 4 for very good, and 5 for excellent. Overall, 71% students said the program was fun, informative, interesting, and helped them to learn. Furthermore, 77% of the students would suggest this program to others. Students indicated that they appreciated learning about nutrition and healthy eating, participating in the recipe demonstrations, or trying the recipes at home.

Table 4.10. Correlation among the beverage intake percentage of females class B

Drinks		Milk				Juice			
		Pre-test n= 10	Post-test n= 10	3 m n=10	1 y n= 7	Pre-test n= 10	Post-test n= 10	3 m n= 10	1 y n= 7
Juice	r	-0.055	0.164	-0.085	0.321				
	P	0.881	0.650	0.815	0.482				
Sugary drinks	r	-1.00**	-0.875**	-0.612	-0.929**	0.055	-0.534	-0.547	-0.536
	P	0.000	0.001	0.060	0.003	0.881	0.112	0.102	0.215
CSD	r	-0.76**	-0.675*	-0.430	-0.429	-0.231	-0.527	-0.486	-0.929**
	P	0.011	0.032	0.214	0.337	0.521	0.117	0.154	0.003
NCD	r	-0.93**	-0.681*	-0.320	-0.857**	0.055	-0.439	-0.317	-0.179
	P	0.000	0.030	0.056	0.014	0.881	0.204	0.372	0.702
Attitude	r	0.644	0.505	0.155	0.154	-0.328	0.716*	-0.047	0.617
	P	0.044	0.137	0.669	0.741	0.354	0.020	0.898	0.140
Knowledge	r	0.068	0.391	0.178	0.019	-0.317	0.764**	0.502	-0.636
	P	0.851	0.263	0.623	0.968	0.372	0.010	0.140	0.125

Class B: Self-taught class in Saskatoon high school
CSD: carbonated soft drinks
NCD: non-carbonated soft drinks
Sugary Beverages: the sums of CSD and NCD
r: Spearman Rho Correlation
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Table 4.11. Correlation among the beverage intake percentage of male students in self-taught class

Drinks		Milk				Juice			
		Pre-test n= 14	Post-test n= 14	3 m n= 14	1 y n= 12	Pre-test n= 14	Post-test n= 14	3 m n= 14	1 y n= 12
Juice	r	-0.596*	-0.686**	-0.73**	-0.637*				
	P	0.025	0.007	0.003	0.026				
Sugary drinks	r	-0.73**	-0.701**	-0.295	-0.077	0.051	0.004	-0.341	-0.620*
	P	0.003	0.005	0.306	0.812	0.864	0.988	0.233	0.032
CSD	r	-0.348	-0.134	0.035	0.014	-0.132	-0.250	-0.511	-0.655*
	P	0.223	0.647	0.905	0.966	0.652	0.389	0.062	0.021
NCD	r	-0.516*	-0.719**	-0.380	-0.063	-0.121	0.075	-0.176	-0.203
	P	0.059	0.004	0.180	0.846	0.681	0.799	0.547	0.527
Attitude	r	0.383	-0.256	0.161	-0.620*	-0.399	0.081	-0.176	-0.640*
	P	0.176	0.377	0.582	0.032	0.157	0.757	0.548	0.024
Knowledge	r	0.275	-0.062	0.190	-0.655*	-0.174	0.221	-0.231	-0.065
	P	0.340	0.832	0.515	0.021	0.551	0.448	0.428	0.840

Class B: Self-taught class in Saskatoon high school 3 m: 3 month follow-up
r: Spearman Rho Correlation Sugary Beverages: the sums of CSD and NCD
CSD: carbonated soft drinks NCD: non-carbonated soft drinks
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Table 4.12. Satisfaction level and comments of students in class A and B

	Class A	Class B
Satisfaction level	3.6	3.0
What I liked most about the *FUEL*:	1. The *FUEL* provided opportunities to try different drink. 2. The *FUEL* increased the ability to make the drink. 3. There is no homework during the *FUEL* study. 4. The *FUEL* provided information. 5. The *FUEL* contained interesting facts. 6. Thethe teachers or instructors in the *FUEL* study were friendly. 7. The *FUEL* is interactive	1. The *FUEL* presented lot of information, gave a lot of facts about fast food 2. I learn something from the *FUEL* 3. The FUEL provided recipes that were liked by parents. 4. The *FUEL* provided interesting facts 5. The *FUEL* provided information about healthy eating 6. The *FUEL* showed healthy food choice.

Class A: Peer educator class in Saskatoon high school
Class B: Self-taught class in Saskatoon high school

4.5. Beverage intake of student in classes C and D

Figures 4.11 and 4.12 show that nutrition education in both classes altered students' beverage intake, especially in decreasing sugary beverage intake. The change of students' beverage intake in class D (Prince Albert self-taught class) could not be observed by three months follow up. Although the multiple comparisons did not reveal any differences, it can be seen in Figure 4.11 that the sugary beverage intake was decreasing at three months follow up. When the beverage intake of male and female students in class C (dietitian-taught class) was analyzed separately, the change is not significant and the figure was not shown.

Females in self-taught class altered their beverage intake slightly (Figure 4.13), and males in the same class decreased their carbonated beverage intake after the intervention (Figure 4.14). The girls increased their sugary beverage intake at three months follow up. Although the decrease of carbonated beverage intake could not be detected at three months follow up, a decrease in sugary beverages was observed at the same time. This occurrence might be caused by a slight decrease in both carbonated beverage and non-carbonated beverage intakes.

Table 4.13 shows negative correlations among percent contribution of students' beverage intakes in class C. A negative correlation between the percent contribution of milk and sugary beverage intakes appeared at all beverage intake assessments. This negative correlation was mainly caused by the percentage of non-carbonated beverage intake. The negative correlation between the percentage of milk and juice intake disappeared at post-test only.

In class C, Table 4.14 shows that the negative correlation between the percent contributions of milk and sugary beverage intake in girls grew stronger from the pre-test to the three month follow up. The negative correlation between the percentage of milk and CSD intakes was found at three month follow up only. The same phenomenon also happened between the percentage of milk and CSD intake and the percentage of milk and juice intakes.

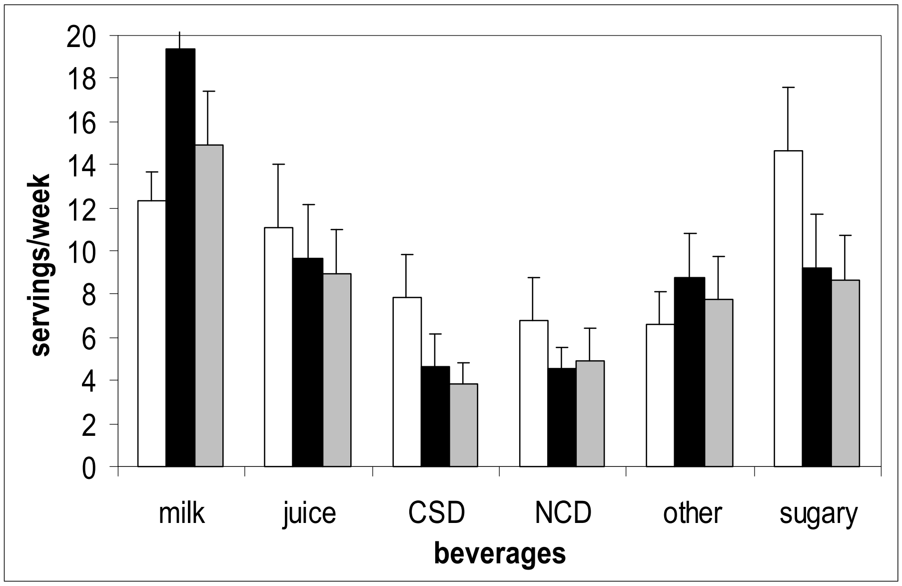

Figure 4.13. Beverage intake of students in class C

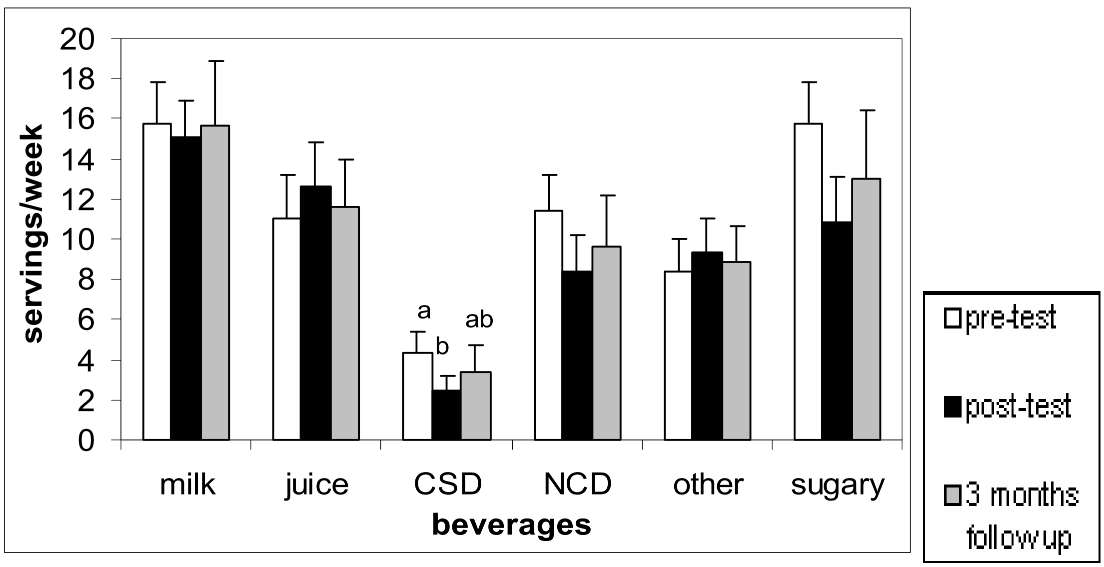

Figure 4.14. Beverage intake of students in class D

Note: Class C: Dietitian-taught class in Prince Albert high school, Class D: self-taught class in Prince Albert high school
CSD: carbonated soft drink intake, NCD: non-carbonated soft drink intake, Sugary: the combination of CSD and NCD.
The intake is presented in mean and standard error of mean.
The different letter between the beverage intake assessments noted a significant difference ($P<0.05$).
The number of students in class C during the pre-test=20, post-test= 21, and 3 month follow-up=20
The number of students in class D during the pre-test=24, post-test= 24, and 3 month follow-up=23

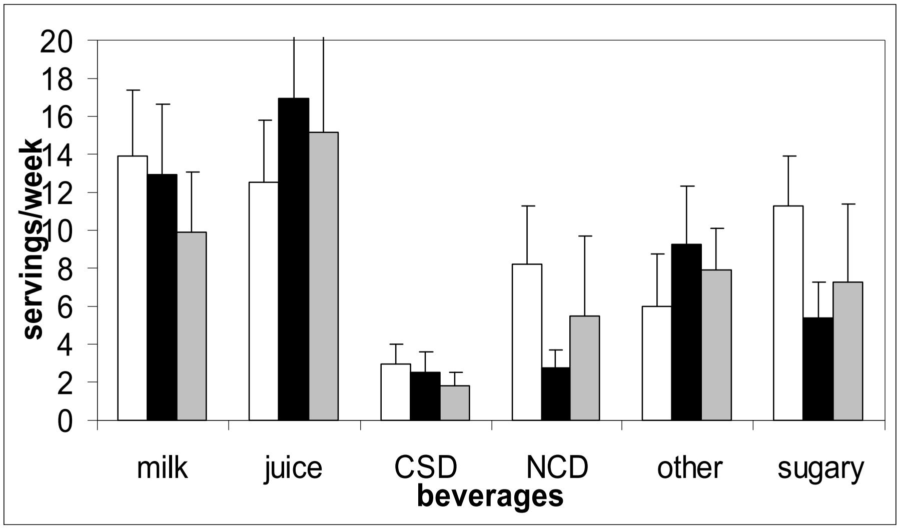

Figure 4.15. Beverage intake of female students in class D

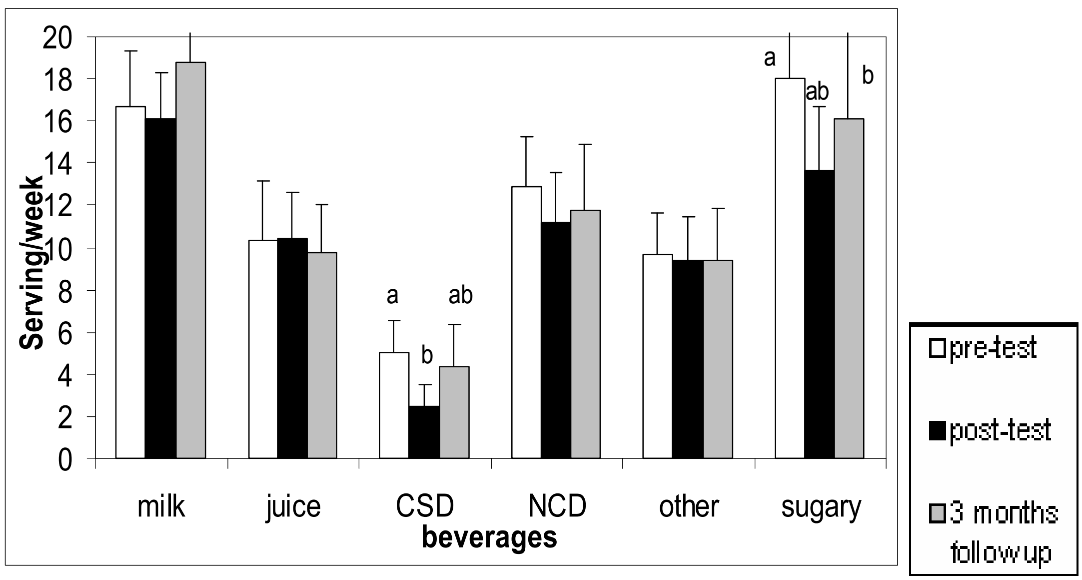

Figure 4.16. Beverage intake of male students in class D

Note: Class D: Self-taught class in Prince Albert high school
CSD: carbonated soft drink intake, NCD: non-carbonated soft drink intake, Sugary: the combination of CSD and NCD.
The intake is presented in mean and standard error of mean.
The different letter between the beverage intake assessments noted a significant difference ($P<0.05$).
The number of girls in class D during the pre-test=8, post-test= 8, and 3 month follow-up=8
The number of boys in class D during the pre-test=16, post-test= 16, and 3 month follow-up=15

Table 4.13. Correlation among the beverage intake percentage of students in class C

Drinks		Milk			Juice		
		Pre-test n= 20	Post-test n= 21	3 m n= 20	Pre-test n= 20	Post-test n= 21	3 m n= 20
Juice	R	-0.515*	-0.392	-0.643**			
	P	0.020	0.079	0.002			
Sugary drinks	R	-0.629**	-0.730**	-0.665**	-0.512	-0.260	-.071
	P	0.003	0.000	0.001	0.522	0.254	.766
CSD	r	-0.156	-0.606**	-0.419	-0.200	-0.165	-.277
	P	0.512	0.004	0.066	0.398	0.476	.236
NCD	R	-0.600**	-0.518*	-0.603**	0.040	-0.174	.108
	P	0.005	0.016	0.005	0.867	0.451	.651
Attitude	R	-0.135	-0.326	0.211	0.188	0.134	.174
	P	0.569	0.149	0.372	0.427	0.562	.464
Knowledge	R	0.153	0.199	0.175	-0.069	0.081	-.152
	P	0.519	0.386	0.460	0.771	0.726	.521

Class C: Dietitian-taught class in Prince Albert high school
3 m : three month follow-up   Sugary Beverages: the sums of CSD and NCD
CSD: carbonated soft drinks   NCD: non-carbonated soft drinks
r: Spearman Rho Correlation
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Table 4.14. Correlation among the beverage intake percentage of female students in class C

Drinks		Milk			Juice		
		Pre-test n= 12	Post-test n=12	3 m n=12	Pre-test n= 12	Post-test n=12	3 m n=12
Juice	R	-0.552	-0.320	-0.560*			
	P	0.063	0.286	0.058			
Sugary	R	-0.647*	-0.638*	-0.790**	-0.231	-0.385	0.081
drinks	P	0.023	0.019	0.002	0.471	0.194	0.803
CSD	r	-0.500	-0.522	-0.571*	-0.025	-0.186	-0.060
	P	0.098	0.067	0.052	0.940	0.542	0.853
NCD	R	-0.381	-0.304	-0.664**	-0.028	-0.319	-0.035
	P	0.221	0.312	0.018	0.931	0.289	0.914
Attitude	R	0.058	-0.277	0.828	0.241	0.071	0.229
	P	0.857	0.360	0.374	0.450	0.817	0.473
Know-	R	.0172	0.345	-0.124	0.206	-0.031	-0.015
ledge	P	0.593	0.249	0.700	0.521	0.920	0.964

Class C: Dietitian-taught class in Prince Albert high school
3 m: three month follow-up   Sugary Beverages: the sums of CSD and NCD
NCD: non-carbonated soft drinks   CSD: carbonated soft drinks
r: Spearman Rho Correlation
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

For male students who were taught by a dietitian, the negative correlation between the percentage of milk and CSD intakes became weaker (Table 4.15). The weakest negative correlation was observed at three months follow up. The negative correlation between the percent contribution of milk and sugary drinks intake was not observed at three month follow up.

Table 4.15. Correlation among the beverage intake percentage of male students in class C

Drinks		Milk			Juice		
		Pre-test n= 8	Post-test n= 8	3 m n= 8	Pre-test n= 8	Post-test n= 8	3 m n= 8
Juice	R	-0.467	-0.571	-0.548			
	P	0.243	0.139	0.160			
Sugary drinks	R	-0.714*	-0.762*	-0.667	-0.120	0.048	-0.190
	P	0.047	0.028	0.071	0.778	0.911	0.651
CSD	r	-0.810*	-0.786*	-0.714*	0.144	0.167	-0.071
	P	0.015	0.021	0.047	0.734	0.693	0.867
NCD	R	-0.381	-0.690*	-0.262	-0.287	0.167	-0.500
	P	0.352	0.058	0.531	0.490	0.693	0.207
Attitude	R	-0.171	-0.494	0.051	0.098	0.346	0.217
	P	0.686	0.213	0.904	0.817	0.401	0.606
Knowledge	R	0.230	0.036	0.554	-0.251	0.467	0.060
	P	0.584	0.933	0.154	0.550	0.243	0.887

Class C: Dietitian-taught class in Prince Albert high school
3 m: 3 month follow-up
CSD: carbonated soft drinks NCD: non-carbonated soft drinks
Sugary Beverages: the sums of CSD and NCD r: Spearman Rho Correlation
*Correlation is significant at the 0.05 level (2-tailed)

The correlation among the percentage of students' beverage intake in class D is presented in Table 4.16. A negative correlation between percent contribution of milk and juice intakes appeared only at post-test. Another negative correlation between the percentage of milk and sugary beverages was detected at three month follow-up. A negative correlation between the percentage of juice and sugary beverages intake was mainly caused by non-carbonated beverage intake.

Table 4.16. Correlation among the beverage intake percentage of students class D

Drinks		Milk			Juice		
		Pre-test n= 24	Post-test n= 24	3 m n= 23	Pre-test n= 24	Post-test n= 24	3 m n= 23
Juice	R	-0.300	-0.677**	-0.239			
	P	0.154	0.000	0.272			
Sugary	R	-0.191	-0.280	-0.432*	-0.796**	-0.392*	0.061
drinks	P	0.370	0.186	0.040	0.000	0.058	0.781
CSD	r	-0.138	0.081	-0.143	-0.314	-0.437*	-0.223
	P	0.522	0.706	0.515	0.135	0.033	0.307
NCD	R	0.091	-0.323	-0.071	-0.527**	-0.148	-0.327
	P	0.672	0.124	0.749	0.008	0.489	0.128
Attitude	R	0.459*	0.065	0.025	-0.321	0.340	0.080
	P	0.024	0.764	0.909	0.126	0.104	0.715
Knowled	R	-0.205	-0.200	0.061	0.016	0.269	0.447*
ge	P	0.337	0.349	0.783	0.941	0.204	0.032

Class D: self-taught class in Prince Albert high school
3 m: 3 month follow-up Sugary Beverages: the sums of CSD and NCD
CSD: carbonated soft drinks NCD: non-carbonated soft drinks
r: Spearman Rho Correlation
*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

Although the negative correlation between the percentage of juice intake and milk intake enhanced at the post-test of female intake in self-taught class, it grew weaker at three months follow up (Table 4.17). The negative correlation between percentage of juice and sugary beverage intake became insignificant after the intervention.

Table 4.17. Correlation among the beverage intake percentage of female students in class D

Drinks		Milk			Juice		
		Pre-test n= 8	Post-test n= 8	3 m n=8	Pre-test n= 8	Post-test n= 8	3 m n= 8
Juice	R	-0.714*	-0.810*	-0.548			
	P	0.047	0.015	0.160			
Sugary	R	0.190	0.119	-0.238	-0.714*	-0.619	-0.167
drinks	P	0.651	0.779	0.570	0.047	0.102	0.693
CSD	r	0.095	0.192	-0.122	0.095	-0.623	-0.073
	P	0.823	0.649	0.774	0.823	0.099	0.863
NCD	R	0.167	0.108	-0.619	0.167	-0.407	-0.071
	P	0.693	0.799	0.102	0.693	0.317	0.867
Attitude	R	0.466	0.000	0.358	-0.037	0.436	-0.140
	P	0.244	1.000	0.385	0.931	0.280	0.740
Knowled	R	0.473	-0.327	0.025	0.303	0.570	0.405
ge	P	0.237	0.429	0.954	0.466	0.140	0.319

Class D: Self-taught class in Prince Albert high school
3 m: 3 month follow-up Sugary Beverages: the sums of CSD and NCD
CSD: carbonated soft drinks NCD: non-carbonated soft drinks
r: Spearman Rho Correlation *Correlation is significant at the 0.05 level (2-tailed)

Table 4.18 describes the correlation among males' beverage intakes. Negative correlations can be seen between the percentage of milk and juice intake, milk and sugary drink intake, and juice and sugary drink intake.

Table 4.18. Correlation among the beverage intake percentage of male students in class D

Drinks		Milk			Juice		
		Pre-test n= 16	Post-test n= 16	3 m n= 15	Pre-test n= 16	Post-test n= 16	3 m n= 15
Juice	R	-0.088	-0.735**	-0.114			
	P	0.744	0.001	0.685			
Sugary	R	-0.394	-0.491*	-556*	-0.796**	-0.126	0.127
drinks	P	0.131	0.053	0.031	0.000	0.641	0.652
CSD	r	-0.311	0.080	-0.310	-0.294	-0.493*	-0.463
	P	0.241	0.769	0.261	0.269	0.053	0.082
NCD	R	0.153	-0.546*	-0.104	-0.513*	0.174	0.018
	P	0.572	0.029	0.713	0.042	0.520	0.950
Attitude	R	0.507*	0.124	-0.051	0.074	-0.486*	-0.102
	P	0.045	0.648	0.857	0.785	0.056	0.719
Knowled	R	-0.139	-0.110	0.295	0.051	0.027	0.005
ge	P	0.606	0.684	0.286	0.852	0.921	0.985

Class D: Self-taught class in Prince Albert high school
3 m: 3 month follow-up
CSD: carbonated soft drinks
NCD: non-carbonated soft drinks
Sugary Beverages: the sums of CSD and NCD
r: Spearman Rho Correlation
**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Students, especially girls, in self taught class increased their knowledge score significantly. This improvement was detected at three month follow up. Students in both classes did not show any significant difference in the level of satisfaction towards *FUEL* study. The average of the level of satisfaction was between good and very good.

The level of satisfaction of students in class C and D is not significantly different. Overall, 73% students from class C and D would suggest the *FUEL* to others. Furthermore, 57% class C and 33% class D students stated that the intervention was fun, informative, and helped them to eat and drink healthier. Table 4.19 describes students' satisfaction level and the average comments given by students.

Table 4.19. Satisfaction level and comments of students in class C and D

	Class C	Class D
Satisfaction level	3.8	3.4
What I liked most about the *FUEL*:	1. The *FUEL* provided nutritional facts. 2. The *FUEL* provided information about other healthier food choices instead of junk food. 3. The *FUEL* consisted of games and activities. 4. The *FUEL* had information on food portions. 5. The FUEL provided information about fast food nutrient content (sugar, fat, salt).	1. The *FUEL* provided recipes. 2. The *FUEL* had information about sugar content in foods. 3. The *FUEL* teaches to start eating healthier. 4. The *FUEL* had food guide and physical activity guide. 5. The *FUEL* did a draw for the sweater. 6. The *FUEL* provided information about the "nutritional facts." 7. The *FUEL* had information about the amount of money saved by stop buying soft drinks 8. The *FUEL* was easy to read 9. The *FUEL* study provided the food guide slide

Class C: Dietitian-taught class in Prince Albert high school
Class D: Self-taught class in Prince Albert high school

4.6. Summary of Findings

To simplify the comparison among all classes, a summary of findings was provided in Table 4.20 and Table 4.21. Table 4.21 describes the summary of primary findings at the post test in all classes. The summary of findings at three month follow-up was shown in Table 4.21.

Table 4.20. Summary of significant beverage intake relationships (immediate post-test)

	Multiple strategies		Single strategy	
	Class A[1] (n= 30)	Class C[2] (n= 21)	Class B[1] (n= 24)	Class D[2] (n= 24)
Milk and juice	-0.427*			-0.677**
Milk and sugary beverages	-0.697**	-0.730**	-0.819**	
Milk and NCD	-0.637**	-0.518*	-0.785**	
Milk and CSD	-0.387*	-0.606**	-0.453*	
Juice and sugary beverages				-0.392*
Juice and CSD	-0.361*		-0.476*	-0.437*
Intakes from baseline for milk				
Intakes from baseline for juice		(↓)		
Intakes from baseline for NCD				
Intakes from baseline for CSD				
Intakes from baseline for sugary drinks	↓	(↓)		↓

[1] Saskatoon [2] Prince Albert

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

() Significantly different after Friedman test, but not significantly different after bonferoni adjustment.

Table 4.21. Summary of significant beverage intake relationships (3-month post-test)

	Multiple strategies		Single strategy	
	Class A[1] (n= 32)	Class C[2] (n= 20)	Class B[1] (n= 24)	Class D[2] (n= 23)
Milk and juice	-0.558**	-0.643**		
Milk and sugary beverages	-0.443*	-0.665**	-0.483*	-0.432*
Milk and NCD	-0.487**	-0.603**	-0.487*	
Milk and CSD			-0.476*	
Juice and sugary beverages	-0.384*			
Juice and NCD				
Juice and CSD				
Intakes from baseline for milk				
Intakes from baseline for juice		(↓)		
Intakes from baseline for NCD				
Intakes from baseline for CSD				
Intakes from baseline for sugary drinks	↓	(↓)		

[1] Saskatoon [2] Prince Albert

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

() Significantly different after Friedman test, but not significantly different after bonferoni adjustment.

5. DISCUSSION

The *FUEL* nutrition education intervention study targeted Grade 9 students because during this period in their life students may have more disposable income from their part-time or even full-time job. According to Saskatchewan Labour (2005), one in every three full-time high school students has an occupation. The study did not solicit information about family income or family size in the *FUEL* questionnaires. The income level stated in the results was derived from Saskatoon and Prince Albert mapping of family income, and fell into the cluster called middle class.

5.1. School Environment

School food environment reflects the nutrition integrity of the school, which has become one of the more complex and challenging school issues of recent time (Kubik, Lytle, Story, 2005). The school food environment includes the foods and beverages offered in school vending machines and school cafeteria, foods used as rewards and incentives in the classroom or sold as part of school fundraising. Parental and peer support of healthy food choice at school, the role modeling behaviour of staff and students, and school food policies and practices that support healthy food choice are also considered components of the school food environment (CDC, 1996). The results found that high schools in the *FUEL* study offered students a variety of beverages that includes carbonated soft drink, fruit drinks, and sport drinks, milk and 100% fruits juices. Students purchase these beverages from vending machines and school cafeterias. In high schools in Canada, access to soft drink vending machines appears to be more available in large urban center schools (Henry, 2004). Schools participating in the *FUEL* study had fewer soft drink vending machines than those reported in the literature (CSPI, 2004; French et al, 2000; Harnack et al., 2000; Wechsler et al, 2001). In both the US and Canada there are calls to reduce the number of soft drink vending machines in schools (French et al., 2002; Henry, 2004; Kubik et al., 2005). In addition, Refreshment

Canada (consortium of Canadian soft drink manufacturers) voluntarily removed carbonated soft drinks from elementary schools, however, non-carbonated sugar sweetened soft drinks are still available in vending machines (Henry, 2004). This is a promising first step, which hopefully can be followed by high schools.

In the *FUEL* study, soft drink vending machines were located mainly at the school's entrance and the cafeteria; high traffic areas. Most machines had "eye catching" displays from the soft drink companies such as Coco Cola™ or Pepsi™. The promotion of carbonated and other sugar-sweetened beverages such as found in soft drink vending machines may be sending inconsistent messages about nutrition as students might look at the nutrition education and healthy eating messages as academic exercises that are not important to be carried out in daily life (Watkins, 2001). Inconsistent nutrition messages, policies, and practices compromise the effectiveness of school-based nutrition education intervention (Gross & Cinelli, 2004). The availability of beverages influences students' consumption (Hanson et al., 2005; Vereecken, Bobelijn, & Maes, 2005; Lee & Reicks, 2003; Gimm, Harnack, & Stry, 2004). The increase of beverage availability means the increase of offers, and children and adolescents will drink milk when the milk is offered and served (Pilant & Skinner, 2004; Fischer, Mitchell, Smiciklas-Wright, Mannino, & Birch, 2004).

Kramer et al. (2002) suggested several key actions to provide healthy food and beverages in schools. These include creating a pleasant eating environment, selling foods with appropriate nutrition standards, and integrating behaviour-focused nutrition education into curriculum.

5.2. The Baseline Survey

5.2.1. The beverage intake of grade nine students in two Saskatoon schools

The results show that the mean daily intake of milk by students was two servings and of sugary beverages, also two servings. These results are similar with the findings of the Whiting et al. (2001) study of adolescents in Saskatoon assessed in mid 1990s, and of a recent study of adolescents in Ontario (Greene-Finestone, Campbell, Gutmanis, & Evers, 2004) where more than half of the participants in Ontario stated that they consumed soft drinks daily. This situation suggests a need for intervention in promoting milk intake since the average of milk intake barely met the recommendation of Canada's Food Guide to Healthy Eating for adolescents (2-4 servings per day). However, the *FUEL* study underestimated students' milk product intake because we only measured the fluid milk intake. At the same time, on average adolescents drank two servings of sugary beverages everyday that each provided 18-35 g added sugar. Although the added sugar intake by grade 9 students in the *FUEL* study was below 25% energy intake as recommended by Institute of Medicine (2002), added sugar intake still may play an important role in obesity. Bray, Nielsen, and Popkin (2004) found that 6.9% energy from added sugar provided by soft drinks contributed to the increase of body weight that led to obesity.

Females' milk and sugary beverage intakes were lower than males' in the *FUEL* study, which is similar with the Whiting et al. (2001) study. The gender difference in milk consumption was also found in US adolescents (Grunbaum et al., 2002). The likelihood of milk consumption of more than 3 servings per day was significantly higher in boys than in girls. Girls aged 16-17 years have a tendency to link milk with fat and weight gain, which may be a reason why girls may limit their milk intake (Auld et al., 2002). Watt and Sheiham (1996) observed that sometimes girls might think that they are overweight when they are not. Dieting occasions, which are more likely to be found in girls (Lien, Jacobs, & Klepp, 2002), increase with age and can lead to inadequate intake of milk products (Neumark-Sztainer et al., 1997; Yannakoulia, Krayiannis, Terzidou, Kokkevi, & Sidossis, 2004). In contrast in Greek adolescents, the likelihood of drinking milk daily, especially low fat milk, was higher in students who were on a diet (Yannakoulia et al., 2004) while students who were not on a diet consumed more soft drinks. On the other hands, boys' beliefs of the importance of milk increase their milk intake (Auld et al., 2002).

Starting from grade 7, more girls skip breakfast with various reasons, such as saving time to sleep in and feeling not hungry in the morning (or have started dieting) (Evers, Taylor, Manske, Midgett, 2001). Skipping breakfast can lead to lower milk and calcium intakes since milk is usually consumed during breakfast (Bowman, 2002; Evers, Taylor, Manske, Midgett, 2001; Lee & Reicks, 2003). Adolescents who skip meals tend to eat more snacks and drink more soft drinks.

Students in the *FUEL* study reported drinking more non-carbonated beverages than carbonated beverages. The non-carbonated beverages included ice tea, coffee with sugar, sport drinks, and fruit drinks. Some of these non-carbonated beverages are fortified with vitamins and minerals. In recent years fruit-flavoured drinks, often made up of 5 to 19 percent real juice, have emerged as a growing component of children and adolescent diets. Hampl, Taylor, & Johnson (1999) reported that despite their higher sugar content, compared to 100 % fruit juices, fruit-flavoured (fruit drinks) drinks provide about 16 percent vitamin C in the diet of adolescents. Parks and colleagues (2002) note that although these juices may improve vitamin intakes, their effect on nutrition is not fully understood. In addition, adolescents with low vitamin C intakes (8-18 mg) have been shown to consume significantly more soft drinks and less high-vitamin C fruit juice than adolescents with high intake of vitamin C. Adolescents who consume desirable amounts of vitamin C intake (>50 mg) reported consuming higher amounts of fruit juice (Hampl et al., 1999). The consumption of high intake of sweetened beverage may also compromise overall nutrient intake (Alexy, Sichert-Hellert, and Kersting 2002)

The study also found that participants consumed a significant amount of fruit juices. The proportion of adolescents' intake of fruit and vegetable juice relative to energy-containing beverages has been increasing overtime (Vatanparast, Lo, Henry, Whiting, submitted). The trend towards increased fruit and vegetable appears favourable; however, the debate continues with some researchers arguing that at least in the early years high intakes of fruit juices may be unfavourable to children's health (Dennison, Rockwell, & Baker, 1997; Tanasescu, Ferris, Himmelgreen, Rodriques, & Perez-Escamilla, 2000). Nonetheless, studies of adolescents have reported intakes lower than the recommended number of servings of fruits and vegetables per day (the recommendation is five to 10 servings daily); with fifty percent of their intake coming from juice (Field, Gillman, Rosner, Rockett, & Colditz, 2003). Phillips et al (2004) reported that 100% fruit juice is an excellent source of many essential vitamins (e.g. Vitamin C). Along with vitamin C, studies in Germany and the US have found that fruit juice also contributes other micronutrients, such as B_6, for adolescents (Sichert-Heller & Kersting, 2001; Hampl et al., 1999).

Adolescents in Spain consumed 90 mL/day (boys) and 76 mL/day (girls) 100% fruit juice. Teenagers who did not eat fruit drank more fruit drinks than those who consumed fruit (Serra-Majem et al., 2001). Compared to *FUEL* study, students in Spain drank lower amount of fruit juice, but higher amount of fruit drinks. Consumption of sugary foods, fruit, vegetable, and 100% fruit and vegetable juices established at the age 15 was preserved until age 21 in Norwegian adolescents (Lien, Jacobs, & Klepp, 2002).

The other beverage category consisted of black coffee, hot tea, and bottled water. Black coffee and hot tea contain caffeine (Trugo, 2003; Owuor, 2003) as do cola beverages (Jorge, 2003). The number of adolescents who consume caffeine has increased overtime. Soft drinks is the highest contributor of caffeine in adolescents' beverage intake (more than 60%), tea (more than 20%), and coffee (more than 5%) (Frary, Johnson, Wang, 2005). Studies such as Hering-Hanith & Gadoth (2003) have found that caffeine compromises children health, by causing headache in children age 9 years after consuming caffeine 1414 mg daily.

By correlating the percent contribution of each beverage providing energy (referred to as "caloric beverages"), negative relationships were found among them as shown in Table 4.4. These negative relations between percent contribution of milk and sugary beverages, milk and juice, and juice and sugary beverages in girls and boys may suggest that students replaced their milk intake with these other beverages. However, there are limitations to this analysis. A positive correlation among the beverage intakes can mean that a student with a high energy requirement drank a lot of milk and a lot of soft drinks. On the other hand, a negative correlation was expected in analyzing the percent contribution because as the percent contribution of one beverage intake increased, those of others would decrease. Hence, one must be cautious in interpretation; in the *FUEL* study, only the significant negative correlations will be interpreted.

In agreement with our findings, other studies showed that the replacement of milk by soft drink intake occurred as early as grade 3 (Blum, Jacobsen, & Donnelly, 2005; Lytle, Seifert, Greenstein, & McGovern, 2000), where the strongest inverse correlation was shown between milk intake and carbonated soft drink intake. These results are different from our 24-hour data (Vatanparast, Lo, Henry, and Whiting, submitted) and from that of Whiting et al. (2001) who detected a significant inverse relationship between non-carbonated soft drink intake and milk intake. This difference could be caused by the differences in data collecting and analysis. In the *FUEL* study, a beverage frequency questionnaire was used to assess students' beverages intake, and the correlations between beverage intakes were calculated in the form of percent contribution of each beverage intake in caloric beverages (milk, juice, and sugary beverages). However, all studies found the same phenomenon that adolescents tended to replace their milk intake with sugary beverages.

The results showed that the most popular beverage consumed everyday at school was plain water, followed by soft drink, fruit juice, and milk. The attitude of school staff towards healthy beverage environment (Henry, 2004), availability of beverage choices (Neumark-Sztainer, Wall, Perry, & Story, 2003), and promotion of beverages at school (Neumark-Stainer, Story, Perry, & Casey, 1999) help to shape adolescents' beverage intake. Schools therefore play a critical part of the social environment that shapes young persons' eating and beverage consumption behaviors and can therefore play a large role in helping improve their diet.

5.2.2. Students' knowledge and attitude at the baseline

The results indicated that students in grade 9 had some nutrition knowledge before the intervention. Students in Saskatchewan high schools (Grade 7-12) may receive a unit of healthy eating lessons (Grade 7) and promoting a healthy school food policy unit (Grade 9) which are optional topics in Health Education curriculum (Saskatchewan Education, 1998). Food Study class may be another nutrition information source for students in Grade 10-12 (Saskatchewan Learning, 2005).

Females' nutrition score in Prince Albert classes (classes C and D) was significantly higher than those in Saskatoon classes (classes A and B), but this phenomenon was not found in male students' nutrition score (Table 4.5). There was no difference of nutrition score between genders in two Saskatoon classes, but girls' nutrition score in two Prince Albert classes were higher than boys'. Beech, Rice, Myers, Johnson, and Nicklas (1999) found that in New Orleans grade 9 students, females' nutrition scores were higher than boys'. Although students in classes C and D had slightly higher nutrition scores, they had significantly lower attitude scores.

Although, more than 70% of students declared that the taste of milk is acceptable for them, 60% of them would choose soft drinks over milk. It is very likely that this choice was made because of the convenience and ubiquity of the products or peer pressure (O'Dea, 2003; Messina, Saba, Vollono, Leclercq, & Piccinelli, 2004). Students might also consider that soft drinks were more appealing than milk (Croll, Neumark-Sztainer, & Story, 2001). Furthermore, adolescents' social environment might indicate that typical adolescents always drink soft drinks, and students would follow it as a new pattern (Monge-Rojas, Nuñez, Garita, & Chen-Mok, 2002). Hawaiian adolescents (Novotny, 2003) said that milk should be consumed with certain foods, such as cereal.

Most adolescents associated their friends with unhealthy food and soft drink consumption (Auld et al., 2002; Cullen et al., 1998), but their milk intake would be higher whenever their friends offered support for them to drink milk (Lee & Reicks, 2003). On the other hand, family, relatives, and older people are related with healthy eating (Croll et al., 2001).

Furthermore, Lien, Jacobs Jr., and Klepp (2002) suggested that soft drinks may have a symbolic function for adolescents. Most participants in the *FUEL* study reported that they were aware of ways to include milk in daily diet. Conversely, healthy eating is time consuming and difficult to be incorporated into daily eating for adolescents in Minnesota, Northern Ireland, and England (Croll et al., 2001; McKinley et al., 2005). Overall, students in the *FUEL* study had a positive attitude and knowledge toward healthy beverages, although they indicated a preference for soft drinks. Similar findings were reported in studies of New Zealand and Minnesota adolescents (Wham & Worsley, 2003; Neumark-Stainer et al., 1999); and in United Kingdom's adolescents (Seaman, Bower, & Fleming, 1997).

O'Dea (2003); Kassem, Lee, Modeste, and Johnston (2003) note that although students reported having knowledge about the healthy beverages, they may continue to consume unhealthy because of the thought that beverages are fun, interesting, able to improve mood and strength because of their associated sugar rush, and ability to quench thirst. Adolescents also expressed the need of more food and nutrition education to improve their healthy eating (O'Dea, 2003). Observers such as Croll et al. (2001); Wham & Worsley (2003); Neumark-Stainer et al. (1999); and Hsieh (2004) notes also that adolescents may think that the impact to health of an unhealthy beverage intake does not affect them immediately and can be reversed later on. More emphasize on health effects of unhealthy beverages for adolescents is needed in nutrition education materials.

The *FUEL* questionnaire did not contain specific questions about calcium intake. Students were hesitant about the calcium content in milk and whether one glass of milk would provide enough calcium in daily intake. This indicated that students did not possess sufficient knowledge in making healthy beverage choices. The same condition can be observed in Minnesota adolescents who came from low-income family (Lee & Reicks, 2003) and Rhode Island/ Massachusetts teenagers (Harel, Riggs, Vaz, White, Menzies, 1998).

5.3. Students' beverage intake after the intervention

All classes made nutritionally favourable changes after the intervention concluded. This phenomenon could be caused by the constructivist approach to teaching which guided the development of the *FUEL* Resource package and the implementation of the study. The *FUEL* packages contained recipe, games, experiments and handout information. Students in the self taught groups showed much enthusiasm in trying out the recipes. The material included in the packages allowed students to participate more fully in the learning process, which is more likely to be successful (Lord et al., 2002).

The next section will compare and discuss the findings in class A (peer educator class) and C (dietitian class) together because both classes applied multistrategy teaching method. The discussion of classes B (Saskatoon self-taught class) and D (Prince Albert self-taught class) will be combined. Following, the findings from multi and single strategy teaching methods will be compared.

5.3.1. Peer educator and Dietitian-taught Approaches (Classes A and C)

The peer educator approach showed the most pronounced results in reducing sugary beverages intake. These results supported the results from the TEENS (Lytle et al., 2004) and TACOS study (Trying Alternative Cafeteria Options in Schools) study (Hamdan, Story, French, Fulkerson, & Nelson, 2005). The incorporation of a peer educator in classroom, parental components resulted in behavioural changes in the

TEENS study. The number of media campaign activities done by peers increased the likelihood in affecting students' eating behaviours in the TACOS study. Peer likeability was identified as the strongest predictor in children's eating behaviours by Oliver and Thelen (1996) because they want to have as many friends as possible (Prokhorov et al, 1993). A negative influence of peers on one's eating habits has also been identified by Cullen et al, (2000); Monge-Rojas et al. (2002), and Oliver and Thelen (1996).

The significant improvement of beverage intake in class A (Peer educator class), which was the decrease of sugary beverage intake, was mainly contributed by boys. The behaviour changes reported by boys were also reported in the ATLAS (Adolescents Training and Learning to Avoid Steroid) study (Goldberg et al., 1996). Students in the ATLAS study maintained the nutrition knowledge and attitude until the long term assessment. However the added parental component included in the ATLAS study may have contributed to the sustained changes reported. The intervention was also carried out on groups of athletes, who may have been more motivated to eat healthily.

The extent of contact among peer educators and other students determined the strength of peer educators' influence in changing students' behaviours (Fulkerson et al., 2004; Parker & Fox, 2001). In an adult study with a peer educator approach, the greater duration and frequency of peer educator and subject gathering produced the greater increase in fruit and vegetable intake (Buller et al., 2000). As the students were exposed in more duration of the promotions, they consumed healthier foods more from the cafeteria. The change was influenced by the duration of their involvement in the TACOS (Trying Alternative Cafeteria Options in Schools) study (Hamdan, Story, French, Fulkerson, & Nelson, 2005).

Although girls in class A did not make a strong contribution in the improvement of beverage intake, their intake of sugary beverages went down slightly. The insignificant change in girls' intake could be caused by the lack of family's support, as Kassem et al. (2003) reported that girls identified the importance of family support in changing their beverage intake. Conversely, girls in the study by Watt and Sheiham (1996) were more often than their male peers to mention that friends' encouragement was important in changing their behaviours.

Girls' reaction toward the *FUEL* study was not identical with boys'; however, further study with a higher subject number is needed to confirm these findings. Nonetheless, the same phenomenon was also noted by other studies that indicated healthy beverage consumption meant differently for boys and girls. For boys, healthy beverage consumption meant more energy, important for performance during sport (Croll et al., 2001). On the other hand, female students consider that body image or appearance is very important (Croll et al., 2001; Watt & Sheiham, 1996). The *FUEL* manual stressed more on the calorie content of the beverages. This topic might influence female students to decrease their sugary beverage intake. However, the manual did not put a lot of attention on obesity. The manual uses a more positive approach to change students' beverage intake behaviour because nutrition education may unintentionally create harmful effects whenever negative beliefs and attitudes are transferred to students including poor body image, prejudices about body weight, and bias toward students, as in prejudice toward overweight students (O'Dea & Maloney, 2000). A strong curriculum is also needed to build self-efficacy of peer educators in delivering it (Lee & Murdock, 2001).

Larkey et al. (1999) noticed that the methods chosen by adult peer educators in approaching their colleagues were differentiated by gender. In the *FUEL* study the same approach of asking students to indicate their willingness to participate as peers was used. Students, however, were selected in the early fall term as they were entering their new grade nine class. However, cross-age peers and older peers provided support and mentorship to the same age peers. The existence of older peers and their supports among peer educators are important (Lee & Murdock, 2001). The presence of older peers in nutrition education can produce a greater change than using a teacher taught approach alone (Cohen, Felix, & Brownell, 1989). Although Cohen et al. (1989) suggested that older peers can deliver the intervention alone and still produce changes, the presence of cross-age peers and same-age peers in the *FUEL* study can prolong the exposure time of the intervention on students. The cross-age peers were first year nutrition students and the same-age peers were grade 9 students who volunteered. The cross-age peers might represent the future of the students, and students could easily find their role models among the cross-age peers (Lee & Murdock, 2001). Students also needed informal support and role models from their own friends who could be the same-age peers (Turner, 1999; Anliker et al., 1999).

In this *FUEL* study, peer educators functioned in supportive roles assisting the dietitians or adult teacher during classroom sessions. This technique was also used in other studies of adolescents (Fulkerson, French, Story, Nelson, and Hannan, 2004; Lytle et al., 2004). In studies of longer duration (e.g. 9 months) peer educators are usually given more responsibility such as assisting with the recruitment of subjects, communicating the nutrition knowledge to their subjects, and administering pre- and post-intervention surveys (Anliker et al., 1999; Buller et al., 1999).

Students in the *FUEL* study returned to their baseline behaviours at one year follow-up. This phenomenon, also encountered in the TEENS study (Lytle et al., 2004), could be caused by lack of environment support for students. Students need support from parents and school to sustain their new healthier behaviour (Monge-Rojas et al., 2002). Parents have an active role in children's discovery of new foods which help their children to be aware of dietary balance and diversity (Ottley, 2003). Support from parents was identified as a positive influence towards healthy eating, and parents with a higher education level were more likely to support their children by increasing the availability of healthy foods at home, serving them during meals, and taking children's wishes of foods and beverages into account (Roos, Hirvonen, Mikkilä, Karvonen, & Rimpelä, 2001; Ottley, 2003).

The TEENS study incorporated environmental and minimal parental components besides peer educator component in their study, but students returned to their basic condition at the follow-up assessment. The same challenge was also encountered by the Peterborough Schools Nutrition project with environmental and peer educator components (Parker & Fox, 2001). This occurrence indicated that adolescence is not a stable age. Although teenagers may establish their eating behaviour during this time, the behaviour is susceptible to be changed. The efforts to change adolescents' behaviour have to be done consistently until the alterations are accepted as one of their behaviours. Hence, maintenance sessions are needed to remind students to keep their new behaviours (Goldberg et al., 1996; Prokhorov, Perry, Kelder, & Klepp, 1993).

The negative correlations that were observed between the percentage of juice and milk intakes at the pre-test were mainly caused by boys' intake; however, at the post-test and three-month follow up it was the girls' intake which influenced this. The negative correlation between the percentage of juice and milk intakes (measured only in class A) disappeared at one year follow-up. The sample size was small so the effect could have been due to insufficient power; however, the change could have been caused by the *FUEL* study because the *FUEL* study classified fruit juice as a healthy drink and at the same time, the emphasis was primarily on milk.

There was a negative correlation between percent contribution of milk and sugary beverage intakes. The proportion of non-carbonated soft drink intake seemed to be the major contributor in this. There appeared to be a gender effect with boys' intake being the major determinant. Nonetheless, in class A – the multiple strategies group having peer involvement- the negative correlations between percentage of milk and sugary beverage intakes, milk and juice intakes, and juice and sugary beverage intakes appeared at all time points.

In class C (dietitian-taught class in Prince Albert high school), students decreased their juice and sugary beverage intake after the intervention. However, the Bonferroni correction on the alpha made the differences non-significant after the multiple comparisons. The decrease of juice intake after the study was unexpected. The same phenomenon happened in the New Moves intervention when 19% of the girls regressed after the study (Neumark-Sztainer, Story, Hannan, Stat, & Rex, 2003). After the *FUEL* intervention, students might be aware and more attentive to the food label of the beverages they drank. At the pre-test they might not be able to differentiate whether they drank 100% fruit juices or fruit drinks because one particular brand of beverages may produce both fruit drinks and 100% fruit juices. Students usually can remember the brand of drinks that they consumed (Acuff & Reiher, 1997).

The correlations among the percentages of girls' intakes showed that the negative correlation between sugary beverage and milk intakes decreased after the study. However, the condition was back to the baseline at three months follow up. Although the negative correlation between the percentage of CSD and milk intakes became weaker in boys' intake, the negative correlation between the percentage of NCD and milk intakes appeared which can explain the unchanged negative correlation between sugary beverage and milk intakes.

The students who were taught by a dietitian might have absorbed the nutrition knowledge in class because the lessons were done in both didactic and interactive teaching, as preferred by high school students (Lee et al., 2004). However, these methods were not useful in changing students' food choice in Anderson, Stanberry, Blackwell, and Davidson's study (2001). Moreover, Brazilian high school students did not respond very well when they were taught by a nutritional expert, but their progress was good whenever they were taught by someone whom they perceived to be similar to them (Doyle & Feldman, 1994). Students in class C could have perceived the local dietitian as being similar to them because they share one town and the age of the local dietitian was relatively close to them.

The findings from the *FUEL* indicate a promising change in students' beverage intake. After six classroom sessions was taught by a local dietitian, students decreased their sugary beverage intake. Several studies noted that the integration of a nutrition education manual into school curriculum and trained teachers to deliver it could improve students' healthy behaviours after the teaching of the manual (Gortmaker et al., 1999; Devine, Olson, & Frongillo, 1992).

The decrease of students' sugary beverage intake in class C was not as pronounced as the decrease of students' sugary beverage in peer-educator class (class A). In class C, the significant decrease disappeared after the bonferroni correction. Furthermore, as shown in Table 4.20, the percentage of sugary beverages decreased after the intervention in class A. These results indicated that the peer educator approach was at least the same or more effective in changing students' behaviour than seen in adult-led approaches of other studies. After reviewing 13 studies using peer-led and adult-led approach, Mellanby, Rees, and Tripp (2000) deduced the same conclusion. The results from the *FUEL* study were not enough to prove the effectiveness of peer-led over adult-led because students in both classes changed their beverage consumption significantly after the intervention. The older-peers in class A held the same role as dietitian in class B. The application of peer educators in class A might prolong the exposure time of *FUEL* intervention on students. As discussed in Chapter 2, as the exposure time of a nutrition education program increases, the likelihood of behaviour changes was also increased. Furthermore, peer educators might give students more freedom in setting their own goals in changing beverage consumption, whiled adult-led approach might be perceived as giving them a high degree of activity control in the classroom like teachers (Walin, Bremberg, Haglund, & Holm, 1993). Freedom in setting goals in healthy beverage consumption is important for students because eating behaviours may be considered as a rebellion tool (Story, 1999; McKinley et al., 2005).

5.3.2. Self-Taught Approach (Classes B and D)

The self-taught approach may be effective in adults who are not in a perfect health condition, for example for obese adults (Miller, Eggert, Wallace, Lindeman, & Jastremski, 1993). Nonetheless, students in class B increased their juice intake significantly after one year study. Taken separately, girls and boys in this class did not increase significantly their juice intake, but both genders increased their juice intake over time. No change could be detected at the post-test and 3 month follow up. This may indicate that students need to be more encouraged to change their behaviour positively, and our one year follow up could be the third reminder for them (after the post-test and three month follow up). In class D (self-taught class in Prince Albert high school), students decreased their carbonated beverage intake significantly after the study, but they went back to the baseline condition at three months follow-up. Mainly boys contributed the significant decrease of carbonated beverage intake; however, girls also decreased (not significantly) their carbonated beverage intake after the study.

It is not possible to state that a self-taught approach is more effective for a certain gender (boys or girls) because different reactions from classes B and D were noted even though both classes received the same approach. In class B, girls made a significant decrease in sugary beverage intake, but in class D, boys significantly decreased their sugary beverage intake. However, McKinley et al. (2005) reported that girls often obtain nutrition information from magazines. Girls in this class decreased their sugary beverage intake significantly. There is a possibility in the *FUEL* study that girls in classes B and D read their hand-outs because in class B girls decreased their sugary beverage intake and in class D girls increased their nutrition knowledge significantly. Unfortunately, girls in both classes could not maintain these positive changes for a long time. The handouts can be considered as magazine because they contained interesting nutrition facts with a lot of pictures without long narrative. An additional study is needed to conclude the findings.

Boys in class B also made some positive changes (not significant) that contributed to the significant change in juice intake while class B boys decreased significantly their carbonated beverage intake. However, all changes in boys' intake did not reach the significance in class B and could not be maintained until three months follow-up. The findings from the *FUEL* could not support the pattern that is shown by other studies that stated girls have healthier eating behaviours than boys (Greene-Finestone et al., 2005; Beech et al, 1999).

Nonetheless, the results show that both peer educator and dietitian-taught approaches are more effective in changing grade 9 students' beverage consumption than the self-taught approach. The self-taught approach gave students more freedom in setting their own goals in changing behaviours; however, students' response toward this approach was not definite. Students, in their adolescence, do not have the same responsibility as adults. In a self-taught approach, responsibility is needed in reading the handouts and applying the information in daily behaviours. Callaghan (2005) found that healthy behaviours are positively related to initiative and responsibility. In class A and C, students' awareness might be triggered by the classroom sessions while in class B and D, students had to take the initiative to read the handouts to become aware. Motives can encourage the significant changes that happened in class C and D, such as responsibility, fear of health consequences, respect towards teachers and researchers, and recognition of themselves as unhealthy persons (Sigman-Grant, 2002).

5.3.3. Multi and Single Strategy Teaching Methods

Students in the multiple strategies classes (A and C) made more pronounced and prolonged changes in their behaviour because they may have obtained more concentrated encouragement from the deliverers. The delivery method in these classes combined the use of visual, auditory, tactile, group, and individual teaching styles. These results confirm the results of the Sovyanhadi and Cort (2004) study. Sovyanhadi and Cort (2004) combined role-playing, video presentation, and visual display teaching styles which were effective in the food pyramid session.

Each student may have a different style of learning that is influenced by several dimensions such as 1) the type of information (sensory or intuitive), 2) through which modality is sensory information most effectively perceived (visual or verbal), 3) the way students process the information (actively or reflectively), and 4) the order in which they receive it (sequentially or globally) (Felder, 1993). Kolb (1984) classified the basic learning styles as diverging, assimilating, converging, and accommodating. The use of multi-strategy teaching methods can increase the likelihood in reaching students with diverse learning styles (Tanner & Allen, 2004). Teaching methods are more effective whenever they match students' learning styles (Ford & Chen, 2001). However, there is a possibility that a teaching method that gratifies the need of both learners and teachers is more important than the concordance of learning and teaching styles (McDonough & Osterbrink, 2005).

Felder and Brent (2005) stated that students have not only different learning styles but also different approaches to their study and their attitude about the knowledge. A balanced teaching style is more important than the matching of teaching-learning styles. A multi-approach teaching method may put a certain student in a discomfort whenever a certain unmatched teaching approach is applied; nonetheless, this method may also apply the students' preference teaching styles, so the level of discomfort is not too great to create an ineffective learning activity. On the other hand, the situation may force students to grow in adaptation ability. Most of college students stated that the implementation of a multi strategy teaching method, especially discussion, team work, and the use of internet, helped them in learning (Smith et al., 2005). The single strategy teaching method will probably work better for adults because adult learners are more adaptable to different teaching styles (McDonough & Osterbrink, 2005).

5.5. Strength and Limitation

Having two phases to study (classes A and B, then C and D) was a strong point for the *FUEL* study. The second phase study confirmed the results of the first phase of the study. The participants came from the same socio-economy society and received the *FUEL* manual in a multiple strategies teaching style. However, it should be noted that in the second phased, comments from the students and peers were used to revise the contents of the manual. Therefore the manual in the second phase of the study was relatively different from the first phase of the study. Nonetheless, both classes showed the same tendency after the intervention, which was a reduction of sugary beverage intake.

The arrangement of the *FUEL* manual in a user-friendly mode was another advantage in the intervention. The user-friendly *FUEL* manual provided all the handouts needed to be distributed to students; furthermore, it also contained other trustworthy reading resources. Students, especially in classes B and D, were attracted to reading the handouts from the *FUEL* manual.

A limitation of the study was the use of the beverage frequency questionnaire as the beverage intake assessment tool. Although the beverage frequency questionnaire was developed to ask about most kinds of beverages usually consumed by adolescents, a misclassification might have happened. For example, several fruit juice companies also produce fruit drinks. Although the companies labeled the drinks, students might be inattentive to their beverages and classified them as fruit juice when the beverages were fruit drinks. Furthermore, the beverage frequency questionnaire was a self-administered questionnaire which could lead students to under- or over-estimate their intake. The presence of nutrition graduate students at the time when the incidence was administered could be found intimidating to students, so they might fill the questionnaire as they were expected.

The number of subjects in the *FUEL* study was also a limitation which lowers the statistical power. The *FUEL* study has a small number of subjects because it was a pilot project. Therefore, after conducting the study in class A and B, another confirmation study was done in class C and D. The intervention in class C was slightly different than in class A. Thus, more confirmation studies with more subjects and the same intervention delivery as classes A and D are needed to reach a stronger conclusion of the effectiveness of a peer educator approach and a dietitian-taught approach for adolescents.

6. CONCLUSION

6.1. Conclusion

Schools are supposed to encourage students to practice healthy eating behaviour, including healthy beverage intake. However, triggered by the need of fund raising, most schools tend to sell students' favourite beverages but low in nutrient content. The same tendency was found in all schools in the *FUEL* study, which did not provide healthy beverage choice for their students. On the other hand, vending machines that sold mostly soft drinks were ubiquitous. The presence of unhealthy choices drove students to consume unhealthy beverages, which was shown by the results of the baseline survey. Students mainly consumed soft drinks and fruit juices at schools. Students in the *FUEL* study still consumed a high amount of milk, but they also drank sugary beverages on a daily basis. Therefore, they also demonstrated a tendency to replace healthy beverages, such as milk and 100% fruit juices, with unhealthy beverages, soft drinks.

The baseline survey revealed that all students in the *FUEL* study possessed basic nutrition knowledge about healthy beverages. Students also had positive attitudes toward healthy beverages. Nevertheless, knowledge and positive attitudes toward healthy beverages did not help students to develop healthy beverage consumption behaviours. Students needed skills to apply their knowledge and attitudes into daily live. Furthermore, encouragement and supports from school administration (through a healthy eating environment), friends, and family are important to produce a change in behaviours.

The *FUEL* study successfully implemented multiple and single teaching methods in four classes of grade nine. The comparison of the effectiveness of these methods was observed through the behaviour outcomes of the students, which was beverage consumption behaviours. The findings indicated that the use of multiple teaching strategies was more effective in changing students' beverage consumption behaviours.

Furthermore, students in multiple teaching strategy classes were more likely to sustain their new beverage intake behaviours longer than students in single teaching strategy classes.

The multiple strategies used in the *FUEL* study were peer education and dietitian taught. Students in both peer education and dietitian-taught classes improved their beverage intakes. However, there is not enough evidence to conclude a peer education approach was more effective than a dietitian-taught approach. There was also not enough proof to deduce boys' and girls' reaction toward different methods. The single teaching strategy in the *FUEL* study was a self-taught approach. Although students in the classes with a self-taught approach altered their beverage intake positively, this improvement was not sustainable until three months.

Overall, a school-based nutrition education program can be used effectively in changing students' beverage intake behaviours. The *FUEL* manual was effective in improving students' beverage consumption. Students also expressed their satisfaction toward the *FUEL* program.

6.2. Implication for practice

A nutrition education program can successfully influence adolescents' eating and beverage consumption behaviours. This kind of program should be conducted in a continuously time. All students' in the *FUEL* schools had not received any nutrition education for at least six months prior to the study. Students are most likely to improve their behaviour after accepting a multiple teaching strategy. The incorporation of other components, such as environment, peer, multimedia campaign, and family components, will increase the likelihood of behaviour changing. A nutrition policy in a school is needed to encourage these changes.

The *FUEL* manual provides a user-friendly six lesson manual that can be used by educators with a minimal training. The manual also offers several books and dependable website for additional reading. Educators can use the manual independently by any multiple approaches (peer education and dietitian assistant).

The *FUEL* study established cooperation between high school and a local dietitian. This cooperation can be useful whenever there is not enough time to train teachers in nutrition lessons. Furthermore, the relationship with a local dietitian provided an easier way for teachers to obtain trustworthy nutrition information. This kind of collaboration can benefit everybody involved and should be nurtured by schools and public health. Dietitians may also provided support to teachers at school to encourage the integration of nutrition education into the class room curriculum.

Parents' involvement in nutrition education effort at schools is important in order to leverage the intervention to homes. However, parents often do not have time to be occupied in a complicated intervention design. Perhaps a minimal but continuous involvement of parents should be sufficient to increase parents' awareness in their children beverage intakes.

The results form the FUEL study indicated that students had unhealthy beverage consumption, especially sugary beverages. These results can be a foundation to establish a policy that would regulate schools' nutrition environment and a compulsory nutrition education in schools' curriculum.

6.3. Further Research

Further research with a larger number of participants is needed to confirm the *FUEL* study. A more scrutinized investigation of the effect of each approach on each gender is essential. The *FUEL* program was studied in Caucasian middle class students. A test of the *FUEL* for students who come from different socioeconomic and ethnicity status is also required.

The roles of family and parents have been acknowledged in several papers. Further research should also involve parents and family in the approach. The inclusion of family into a nutrition education intervention can prolong the intervention to homes. A more intense collaboration with schools to investigate the incorporation of environmental component can be an opportunity for a further study.

7. REFERENCES

Acuff, D.F. and Reiher, R.H. (1997). What kids buy and why: the psychology of marketing to kids. New York: Free Press.

Agha, S. and Van Rossem, R. (2004) Impact of a School-based Peer Sexual Health Intervention on Normative Beliefs, Risk Perceptions, and Sexual Behavior of Zambian Adolescents. *Journal of Adolescent Health*, 34(5), 441-452.

Agron, P., Takada, E., and Purcell, A. (2002). California project LEAN's Food On the Run program: an evaluation of a high school-based student advocacy nutrition and physical activity program. Supplement to *Journal of American Dietetics Association*, 103(3), S103-S105.

Alexy, U., Sichert-Hellert, W., and Kersting, M. (2002). Fortification masks nutrient dilution due to added sugars in the diet of children and adolescents. *Journal of Nutrition*, 132, 2785-2791.

Altieri, A., Vecchia, C.L., and Negri, E. (2003). Fluid intake and risk of bladder and other cancers. *European Journal of Clinical Nutrition*, 57(Suppl 2), S59–S68.

American Academic of Pediatric Committee on School Health. (2004). Soft Drinks in Schools. *Pediatrics,* 113(1), 1152-154.

Andersen, L.F., Bere, E., Kolbjornsen, and Klepp, K-I. (2004). Validity and reproducibility of self-reported intake of fruit and vegetable among 6th graders. *European Journal of Clinical Nutrition*, 58, 771-777.

Anderson, J.J.B. (2004). Nutrition and Bone Health in in L.K.Mahan and S. Escott-Stump (Eds), Krause's food, nutrition, & diet therapy (pp.165-179). Philadelphia: Elsevier.

Anderson, T.P., Stanberry, A.M., Blackwell, A.P., and Davidson, C.W. (2001). The effectiveness of nutrition instruction on student nutrition knowledge and food choices. *Journal of Family and Consumer Sciences Education*, 19 (1), 31-37.

Anderzewski, D., Roach, J.A.G., Gay, M.L., and Musser, S.M. (2004). Analysis of coffee fort the presence of acrylamide by LC-MS/MS. *Journal of Agriculture and Food Chemistry*, 52, 1996-2002.

Anliker, J., Damron, D., Ballesteros, M., Feldman, R., Langenber, P., and Havas, S. (1999). Using peer educators in nutrition intervention research: Lesson learned from the Maryland WIC 5 A Day promotion program. *Journal of Nutrition Education*, 31, 347-354.

Anonymous. (1995). The Dairy Producers Regulations, 1995. Retrieved June 5, 2004 from http://www.dairyinfo.gc.ca/pdf_files/saskdairyproducersregulations.pdf.

Arnaud, M.J. (2003). Mild hydration, a risk factor for constipation? *European Journal of Clinical Nutrition*, 57(Suppl 2), S88–S95.

Ashurst, P.R. (1998). Introduction in P.R. Ashurst (Ed), Chemistry and Technology of Soft Drinks and Fruit Juices (pp.1-15). England: Sheffield Academic Press.

Atlas of Canada. (2001). Income measures: Methodological notes. Retrieved at April 29, 2005 from http://atlas.gc.ca/maptexts/map_texts/english/inc_meth_e.html.

Auld, G., Boushey, C.J., Bock, M.A., Bruhn, C., Gabel, K., Gustafon, D., Holmes, B., Misner, S., Novotny, R., Peck, L., Pelican, S., Pond-Smith, D., Read, M. (2002). Perspectives on intake of calcium-rich foods among Asian, Hispanic, and White preadolescent and adolescent female. *Journal of Nutrition Education and Behaviour*, 34, 242-251.

Bandini, L.G., Cyr, h., Must, A., and Dietz, W.H. (1997). Validity of reported energy intake in preadolescent girls. *American Journal of Clinical Nutrition*, 65 (Supply), 1138S-1141S.

Barthold, J., Pearson, J., Elisworth, A., Mason, C., Hohensee, T., McLaud, B., and Lewis, C. (1993). A cardiovascular health education program for rural schools. *Journal of School Health*, 63 (7), 298-301.

Bates, R.P., Morris, J.R., and Crandall, P.G. (2001). Principles and practices of small - and medium - scale fruit juice processing. Rome: Food and Agriculture Organization.

Bayne-Smith, M., Fardy, P.S., Azzollini, A., Magel, J., Schmitz, K.H., and Agin, D. (2004). Improvements in heart health behaviours and reduction in coronary artery disease risk factors in urban teenaged girls through a school-based intervention: The PATH program. *American Journal of Public Health*, 94(9), 1538-1543.

Beech, B.M., Rice, R., Myers, L., Johnson, C., Nicklas, T.A. (1999). Knowledge, attitudes, and practices related to fruit and vegetable consumption of high school students. *Journal of Adolescent Health*, 24, 244-250.

Berkey, C.S., Rockett, H.R., Field, A.E., Gillman, M.W., Colditz, G.A. (2004). Sugar-added beverages and adolescent weight change. *Obesity Research*, 12(5), 778-88.

Birch, L.L. and Fisher, J.O. (1998). Development of eating behaviors among children and adolescents. *Pediatrics*, 101(3 Pt 2), 539-49.

Birnbaum, A.S., Lytle, L.A., and Story, M. Peer leaders and adolescents participating in a multicomponent school based nutrition intervention had dietary improvement (treatment). (2003). *Evidence-Based Nursing*, 6(2), 44.

Birnbaum, A.S., Lytle, L.A., Story, M., Perry, C.L., and Murray, D.M. (2002). Are differences in exposure to a multicomponent school-based intervention associated with varying dietary outcomes in adolescents? *Health Education and Behaviour*, 29 (4), 427-443.

Black, A.E. (2001). Dietary assessment for sport dietetics. *Nutrition Bulletin*, 26, 29-42.

Blum, J.W., Jacobsen, D.J., and Donnelly, J.E. (2005). Beverage consumption patterns in elementary school aged children across a two year period. Journal *of the American College of Nutrition*, 24 (2), 93-98.

Botvin, G.J., Baker, E., Filazzola, A.D., and Botvin E. (1990). A cognitive behavioral approach to substance abuse prevention: One year follow-up. *Addictive Behaviors*, 15, 47-63.

Bowman, S.A. (2002). Beverage choice of young females: Changes and impact on nutrient intake. *Journal of American Dietetics Association*, 102, 1234-1239.

Boyle, M.A. (2003). Community Nutrition in Action: An Entrepreneurial Approach. U.S.A.: Wadsworth Pub Co.

Bratlett, D. and Smith, B.G.N. (2000). Definition, classification and clinical assessment of attrition, erosion and abrasion of enamel and dentine. In M. Addy, G. Embery, W.M. Edgar, and R. Orchardson (Eds), Tooth Wear and Sensitivity (pp.87-92). United Kingdom: Martin Dunitz, Ltd.

Bray, G.A., Nielsen, S.J., and Popkin, B.M. (2004). Consumption of high-fructose corn syrup in beverages may play a role in the epidemic of obesity. *American Journal of Clinical Nutrition*, 79, 537-43.

Brew, K. (2003). α-Lactalbumin. In P.F. Fox and P.L.H. McSweeney (Eds), Advanced dairy chemistry volume 1: Protein (pp. 319-363). New York: Plenum Publishers.

Brown, R. and Ogden, J. (2004). Children's eating attitudes and behaviour: a study of the modeling and control theories of parental influence. *Health Education Research*, 19 (3), 261-271.

Buller, D.B., Buller, M.K., Larkey, L., Sennott-Miller, L., Taren, D., Aickin, M., Wentzel, T.M., and Morrill, C. (2000). Implementing a 5-a-day peer health educator program for public sector labor and trades employees. *Health Education and Behaviour*, 27, 232-240.

Buller, D.B., Morrill, C., Taren, D., Aickin, M., Sennott-Miller, L., Buller, M.K., Larkey, L., Alatorre, C., and Wentzel, T.M. (1999). Randomized trial testing the effect ofpeer education at increasing fruit and vegetable intake. *Journal of the National Cancer Institute*, 91 (17), 1491-1500.

Cabrera, C., Gimeä Nez, R., and Loä Pez, M. C. (2003). Determination of Tea Components with Antioxidant Activity. *Journal of Agricultural and Food Chemistry*, 51, 4427-4435.

Callaghan, D.M. (2005). The influence of spiritual growth on adolescents' initiative and responsibility for self-care. *Pediatric Nursing*, 31 (2), 91-95, 115.

Canadian Food Inspection System implementation Group. (2002). National Dairy Regulation and Code (Production Sector Interpretive Guidelines). Retrieved June 5, 2004 from http://www.cfis.agr.ca/english/regcode/ndrc/int_gide_e.shtml.

Casal, S., Alves, M. R., Mendes, E., Oliveira, B. P. P., and Ferreira, M. A. (2003). Discrimination between Arabica and Robusta coffee species on the basis of their amino acid enantiomers. *J. Agric. Food Chem.* 2003**,** *51,* 6495-6501.

Cavadini, C., Siega-Riz, A.M., and Popkin, B.M. (2000). US. Adolescents food intake trends from 1965 to 1996. *Archives of Disease in Childhood,* 83, 18-24.

Center for Disease Control and Prevention. (1996). Guidelines for school health programs to promote lifelong healthy eating. *Morbidity and Mortality Weekly Report*, 45 (RR-9): 1-33.

Center for Disease Control and Prevention. (2005). BMI - Body Mass Index: BMI for Children and Teens. Retrieved at July 19, 2005 from http://www.cdc.gov/nccdphp/dnpa/bmi/bmi-for-age.htm.

Center for Food and Justice, Urban and Environmental Policy Institute, Occidental College. (2002). Challenging the Soda Companies: The Los Angeles Unified School District Soda Ban.

Center for Science in the Public interest. (2004). Dispensing junk: How school vending undermines efforts to feed children well. Retrieved at May 30th, 2005 from http://cspinet.org/new/pdf/dispensing_junk.pdf.

Chiego, Jr., D.J. (2002) Histology of the Pulp in J.K. Avery (Ed), Oral Development and Histology (pp. 190-224). New York: Thieme Medical Publishers.

Clydesdale, F.M., Kolasa, K.M. and Ikeda, J.P. (1994). All you want to know about fruit juice. *Nutrition Today,* 29(2), 14-28.

Cohen, R.Y., Felix, M.R.J., Brownell, K.D. (1989). The role of parents and older peers in school-based cardiovascular prevention programs: Implications for program development. *Health Education Quarterly*, 16 (2), 245-253.

Cole, T.J. and Rolland-Cachera, M.F. (2002). Measurement and Definition. In W. Burniat, T.J. Cole, I. Lissau, and E.M.E. Poskitt (Ed), Child and Adolescent Obesity: Causes and Consequences, Prevention and Management (pp.1-2). USA: Cambridge University Press.

Consumer Union. (1995). Captive Kids: A report on commercial pressures on kids at school retrieved in June 2nd, 2004 from http://www.consumersunion.org/other/captivekids/pressures.htm.

Croll, J.K., Neumark, Sztainer, D., and Story, M. (2001). Healthy eating: What does it mean to adolescents? *Journal of Nutrition Education*, 33, 193-198.

Cullen, K.W., Baranowski, T., Baranowski, J., Warnecke, C., De Moor, C., Nwachokor, A., Hajek, R.A., and Jones, L.A. (1998). "5 A Day" achievement badge for urban boy scouts: Formative evaluation results. *Journal of Cancer Education*, 13, 162-168.

Cullen, K.W., Baranowski, T., Rittenberry, L., and Olvera, N. (2000). Social-environmental influences on children's diet: Results from focus groups with African-, Euro-, and Mexican-American children and their parents. *Health Education Research*, 15 (5), 581- 590.

Dairy Council of California. (2003). Nutrition intervention establishes healthier food choices: A summary of food consumption among California's adolescents. Retrieved October 4th, 2004 from www.dairycouncilofca.org/edu/edu_eyo_nie.htm.

Dauthy, M.E. (1995). Fruit and Vegetable Processing. Rome: Food and Agriculture Organization of the United Nations.

Dawson-Hughes, B. (2003). Role of calcium in reducing postmenopausal Bone Loss and in fracture prevention in S.A. New and J-P. Bounjour, Nutritional Aspects of Bone Health (pp.145-156). United Kingdom: The Royal Society of Chemistry.

Dennison, B.A., Rockwell, H.L., and Baker, S.L. (1997). Excess fruit juice consumption by preschool-aged children is associated with short stature and obesity. *Pediatrics*, 99(1):15-22.

Densupsoontorn, N., Jirapinyo, P., Tamonsiri, N., Wongarn, R., Phosuya, P., Tritiprat, A., Patraarat, S., Pidatcha, P., Suwannthol, L. (2002). Comparison of the nutrient content of fresh fruit juices vs commercial fruit juices. *Journal of Medical Association of Thailand*, 85(Supply 2), S732-S738.

Department of Health. (1988). The Food and Drugs Act (Division 12, Prepackaged Water and Ice). Retrieved June 5, 2004 from http://www.hc-sc.gc.ca/food-aliment/friia-raaii/food_drugs-aliments_drogues/act-loi/e_index.html.

Department of Health. (1990). The Food and Drugs Act (Division 5, Coffee). Retrieved June 5, 2004 from http://www.hc-sc.gc.ca/food-aliment/friia-raaii/food_drugs-aliments_drogues/act-loi/e_index.html.

Department of Health. (1991). The Food and Drugs Act (Division 20, Tea). Retrieved June 5, 2004 from http://www.hc-sc.gc.ca/food-aliment/friia-raaii/food_drugs-aliments_drogues/act-loi/pdf/e_d-text-2.pdf.

Department of Health. (1993). The Food and Drugs Act (Division 2, Alcoholic Beverages). Retrieved June 5, 2004 from http://www.hc-sc.gc.ca/food-aliment/friia-raaii/food_drugs-aliments_drogues/act-loi/e_index.html.

Department of Health. (1995). The Food and Drugs Act (Division 8, Dairy Products). Retrieved June 5, 2004 from http://www.hc-sc.gc.ca/food-aliment/friia-raaii/food_drugs-aliments_drogues/act-loi/e_index.html.

Department of Health. (1997). The Food and Drugs Act (Division 11, Fruits, Vegetables, their Products and Substitutes). Retrieved June 5, 2004 from http://www.hc-sc.gc.ca/food-aliment/friia-raaii/food_drugs-aliments_drogues/act-loi/e_index.html.

Devine, C.M., Olson, C.M., and Frongillo, Jr., E.A. (1992). Impact of the Nutrition For Life program in junior high students in New York State. *Journal of School Health*, 62(8), 381-385).

Dinçer, B., Hazar, S., and Sen, B.H. (2002). Scanning electron microscope study of the effects of soft drinks on etched and sealed enamel. *American Journal of Orthod Dentofacial Orthop*, 122, 135-141.

Doyle, E.I. and Feldman, R.H.L. (1994). Are local teachers or nutrition expert perceived as more effective among Brazilian high school students? *Journal of School Health*, 64 (3), 115-118.

Evers, S., Taylor, J., Manske, S., and Midgett, C. Eating and smoking behaviours of school children in Southwestern Ontario and Charlottetown, PEI. *Canadian Journal of Public Health*, 92 (6), 433-436.

Felder, R. (1993). Reaching the second tier: Learning and teaching styles in College Science Education. *J. College Science Teaching,* 23(5), 286-290.

Felder, R.M. and Brent, R. (2005). Understanding Student Differences. *J. Engr. Education, 94*(1), 57-72.

Ferrara, L., Montesano, D., Senatore, A. (2001). The distribution of minerals and flavonoids in the tea plant (*Camellia sinensis*). *Farmaco*, 56, 397-401.

Field, A.E., Gillman, M.W., Rosner, B., Rockett, H.R., and Colditz, G.A. (2003). Association between fruit and vegetable intake and change in body mass index among a large sample of children and adolescents in the United States. *International Journal of Obesit*y, 27, 821-826.

Fiordalisi, I. and Finberg, L. (2003). Diarrhea and Dehydration. In R.M. Perkin, J.D. Swift, and D.A. Newton (Eds), Pediatric Hospital Medicine (pp.191-198). Philadelphia: Lippincott Williams & Wilkins.

Fischer, J.O., Mitchell, D.C., Smiciklas-Wright, H., Mannino, M.L., and Birch, L.L. (2004). Meeting calcium recommendations during middle childhood reflects mother-daughter beverage choices and predicts bone mineral status. *American journal of Clinical Nutrition*, 79, 698-706.

Fischer, M., Reimann, S., Trovato, V., and Redgwell, R. J. (2001). Polysaccharides of green Arabica and Robusta coffee beans. *Carbohydrate Research,* 330, 93–101.

Fisher, J.O. and Birch, L.L. (1999). Restricting access to palatable foods affects children's behavioural response food selection, ad intake. *American Journal of Clinical Nutrition*, 69, 1264-1272.

Forcella, S., Mata, A., Mesquita, M.F., and Spoto, G. (2002). Teeth in C. Scully, Oxford Handbook of Applied Dental Sciences (pp.341-348). New York: Oxford University Press.

Ford, N. and Chen, S. (2001). Matching/mismatching revisited: an empirical study of learning and teaching styles. *British Journal of Education Technology*, 32, 5-22

Forshee, R.A., Storey M.L.. (2001). The Association of Demographics and Beverage Consumption with Dental Caries. Presented to the American College of Nutrition 42nd Annual Meeting, October 3-7, Orlando, Florida.

Forshee, R.A. and Storey, M. L. (2003). Total beverage consumption and beverage choices among children and adolescents. *International Journal of Food Science and Nutrition*, 54 (4), 297-307.

Fox, P.F. (2003). Milk proteins: general and historical aspects in P.F. Fox and P.L.H. McSweeney (Ed), Advanced Dairy Chemistry-1: Proteins. New York: Kluwer Academic.

Frary, C.D., Johnson, R.K., and Min, Q.W. (2004). Children and Adolescents Choices of Foods and Beverages high in Added Sugars are associated with intakes of key nutrients and food groups. *Journal of Adolescent Health*, 34, 56-63.

Frary, C.D., Johnson, R.K., and Wang, M.Q. (2005). Food sources and intakes of caffeine in the diets of persons in the United States. *Journal of the American Dietetic Association*, 105, 110-113.

French, S.A., Lin, B-H., and Guthrie, J.F. (2003). National trends in soft drink consumption among children and adolescents age 6 to 17 years: prevalence, amounts, and sources, 1977/1978 to 1994/1998. *Journal of American Dietetics Association*, 102, 1326-1331.

French, S.A., Fulkerson, J.A., and Gerlach, A.F. (2003). Food environment in secondary schools: À la carte, vending machines, and food policies and practices. *American journal of Public Health*, 92, 1161-1167.

French, S.A., Story, M., Fulkerson, J.A. (2002). School food policies and practices: A state-wide survey of secondary school principals. *Journal of the American Dietetic Association*, 102, 1785-1789.

Fulkerson, J.A., French, S., Story, M., Nelson, H., and Hannan, P.J. (2004). Promotions to increase lower-fat food choices among students in secondary schools: Description and outcomes of TACOS (Trying Alternative Cafeteria Options in Schools). *Public Health Nutrition*, 7 (5), 665-674.

Giammattei, J., Blix, G., Marshak, H.H., Wollitzer, A.O., and Pettitt, D.J. (2003). Television watching and soft drink consumption. *Archives of Pediatrics and Adolescents Medicine,* 157, 882-886.

Gidding, S. S., Nehgme, R., Heise, C., Muscar, C., Linton, A., and Hassink, S. (2004). Severe obesity associated with cardiovascular deconditioning, high prevalence of cardiovascular risk factors, diabetes mellitus/hyperinsulinemia, and respiratory compromise. *Journal of Pediatrics,* 144, 766-769.

Gillis, L.J., Kennedy, L.C., Gillis, A.M. and Bar-Or, O. (2002), Relationship between juvenile obesity, dietary energy and fat intake and physical activity. *International Journal of Obesity*, 26, 548-463.

Gilsanz, V. (1999). Accumulation of Bone mass during childhood and adolescence. In E.S. Orwoll, Osteoporosis in Men, The effects of gender on skeletal health (pp.65-80). San Diego, California: Academic Press.

Goldberg, L. and Elliot, D. (1993). ATLAS (Athletes Training and learning to Avoid Steroids) retrieved at June 29, 2004 from www.samha.gov.

Goldberg, L., Elliott, D., Clarke, G., MacKinnon, D., Moe, E., Xoref, L., Green, C., Wolf, S.L., Greffrath, E., Miller, D.J., and Lapin A. (1996). Effects of a multidimensional anabolic steroid prevention intervention: The Adolescents Training and Learning to Avoid Steroids (ATLAS) Program. Journal of the American Medical Association, 276 (19): 1555-1562.

Gortmaker, S.L., Peterson, K., Wiecha, J., Sobol, A.M., Dixit, S., Fox, M.K., Laird, N. (1999). Reducing obesity via a school-based interdisciplinary intervention among youth, Planet Health. *Archives of Pediatrics and Adolescent Medicines*, 153, 409-418.

Goulding, A., Rockell, J.E.P, Black, R.E., Grant, A.M., Jones, I.E., Williams, S.W. (2004). Children who avoid drinking cow's milk is increased risk for *Prepubertal Bone Fracture. Journal of American Dietetics Association*, 104, 250-253.

Greene-Finestone, L.S., Campbell, M.K., Gutmanis, I.A., and Evers, S.E. (2005). Dietary intake among young adolescents in Ontario: Associatoins with vegetarian status and attitude toward health. *Preventive Medicine*, 40, 105-111.

Grimm, G.C., Harnack, L., Story, M. (2004). Factors associated with soft drink consumption in school-aged children. *J Am Diet Assoc*., 104(8):1244-1249.

Grivetti, L.E. and Wilson, T. (2004). A brief history of human beverage consumption, Prehistory to the present in T. Wilson and N.J. Temple (Eds), Beverages in Nutrition and Health (pp.3-18). New Jersey: Humana Press, Inc.

Gross, S.M and Cinelli, B. (2004) Coordinated school health program and dietetics professionals: partners in promoting healthful eating. *J Am Diet Assoc*, 104(5):793-8.

Grunbaum, J.A., Kann, L., Kinchen, S.A., Williams, B., Ross, J.G., Lowry, R., and Kolbe, L. (2002). Youth risk behaviour surveillance-United States, 2001. *The Journal of School Health*, 72 (8), 313-328.

Guerrero-Romero, F., Rodriguez-Moran, M., and Reyes, E. (1999). Consumption of soft drinks with phosphoric acid as a risk factor for the development of hypocalcemia on postmenopausal women. *Journal of Clinical Epidemiolog,* 52(10), 1007-1010.

Hamdan, S., Story, M., French, S., Fulkerson, J.A., Nelson, H. (2005). Perceptions of adolescents involved in promoting lower-fat foods in schools: Associations with level of involvement. *Journal of the American Dietetic Association*, 105: 247-251.

Hampl, J.S., Taylor, C.A., and Johnston, C.S. (1999). Intakes of vitamin C, vegetables and fruits: Which schoolchildren are at risk? *Journal of the American College of Nutrition*, 18 (6), 582-590.

Han, D.S. and Cho, B.S. (2002) Therapeutic approach to hyponatremia. *Nephron*, 92 (suppl 1), 9-13.

Hanson, N.I., Neumark-Sztainer, D., Eisenberg, M.E., Story, M., and Wall, M. (2005). Associations between parental report of the home food environment and adolescent intakes of fruits, vegetables, and dairy foods. *Public health Nutrition*, 8 (1), 77-85.

Hardy, L. (1999). The Lure of School Marketing. American School Board Journal October 1999 retrieved in June 2nd, 2004 from http://www.asbj.com/199910/1099coverstory.html.

Harel, Z., Riggs, S., Vaz, R., White, L., Menzies, G. (1998). Adolescents and calcium: What do they do and do not know and how much they consume. *Journal of Adolescent Health*, 22, 225-228.

Harnack, L., Snyder, P., Story, M., Holliday, R., Lytle, L., Neumark-Sztainer, D. (2000). Availability of a la carte food items in junior and senior high schools: A need assessment. *Journal of the American Dietetic Association*, 100 (6), 701-703.

He, K., Kramer, E., Houser, R. F., Chomitz, V. R., and Hacker, K.A. (2004). Defining and understanding healthy lifestyles choices for adolescents. *Journal of Adolescent Health*, 35, 26-33.

Heaney, R. P., and Rafferty, K. (2001). Carbonated beverages and urinary calcium excretion. *American Journal Clinical Nutrition,* 74, 343-347.

Heller, K.E., Burt, B.A., and Eklund, S.A. (2001). Sugared soda consumption and dental caries in the United States. *Journal of Dental Research,* 80(10),1949-1953.

Henry, C. (2004). Beverage provision and consumption in elementary schools: Exploring the policies and practices of beverage consumption in elementary schools. *Broch Journal of Education*. Accepted.

Hering-Hanit, R. and Gadoth, N. (2003). Caffeine-induced headache in children and adolescents. *Chepalalgia*, 23 (5), 332-335.

Hern, M.J. and Gates, D. (1998). Linking learning with health behaviors of high school adolescents. *Pediatrics Nursing*, 24(2): 127-132.

Hill, J.O., Kriketos, A.D., and Peters, J.C. (2000). Disturbance of Energy Balance in M.H. Stipanuk, Biochemical and Physiological Aspects of Human Nutrition. Pennsylvania: W.B. Saunders Company.

Himes, J.H., Kim, R., Gittelsohn, J., Cunningham-Sabo, L., Weber, J., Thompson, J., Harnack, L., and Suchindran, C. (2003). Impact of the Pathways intervention on dietary intakes of American Indian schoolchildren. *Preventive Medicine*, 37, S55-S61.

Hoelscher, D.M., Evans, A., Parcel, G.S., Kelder, S.H. (2002). Designing effective nutrition interventions for adolescents. Supplement to the *Journal of American Dietetic Association*, 102(3): S52-S63.

Hofer, B.K. (1999). The role of school in United States adolescents' lives. The Educational Systems in United States: The Case Study Findings, available at http://www.ed.gov/pubs/USCaseStudy/chapter4a.html.

Hsieh, P-L. (2004). Factors influencing students' decision to choose healthy or unhealthy snacks at the University of Newcastle, Australia. *Journal of Nursing Research*, 12 (2), 83-90.

Institute of Medicine. (2002). Dietary Reference Intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. Washington, D.C.: The National Academic Press.

Institute of Medicine. (2004). Dietary References Intakes for Water, Potassium, Sodium, Chloride, and Sulfate. USA, The National Academy of Sciences, available in http://www.nap.cdu/openbook/0309091691./html/67.html.

The International Bottled Water Association. (2004). Regulation of bottled water: An Overview. Retrieved at May 20, 2004 from http://www.bottledwater.org/public/publicsearch_main.htm.

Iuliano-Burns, S, Naughton, G., Gibbons, K., Bass, S.L., and Saxon, L. (2003). Regional Specificity of exercise and calcium during skeletal growth in girls: a randomized control trial. *Journal of Bone and Mineral Research*; 18:156-162.

Iuliano-Burns, S., Whiting, S.J., Faulkner, R.A., and Bailey, D.A. (1999). Levels, sources, and seasonality of dietary calcium intake in children and adolescents enrolled in the University of Saskatchewan Pediatric Bone Mineral Accrual Study. *Nutrition Research*, 19 (10), 1471-1483.

Jago, C. (1998). Teens will listen to peers before parents. Education: A teacher finds that kids will heed the rules they themselves set. *Los Angeles Times*. Retrieved at June 20, 2004 from http://home.att.net/~xchar/tna/.

James, J., Thomas, P., Cavan, D., and Kerr, D. (2004). Preventing childhood obesity by reducing consumption of carbonated drinks: cluster randomized controlled trial. *British Medical Journal*, 328 (7450), 1237-1241.

Jensdottir, T., Arnadottir, I.B., Thorsdottir, I., Bardow, A., Gudmundsson, K., Theodors, A., and Holbrook, W.P. (2004). Relationship between dental erosion, soft drink consumption, and gastroesophageal reflux among Icelanders. *Clinical Oral Investigation*, 8(2), 91-96.

Johnson, R.K., and Hankin, J.H. (2003). Dietary assessment and validation. In E.R. Monsen (Ed), Research: Successful Approaches. USA: American Dietetic Association (pp. 227-242).

Jorge, K. (2003). Soft Drinks in B. Caballero, L.Trugo, P. Finglas (Eds), Encyclopedia of Food Sciences and Nutrition (pp.5346-5352). United States: Academic Press.

Kanis, J.A., Johnell, O., Oden, A., Dawson, A., De Laet, C., and Jonsson, B. (2001). Ten year probabilities of osteoporotic fractures according to BMD and diagnostic thresholds. *Osteoporosis International*, 12(12), 989-995.

Kaptoge, S., Dalzell, N., Loveridge, N., Beck, T.J., Khaw, K.T., Reeve, J. (2003) Effects of gender, anthropometric variables, and aging on the evolution of hip strength in men and women aged over 65. *Bone*, 32(5):561-70.

Kassem, N.O., Lee, J.W., Modeste, N.N., and Johnston, P.K. (2003). Understanding soft drink consumption among female adolescents using the Theory of Planned Behaviour. *Health Education Research*, 18 (3), 278-291.

Khani, R.K., Ye, W, Terry, P., and Wolk, A. (2004). Reproducibility and validity of major dietary patterns among Swedish women assessed with a Food-Frequency Questionnaire. *Journal of Nutrition*, 134, 1541-1545.

Kidd, E. A. M. and Nyvad, B. (2003). Caries control for the individual patient. In O. Fejerskov and E.A.M. Kidd, Dental caries: the disease and its clinical management. Malden, MA: Blackwell.

Killen, J.D., Taylor, C.B., Hammer, L.D., Litt, I., Wilson, D.M., Rich, T., Hayward, C., Simmonds, B., Kraemer, H., Varady, A. (1993). An attempt to modify unhealthful eating attitudes and weight regulation practices of young adolescent girls. *International Journal of Eating Disorders*, 13(4), 369-384.

Kleiner, S.M. (1999). Water, an essential but overlooked nutrient. *Journal of the American Dietetic Association*, 99(2), 200-206.

Knochel, J.P. (2003). Phosphorus Retrieved in Dec 7th, 2003 from http://lpi.oregonstate.edu/infocenter/minerals/phosphorus/

Kolb, D.A. (1984). Experiential learning : experience as the source of learning and development. Englewood Cliffs, N.J. : Prentice-Hall

Kramer-Atwood, J.L., Dwyer, J., Hoelscher, D.M., Nicklas, T.A., Johnson, R.K., and Schulz, G. (2002). Fostering healthy food consumption in schools: Focusing on the challenges of competitive foods. *Journal of the American Dietetic Association*, 102 (9), 1228-1232.

Kruse, J.A. (2003). Hyponatremia. In J.A. Kruse, M.P. Fink, and R.W.Carlson (Eds), Saunders Manual of Critical Care (pp.119-123). United States of America: Elsevier.

Kubik, M.Y., Lytle, L.A., Story, M. (2005). Soft drinks, candy, and fast food: What parents and teachers think about the middle food environment. *Journal of the American Dietetic Association*, 105, 233-239.

Kumanyika, S.K., Tell, G.S., Shemanski, L. Martel, J., and Chincili, V. (1997). Dietary assessment using a picture-sort approach. *American Journal of Clinical Nutrition*, 65 (Supply), 11123S-1129S.

Laquatra, I. (2004). Nutrition for weight management in L.K.Mahan and S. Escott-Stump (Eds), Krause's food, nutrition, & diet therapy (pp.558-593). Philadelphia: Elsevier.

Larkey, L.K., Alatorre, C., Buller, D.B., Morril, C., Buller, M.K., Taren, D., and Sennott-Miller, L. (1999). Communication strategies for dietary change in a worksite peer educator intervention. *Health Education Research*, 14 (6), 777-790.

Larsen, M.J. and Nyvad, B. (1999). Enamel erosion by some soft drinks and orange juice relative to their pH, buffering effect and contents of calcium phosphate. *Caries Research*, 33, 81-87.

Larsen, M.J. and Richards, A. (2002). Fluoride is unable to reduce dental erosion from soft drinks. *Caries Research*, 36, 75-80.

Lee, A., Siu, D.C.H, Au, S.K.L., Chen, R.C.I., Cheng, K.W., Yau, F.T., Tong, L.C.T., Chan, S.Y., Tsang, W.W., Ho, M. (2004). What are the needs of students? An experience from a district based health promoting schools project in Hong Kong. *Asia-Pacific Journal of Public Health*, 16 (Supply), S17-S21.

Lee, F.C.H. and Murdock, S. (2001). Teenagers as teachers programs: Ten essential elements. Journal of Extension, 39 (1). Retrieved at October 22, 2004 from http://joe.org/joe/2001february/rb1.html.

Lee, H.H.C., Gerrior, S. A., and Smith, J. A. (1998). Energy, macronutrient, and food intakes in relation to energy compensation in consumers who drink different types of milk. *American Journal of Clinical Nutrition*, 67, 616-623.

Lee, R.D. and Nieman, D.C. (2003). Nutritional Assessment. New York: The McGraw-Hill Companies, Inc.

Lee, S. and Reicks, M. (2003). Environmental and behavioral factors are associated with the calcium intake of low-income adolescent girls. *Journal of the American Dietetic Association*, 103, 1526-1529.

Leger, L.St. (2001). Schools, health literacy and public health: Possibilities and challenges. *Health Promotion International*, 16 (2), 197-205.

Lien, N., Jcobs Jr., D.R., and Klepp, K-I. (2002). Exploring predictors of eating behaviour among adolescents by gender and socio-economic status. *Public Health Nutrition*, 5 (5), 671-681.

Little, J.C., Perry, D.R., Volpe, S.L. (2002). Effect of nutrition supplement education on nutrition supplement knowledge among high school students from a low-income community. *Journal of Community Health*, 27(6), 433-450.

London International Coffee Organization. (2004). About Coffee. Retreived August 7, 2004 from http://www.ico.org/frameset/coffset.htm.

Long, J.A. and Stevens, K.R. (2004). Using technology to promote self-efficacy for healthy eating in adolescents. *Journal of Nursing Scholarship*, 36 (2), 134-139.

Lord, T., Travs, H., Magill, B., and King, L. (2002). Comparing Student-centered and teacher-centered instruction in College Biology Labs. Proceedings: Pathways to change: An international conference on transforming Math and Science education in the K16 continuum. Arlington, VA.

Lorenz, J.M and Kleinman, L.I. (2003). Physiology and Pathophysiology of Body Water and Electrolytes. In L.A. Kaplan, A.J. Pesce, and S.C. Kazmierczak (Eds), Clinical chemistry : theory, analysis, correlation (pp.452-453)**.** Missouri: Mosby, Inc.

Ludwig, D.S., Peterson, K.E. and Gortmaker, S.L. (2001). Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet*, 357, 505-508.

Lytle, J.C., Perry, D.R., and Volpe, S.L. (2002). Effect of nutrition supplement education on nutrition supplement knowledge among high school students from a low-income community. *Journal of Community Health*, 27 (6), 433-451.

Lytle, L.A. (2002). Nutritional issues for adolescents. *Journal of the American Dietetics Association*, 102(3), S8-S12.

Lytle, L.A., Murray, D.M., Perry, C.L., Story, M., Birnbaum, A.S., Kubik, M.Y., Varnell, S. (2004). School-based approaches to affect adolescents' diet: Results from the TEENS study. *Health Education and Behaviour*, 31 (2), 270-287.

Lytle, L.A., Seifert, S., Greenstein, J., and McGovern, P. (2000). How do children's eating pattern and food choices change over time? Results from a cohort study. *American journal of Health Promotion*, 14(4), 222-228.

Marangella, M., Di Stefano, M., Casalis, S., Berutti, S., D'Amelio, P., Isaia, G. C. (2004). Effects of potassium citrate supplementation on bone metabolism. *Calcif Tissue Int,* 74, 330–335.

Marshall, T.A., Levy, S.M., Broffitt, B., Warren, J.J., Eichenberger-Gilmore, J.M., Burns, T.D., and Stumbo, P.J. (2003). Dental caries and beverage consumption in young children. *Pediatrics*, 112 (3 Pt 1), e184-e191.

Marshall, T.A., Gilmore, J.M.E., Broffitt, B., Stumbo, P.J., and Levy, S.M. (2005). Diet quality in young children is influenced by beverage consumption. *Journal of the American College of Nutrition*, 24 (1), 65–75.

Massey, L.K. and Strang, M.M. (1982). Soft drink consumption, phosphorus intake, and osteoporosis. *Journal of American Dietetic Association*, 80, 581-583.

Massey-Stokey, M. (2002). Adolescent nutrition: Needs and recommendation for practice. *The Clearing House*, 75(6), 286-291.

Matkovic, V., Crncevic-Orlic, Z., and Landoll, J.D. (2003). Role of calcium in Maximizing peak bone mass development in S.A. New and J.P. Bounjour, Nutritional Aspects of Bone Health (pp.129-144). United Kingdom: The Royal Society of Chemistry.

Matthews, R. and Al-Bayaty, H. (2002). Teeth. In C. Scully (Ed), Oxford Handbook of Applied Dental Sciences (pp.85-108). New York: Oxford University Press.

Maughan, R.J. (2003). Impact of mild dehydration on wellness and on exercise performance. *European Journal of Clinical Nutrition*, 57(Suppl 2), S19-S23.

May, J. and Waterhouse, P.J. (2003). Dental erosion and soft drinks: A qualitative assessment of knowledge, attitude and behavior using focus groups of schoolchildren. A preliminary study. *International Journal of Pediatric Dentistry*, 13(6), 425-433.

Mazariegos-Ramos, E., Guerrero-Romero, F., Rodríguez-Morán, M., Lazcano-Burciaga,, G., Paniagua, R., and Amato, D. (1995). Consumption of soft drinks with phosphoric acid as a risk factor for the development of hypocalcemia in children: A case-control study. *Journal of Pediatric*, 126, 940-942.

McBean, L.D., Miller, G.D., and Heaney, R.P. (2004). Effect of cow's milk on human health in T. Wilson and N.J. Temple (Eds), Beverages in Nutrition and Health (pp.3-18). New Jersey: Humana Press, Inc.

McDonald, J., and Grove, J. (2001). Youth for yout: Piercing together the peer education jigsaw. *Second International Conference on Drugs and Young People: Exploring the Bigger Picture Proceedings*. Available at http://www.peer.ca/mcdonald.pdf.

McDonald, R. E., Avery, D. R., and Stookey, G. K. (2000). Dental Caries in the Child and Adolescent**.** In R.E. McDonald and D. R. Avery (Eds), Dentistry for the Childe and Adolescent (pp. 209-246). St. Louis: Mosby.

McDonald's Quality and Nutrition Information. (2004). McDonald's USA Nutrition Facts for Popular Menu Items. Retrieved May 30, 2004 from: www.mcdonalds.com/app_controller.nutriiton.categories.nutrition.indexhtml.

McDonough, J.P. and Osterbrink, J. (2005). Learning styles: An issue in clinical education? *AANA Journal,* 73 (2), 89-93

McGartland, C., Robson, P.J., Cran, G., Savage, M.J., Watkins, D., Rooney, M., and Boreham, C. (2003). Carbonated soft drink consumption and bone mineral density in adolescence: The Northern Ireland Young Hearts Project. *Journal of Bone and Mineral Research,* 18(9), 1563-1569.

McGrane, M.M. (2000). Carbohydrate Metabolism-Synthesis and Oxidation. In M.H. Stipanuk (Ed), Biochemical and Physiological Aspects of Human Nutrition (pp. 158-205). Pennsylvania: W.B. Saunders Company.

McKinley, M.C., Lowis, C., Robson, P.J., Wallace, J.M.W., Morrissey, M., Moran, A., and Livingstone, M.B.E. (2005). It's good to talk: Children views on food and nutrition. *European Journal of Clinical Nutrition*, 59 542-551.

McKinley, M.J. and Johnson, A.K. (2004). The physiological regulation of thirst and fluid intake. *News in Physiological Science*, 19, 1-6.

McManis, D. and Sorensen, D. (2000). The role of comprehensive school health education programs in the link between health and academic performance: A literature review. Massachusetts: Massachusetts Department of Education: Learning Support Services.

Mellanby, A.R., Rees, J.B., Tripp, J.H. (2000). Peer-led and adult-led school health education: a critical review of available comparative research. *Health Educ Res*., 15 (5), 533-545.

Messerer, M., Johansson, S-E, and Wolk, A. (2004). The validity of questionnaire-based micronutrient intake estimates is increased by including dietary supplement use in Swedish men. *Journal of Nutrition*, 134, 1800-1805.

Messina, F., Saba, A., Vollono, C., Leclercq, C., Piccinelli, R. (2004). Beliefs and attitudes towards the consumption of sugar-free products in a sample of Italian adolescents. *Eur J Clin Nutr*., 58(3):420-8.

Miller, W.C., Eggert, K.E., Wallace, J.P., Lindeman, A.K., and Jastrenski, C. (1993). Successful weight loss in a self-taught, self-administered program. International *Journal of Sports and Medicine*, 14 (7), 401-405.

Milne, D.B. and Nielsen. (2000). The interaction between dietary fructose and magnesium adversely affects macromineral homeostasis in men. *Journal of American College of Nutrition,*19(1), 31-37.

Molnar, A. (2003). No Student Left Unsold: 6th Annual Report on Schoolhouse Commercialism Trends. *Education Policy Studies Laboratory: Commercialism in Education Research Unit.* Retreived in June 12th, 2004 from http://www.asu.edu/educ/epsl/CERU/CERU_2003_Annual_Report.htm.

Monge-Rojas, R., Nuñez, H.P., Garita, C., Chen-Mok, M. (2002). Psychosocial aspects of Costa Rican adoelscents' eating and physical activity patterns. *Journal of Adoelscents Health*, 31, 212-219.

Mrdjenovic, G. and Levitsky, D.A. (2003). Nutritional and energetic consequences of sweetened drink consumption. *Journal of Pediatrics*, 142, 604-610.

Muhajarine, N., Delanoy, S., Hartsook, L., and Hartsook, B. (2003). Community mapping for children in Saskatoon. Retrieved at April 1, 2005 from http://www.spheru.ca/PDF%20Files/Understanding%20the%20Early%20Years,%20Saskatoon,%20Community%20Mapping.pdf.

Nader, P.R., Sellers, D.E., Johnson, C.C., Perry, C.L., Stone, E.J., Cook, K.C., Bebchuk, J., and Luepker, R.V. (1996). The effect of adult participation in a school-based family intervention to improve Children's diet and physical activity: the Child and Adolescent Trial for Cardiovascular Health. *Preventive Medicine*, 25(4), 455-64.

National Soft Drink Association. (2003). What's in Soft Drink? Retrieved June 5, 2004, from http,//www.nsda.org/softdrinks/History/whatsin.html.

Nelson, A.L. (2000). Sweeteners: Alternative. St. Paul, Minnesota: Eagan Press.

Nestle, M. (2000). Soft drink "pouring rights": marketing empty calories to children. *Public Health Report*; 115: 308-309.

Nestle, M. (2002). Food politics: how the food industry influences nutrition and health. Berkeley: University of California Press.

Neumark-Sztainer, D., Story, M., Dixon, L.B., Resnick, M.D., and Blum, R.W. (1997). Correlates of inadequate consumption of dairy products among adolescents. *Journal of Nutrition Education*, 29, 12-20.

Neumark-Sztainer, D., Story, M., Hannan, P.J., Rex, J. (2003). New Moves: a school-based obesity prevention program for adolescent girls. *Preventive Medicine*, 37(1), 41-51.

Neumark-Sztainer, D., Story, M., Perry, C., and Casey, M.A. (1999). Factors influencing food choices of adolescents: Findings from focus-group discussions with adolescents. *Journal of the American Dietetic Association*, 99, 929-934.

Neumark-Sztainer, D., Wall, M., Perry, C., and Story, M. (2003). Correlates of fruit and vegetable intake among adolescents: Findings from Project EAT. *Preventive Medicine*, 37, 18-208.

Nguyen, U.N., Dumoulin, G., Henriet, M.T., and Regnard, J. (1998). Aspartame ingestion increases urinary calcium, but not oxalate excretion, in healthy subject. *The Journal of Clinical Endocrinology and Metabolism 83(1):165-168*.

Nicklas, T.A., Johnson, C.C., Myers, L., Farris, R.P., Cunningham, A. (1998). Outcome of a high school program to increase fruit and vegetable consumption: Gimme 5- A fresh nutrition concept for students. *Journal of School Health*, 68 (6), 248-253.

Novotny, R., Han, J-S, and Biernacke, I. (1999). Motivators and barriers to consuming calcium-rich foods among Asian adolescents in Hawaii. *Journal of Nutrition Education*, 31, 99-104.

O'Dea, J. and Maloney, D. (2000). Preventing eating and body image problems in children and adolescents using the health promoting schools framework. Journal *of School Health*, 70 (1), 18-21.

O'Dea, J.A. (2003). Why do kids eat healthful food? Perceived benefits of and barriers to healthful eating and physical activity among childrens and adolescents. *Journal of the American Dietetics Association*, 103(4), 497-507.

Oliver, K.K. and Thelen, M.H. (1996). Chidlren's perception of peer influence on eating concerns. *Behaviour Therapy*, 27, 35-39.

Ottley, C. (2003). Health and Fitness series-4: Getting children to develop a healthy relationship with food. *Journal of Family Health Care*, 13 (4), 95-97.

Owuor, P.O. (2003). Chemistry: Tea. . In B. Caballero, L. Trugo, and P. Finglas (Eds), Encyclopedia of Food Sciences and Nutrition (pp. 5743-5752). USA: Academic Press.

Özcebe, H. and Akin, L. (2003). Effects of Peer Education on Reproductive Health Knowledge for Adolescents Living in Rural Areas of Turkey. Journal of Adolescent Health; 33: 217-218.

Park, Y., Meier, E., Bianchi, P., Song, W.O. (2002). Trends in Children's Consumption of Beverages: 1987 to 1998. *Family Economics and Nutrition Review*, 14(2), 69-79.

Parker, L. and Fox, A. (2001). The Peterborough Schools Nutrition Project: A multiple intervention programme to improve school-based eating in secondary schools. *Public Health Nutrition*, 4 (6), 1221-1228.

Petridou, E., Karpathios, T., Dessypris, N., Simou, E., and Trichopoulos, D. (1997). The role of dairy products and non alcoholic beverages in bone fractures among achoolage children. *Scandivanian Journal of Social Medicine,* 25(2), 119-125.

Phillips, S., Starkey, L.J., and Gray-Donald. (2004). Food habits of Canadians: Food sources of nutrients for the adolescent sample. *Canadian Journal of Dietetic Practice and Research*, 65(2), 80-84.

Piesco, N.P. (2002). Histology of Dentin. In J.K. Avery (Ed), Oral Development and Histology (pp. 172-189). New York: Thieme Medical Publishers.

Pilant, B.B. and Skinner, J.D. (2004). Availability of competitive foods and beverages during lunch in middle schools. *Topics in Clinical Nutrition*, 19 (1), 20-27.

Popkin, B.M. and Nielsen, S.J. (2003). The sweetening of the world's diet. *Obesity Research*, 11(11), 1325-1332.

Prokhorov, A.V., Perry, C.L., Kelder, S.H., and Klepp, K-I. (1993). Lifestyle values of adolescents: Results from Minnesota Heart Health Youth Program. *Adolescence*, 28 (111), 637-647.

Public Health Nutritionists of Saskatchewan. (2004). Nutrition Guidelines for Schools. Research Centre Report #04-01: *28 pages, $11*. http://www.ssta.sk.ca/research/students/04-01.htm.

Pugh, M.J.V. and Hart, D. (1999). Identity development and peer group participation in J.A. McLellan and M.J.V. Pugh, The role of peer groups in adolescent social identity: exploring the importance of stability and change. United States of America: Jossey-Bass, Inc.

Rampersaud, G.C., Bailey, L.B., and Kauwell, G.P. (2003). National Survey beverage consumption data for children and adolescents indicate the need to encourage a shift toward more nutritive beverages. *Journal of American Dietetics Association*, 103, 97-100.

Reddy, R., Rhodes, J.E., Mulhall, P. (2003). The influence of teacher support on student adjustment in the middle school years: a latent growth curve study. *Dev Psychopathol,* 15(1):119-38.

Resnicow, K., Odom, E., Wang, T., Dudley, W.N., Mitchell, D., Vaughan, R., Jackson, A., and Baranowski, T. (2000). Validation of three food frequency questionnaires and 24-hour recalls with serum carotenoid levels in a sample of African-American adults. *American Journal of Epidemiology*, 152, 1072-1080.

Reynolds, K. D., Franklin, F. A., Binkley, D., Raczynski, J. M., Harrington, K. F., Kirk, K. A., and Person, S. (2000). Increasing the Fruit and Vegetable Consumption of Fourth-Graders: Results from the High 5 Project. *Preventive Medicine*, 30, 309-319.

Rhodes, J.E., Grossman, J.B., and Resch, N.L. (2000). Agents of change: Pathways through which mentoring relationships influence adolescents' academic adjustment. *Child Development*, 71(6), 1662-1671.

Rockett, H.R.H., and Colditz, G.A. (1997). Assessing diet of children and adolescents. *American Journal of Clinical Nutrition*, 65 (supply): 1116S-1122S.

Rockett, H.R.H., Wolf, A.M., and Colditz, G.A. (1995). Development and reproducibility of a food frequency questionnaire to assess diet of older children and adolescents. *Journal of the American Dietetic Association*, 93(3), 336-340.

Roos, E.B., Hirvonen, T., Mikkilä, V., Karvonen, S., and Rimpelä, M. (2001). Household educational level as a determinant of consumption of raw vegetables among male and female adolescents. *Preventive Medicine*, 33, 282-291.

Roos, E.H. and Donly, K.J. (2002) In vivo dental plaque pH variation with regular and diet soft drinks. *Pediatrics Denstistry*, 24, 350-353.

Rosso, I. and Rise, J. (1994). Concordance of parental and adolescent health behaviors. *Social Science and Medicine*; 38(9): 1299-1305.

Sacks, D. (2003). Age limits and adolescents. *Pediatric Children and Health*, 8 (9), 577.

Sánchez, G.A. and De Preliasco, M.V.F. (2003). Salivary pH changes during soft drinks consumption in children. *International Journal of Paediatric Dentistry*, 13(4), 251-237.

Saskatchewan Education. (1998). Health Education: A Curriculum Guide for the Middle Level (Grades 6-9). Regina, SK: Saskatchewan Education.

Saskatchewan Labour. (2005). Who are the young workers anyway? Retrieved at May 26, 2005 from http://www.readyforwork.sk.ca/students-workers/focus-report/who-are.htm.

Saskatchewan Learning. (2005). Evergreen Curriculum Guides & Resources. Retrieved at May 3, 2005 from http://www.sasked.gov.sk.ca/branches/curr/evergreen/sub_grade.shtml.

Saskatchewan River School Board. (2004). Beliefs. Retrieved at March 31, 2004 from http://www.carlton.paschools.pa.sk.ca/

Saskatchewan School Trustees Association. (1993). Nutrition Gudelines for Schools. SSTA Research Centre Report: #93-05.

Sawyer, L.. (2003). β-Lactoglobulin. In P.F. Fox and P.L.H. McSweeney (Eds), Advanced dairy chemistry volume 1: Protein (pp. 319-363). New York: Plenum Publishers.

Schulze, M.B., Manson, J.E., Ludwig, D.S., Colditz, G.A., Stampfer, M.J., Willett, W.C., Hu, F.B. (2004). Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *Journal of American Medal Association*, 292 (8), 927-934.

Schwartz, R.P. (2003). Soft drinks taste good, but the calories count. *Journal of Pediatric*, 142, 599-601.

Seaman, C.E.A., Bower, J., and Fleming, M. (1997). Nutrition knowledge and lunchtime eating habits of secondary school children in Lothian. *Journal of Consumer Studies and Home Economics*, 21, 259-269.

Senkfor, S., Berl, T., and Liu, K.D. (2003). Hyponatremia and Hypernatremia. In P.E. Parsons and J.P. Wiener-Kronish (Eds), Critical Care Secrets (pp.247-250). Philadelphia: Hanley and Belfus, Inc.

Serra-Majem, L., Ribas, L., Ngo, J., Aranceta, J., Garaulet, M., Carazo, E., Mataix, J., Pérez-Rodrigo, Quemada, M., Tojo, R., and Vázquez, C. (2001). Risk of inadequate intakes of vitamins A, B1, B6, C., E, folate, iron, and calcium in Spanish population aged 4 to 18. *International Journal of Vitamin and Nutrition Research*, 71 (6), 325-331.

Sheng, H-P. (2000). Body Fluids and Water Balance. In M.H. Stipanuk (Ed), Biochemical and Physiological Aspects of Human Nutrition. Pennsylvania: W.B. Saunders Company.

Sichert-Hellert, W. and Kersting, M. (2001). Significance of fortified beverages in the long-term diet of German children and adolescents: 15-year results of the DONALD study. *International Journal of Vitamin and Nutrition Research*, 71 (6), 356-363.

Siegel, D.M., Aten, M.J., Roghmann, K.J., Enaharo, M. (1998). Early effects of a school-based human immunodeficiency virus infection and sexual risk prevention intervention. *Archives of Pediatrics and Adolescent Medicine*, 152(10),961-70.

Sigelman, C.K. and Shaffer, D.R. (1991). Life-Span Human Development. Belmont, California: Wadsworth.

Sigmant-Grant, M. (2002). Strategies for counseling adolescents. *Journal of the American Dietetic Association*, 102 (Supplement 3), S32-S39.

Sloane, B.C. and Zimmer, C.G. (1993). The power of peer health education. *The Journal of American College Health,* 41(6), :241-245.

Smith, M. U. and DiClemente, R. J. (2000). STAND: A Peer Educator Training Curriculum for Sexual Risk Reduction in the Rural South. *Preventive Medicine,* 30**,** 441–449

Smith, A. C., Stewart, R., Shields, P., Hayes-Klosteridis,_J., Robinson, P., and Yuan, R. (2005). Introductory biology courses: A framework to support active learning in large enrollment introductory science courses. *Cell Biology Education*, 4, 143–156,

Sohn, W-S., Heller, K.E., Burt, B.A. (2001). Fluid consumption related to climate among children in the United States. *Journal of Public Health Dentistry*, 61(2), 99-106.

Soliven, S.R. (2003). Teaching styles of high school Physics teachers. Hawaii International Conference of Education Proceedings. Retrieved at June 27, 2005 from http://www.hiceducation.org/Edu_Proceedings/Samuel%20R.%20Soliven.pdf.

Sovyanhadi, M. and Cort, M.A. (2004). Effectiveness of Various Nutrition Education Teaching Methods for High School Students: a Case Study in Alabama, United States. *Mal J Nutr*., 10 (1), 31-37

Spear, B.A. (2002). Adolescent growth and development. *Journal of the American Dietetics Association*, 102(3), S23-S29.

Spear, B.A. (2004). Nutrition in Adolescence in L.K.Mahan and S. Escott-Stump (Eds), Krause's food, nutrition, & diet therapy (pp.284-301). Philadelphia: Elsevier.

Squire, D.L. (1990). Heat Illness: Fluid and electrolyte issues for pediatric and adolescent athletes. *Pediatric Clinics of North American*, 37(5), 1085-1109.

Stang, J. (2002). Assessment of nutritional status and motivation to make behaviour changes among adolescents. *Journal of the American Dietetic Association*, 102 (3 Supply 1): S13-S22.

St-Onge, M.P. Keller, K.L., and Heymsfield, S.B. (2003). Changes in childhood food consumption patterns: a cause for concern in light of increasing body weights. *American Journal of Clinical Nutrition*, 78, 1068-1073.

St-Onge, M.P., Rubiano, F., Denino, W.F., Jones Jr, A., Greenfield, D., Ferguson, P.W., Akrabawi, S., and Heymsfield, S.B. (2004). Added thermogenic and satiety effects of a mixed nutrition vs a sugar-only beverage. *International Journal of Obesity*, 28, 248-253.

Storey, M.L, Forshee, R.A, Anderson, P.A. (2004). Association of adequate intake of calcium with diet, beverage consumption, and demographic characteristics among children and adolescents. *Journal of American College of Nutrition*, 23(1), 18-33.

Story, M. (1999). School-based approaches for preventing and treating obesity. *Int J Obes Relat Metab Disord.*, 23 (Suppl 2), S43-51.

Story M, and Neumark-Sztainer D. (1996). School-Based Nutrition Education Programs and Services for Adolescents. *Adolescent Medicine*, 7(2), 287-302.

Stubbs RJ, and Whybrow S. (2004). Energy density, diet composition and palatability: influences on overall food energy intake in humans. Physiology and Behaviours, 81(5), 755-64.

Sturdevant, M.S. and Spear, B.A. (2002). Adolescent psychosocial development. *J Am Diet Assoc.*, 102 (3 Suppl), S30-S31.

Subar, A.F. (2004). Developing Dietary Assessment Tools. *Journal of the American Dietetic Association*, 105(5), 769-770.

Tanner, K and Allen, D. (2004). Approaches to Biology teaching and learning: Learning styles and the problem of instructional selection-Engaging all students in Science courses. *Cell Biology Education*, 3, 197- 201.

Tanasescu, M., Ferris, A.M., Himmelgreen, D.A., Rodriguez, N., and Perez-Escamilla, R. (2000). Biobehavioral factors are associated with obesity in Puerto Rican children. *J Nutr.,* 130 (7), 1734-42.

Taylor, T, Serrano, E., and Anderson, J. (2001). Management issues related to effectively implementing a nutrition education program using peer educators. Journal of Nutrition Education, 33(5), 284-92.

Taylor, R.B. (1998). Ingredients. In P.R. Ashurst (Ed), Chemistry and Technology of Soft Drinks and Fruit Juices (pp.16-54). England: Sheffield Academic Press.

Telch, M.J., Miller, L.M., Killen, J.D., Cooke, S., and Maccoby, N. (1990). Social influences approach to smoking prevention: the effects of videotape delivery with and without same-age peer leader participation. *Addicted Behaviours*,15(1), 21-8.

Ten-Cate, J.M., Larsen, M.J., Pearce, E.I.F., and Fejerskov, O. (2003). Chemical interactions between the tooth and oral fluids in O. Fejerskov and A.M. Kidd (Ed), Dental Caries: The disease and its clinical management (pp. 49-70). Denmark: Blackwell Munksgaard.

The Alberta Public Health Association. (2003). Resolution 6: The elimination of soft drink promotion in schools. Retrieved at January 5, 2005 from http://www.apha.ab.ca/Resolutions/SoftDrinks.pdf.

The Council of the European Union. (2001). Council Directive 2001/112/EC. Official Journal of the European Communities, L10/58-L10/66. http://www.fsai.ie/legislation/food/eu_docs/food_products/FruitJuices_etc/Dir%202001.112%20EC.pdf

The Swiss Association for Nutrition. Water and Non-Alcoholic Drinks. Retrieved in January 28, 2004 from http://www.healthandage.com/Home/!gm=2!gc=1!gid2=2379

Tremblay. M.S., Katzmarzyk, P.T., and Willms, J.D. (2002). Temporal trends inoverweight and obesity in Canada, 1981-1996. *International Journal of Obesity*, 26, 538-543.

Troiano, R. P., Briefel, R. R., Carroll, M. D., and Bialostosky, K. (2000). Energy and fat intakes of children and adolescents in the United States: data from the National Health and Nutrition Examination Surveys. *American Journal of Clinical Nutrition*, 72(supply), 1343S-1353S.

Trugo, L.C. (2003). Analysis of coffee products. In B. Caballero, L. Trugo, and P. Finglas (Eds), Encyclopedia of Food Sciences and Nutrition (pp. 1498-1506). USA: Academic Press.

Tseng, M. (2004). The influence of the parent on childhood dietary intake. *Public Health Nutrition*, 7(2), 251-252.

Turner, G. (1999). Peer support and young people's health. *Journal of Adolescence*, 22, 567-572.

Tylavsky, F.A., Holliday, K., Danish, R., Womack, C., Norwood, J., and Carbone, L. (2004). Fruit and vegetable intakes are an independent predictor of bone size in early pubertal children. *American Journal of Clinical Nutrition*, 79, 311-317.

US General Accounting Office. (2000). Public Education: Commercial activities in schools. GAO: HEHS-00-156. Retrieved June 1, 2004 from http://frwebgate.access.gpo.gov/cgi-bin/useftp.cgi?IPaddress=162.140.64.21&filename=he00156.pdf&directory=/diskb/wais/data/gao.

Valtin, H. (2002). "Drink at least eight glasses of water a day." Really? Is there scientific evidence for "8 x 8"? *American Journal of Physiology, Regulatory, Integrative, and Comparative Physiology*, 283(5),R993-1004.

Van Keer H. (2004). Fostering reading comprehension in fifth grade by explicit instruction in reading strategies and peer tutoring. British Journal of Educational Psychology, 74(Pt 1), 37-70.

Varnam, A.H. and Sutherland, J.P. (1999). Beverages: Technology, chemistry, and microbiology. New York: Chapman & Hall.

Vatanparast, H., Lo, E., Henry, C.J., Whiting, S.J. (submitted). Trends of beverage intake from 1991-2004 in grade 9 students living in Saskatoon show substitution of milk by non-carbonated soft drinks. *Canadian Journal of Public Health.*

Vereecken, C.A., Bobelijn, K., and Maes, L. (2005). School food policy at primary and secondary schools in Belgium-Flanders: Does it influence young people's food Habits? *European Journal of Clinical nutrition*, 59, 271-277.

Wabitsch, M. (2002). Molecular and biological factors with emphasis on adipose tissue development. In W. Burniat, T.J. Cole, I. Lissau, and E.M.E. Poskitt (Ed), Child and Adolescent Obesity: Causes and Consequences, Prevention and Management (pp.50-68). USA: Cambridge University Press.

Wallin, E., Bremberg, S., Haglund, B., Holm, L.E. (1993). Cancer prevention in schools: design and pilot testing of a nutritional curriculum for mid-adolescents. *J Cancer Educ.*, 8 (2), 145-150.

Walstra, P., Geurts, T.J., Noomen, A., Jellema, A., van Boekel, M.A.J.S. (1999). Dairy Technology, principles of milk properties and processes (pp.1-27). New York: Marcell Dekker.

Wardlaw, G.M., Hampl, J.S., DiSilvestro, R.A. (2004). Perspectives in Nutrition. USA: McGraw-Hill Inc.

Waterhouse, A.L. (2002). Wine Phenolics. In D.K. Das and F. Ursini (Eds), Alcohol and wine in health and disease. New York: New York Academy of Science.

Watkins, S.R. (2001). Foods sold in competition with USDA school meal programs. Retrieved November 19, 2004 from http://www.fns.usda.gov/cnd/Lunch/CompetitiveFoods/report_ congress.htm.

Watt, R.G. and Sheiham, A. (1996). Dietary patterns and changes in inner city adolescents. *Journal of Human Nutrition and Dietetics*; 9, 451-461.

Weaver, C.M. (2003). Calcium. Retrieved Dec 7, 2003, from http://lpi.oregonstate.edu/infocenter/minerals/calcium/index.html.

Wechsler, H., Brener, N.D., Kuester, S., and Miller, C. (2001). Food service and foods and beverages available at school: Results from the school health policies and programs study 2000. *The journal of School Health*, 71 (7), 313-324.

Weiss, R., Dziura, J., Burgert, T. S., Tamborlane, W.V., Taksali, S. E., Yeckel, C. W., Allen, K., Lopes, M., Savoye, M., Morrison, J., Sherwin, R. S., and Caprio, S. (2004) Obesity and the metabolic syndrome in children and adolescents. *New England Journal of Medicine*, 350, 2362-2374.

Wham, C.A. and Worsley, A. (2003). New Zealanders' attitudes to milk: Implications for public health. *Public Health Nutrition* 6 (1), 73-78.

Whiting, S.J., Healey, A., Psiuk, S., Mirwald, R., Kowalski, K., Bailey, D.A. (2001). Relationship between carbonated and other low nutrient dense beverages and bone mineral content of adolescents, *Nutrition Research*, 21, 1107-1115.

Whitmire, S.J. (2004). Water, electrolytes, and acid-base balance in L.K.Mahan and S. Escott-Stump (Eds), Krause's food, nutrition, & diet therapy (pp.165-179). Philadelphia: Elsevier.

Wilson, K. (1999). Coffee, Cocoa, and Tea. United Kingdom: CABI Publishing.

World Health Organization. (2003). Obesity and Overweight. Retrieved May 29, 2004, from http://www.who.int/dietphysicalactivity/media/en/gsfs_obesity.pdf.

World Heath Organization. (2002). Bottled drinking water. Retrieved at May 25, 2004 from http://www.who.int/mediacentre/factsheets/fs256/en/index.html.

Wyshak, G. (2000). Teenaged girls, carbonated beverage consumption, and bone fractures. *Archives of Pediatric and Adolescent Medicine*, 154, 610-613.

Wyshak, G. and Firsch, R.E. (1994). Carbonated beverages, dietary calcium, the dietary calcium/phosphorus ratio, and bone fractures in girls and boys. *Journal of Adolescent Health*, 15, 210-215.

Wyshak, G. Frisch, R.E., Albright, T.E., Albright, N. L., Schiff, I., and Witschi, J. (1989). Nonalcoholic Carbonated Beverage Consumption and Bone Fractures Among Women Former College Athletes. *Journal of Orthopaedic Research,* 7, 91-99.

Yannakoulia, M., Karayiannis, D., Terzidou, M., Kokkevi, A., Sidossis, L.S. (2004). Nutrition-related habits of Greek adolescents. *European Journal of Clinical Nutrition*, 58, 580-586.

Yi, K.P., Meier, E.R., Bianchi, P., and Won, O.S. (2002). Trends in children consumption of beverages: 1987 to 1998. *Family Economics and Nutrition Review*, 14(2), 69-79.

Young, E.M., and Fors, S.W. (2001). Factors related to the eating habits of students in grades 9-12. *Journal of School Health*, 71(10), 483-8.

Zohouri, F.V., Rugg-Gunn, A.J., Fletcher, E.S., Hackett, A.F., Moynihan, P.J., Mathers, J.C., and Adamson, A.J. (2004). Changes in water intake of Northumbian adolescents 1980 to 2000. *British Dental Journal*, 196(9), 547-552.

Zuo, Y., Chen, H., and Deng, Y. (2002). Simultaneous determination of catechins, caffeine, and gallic acids in green, oolong, and pu-erh tea using HPLC with photodiode array detector. *Talanta*, 57, 307-316.

Zwiauer, K.F.M., Caroli, M., Malecka-Tendera, E., and Poskitt E.M.E. (2002). Clinical features, adverse effects and outcome in W. BUrniat, T.J. Cole, I. Lissau, and E.M.E. Poskitt (Ed), Child and Adolescent Obesity: Causes and Consequences, Prevention and Management (pp.131-153). USA: Cambridge University Press.

APPENDIX

Appendix 1. Ethic Approval

Appendix 1.1. Ethic Approval for the first phase study

UNIVERSITY OF SASKATCHEWAN
BEHAVIOURAL RESEARCH ETHICS BOARD
http://www.usask.ca/research/ethics.shtml

NAME: Carol Henry
College of Pharmacy and Nutrition

BSC#: 03-822

DATE: March 10, 2003

The University of Saskatchewan Behavioural Research Ethics Board has reviewed the revisions to the Application for Ethics Approval for your study "Evaluation of a Nutrition Education Intervention Aimed at Promoting Beverage Consumption in High Schools."

1. Your study has been APPROVED.
2. Any significant changes to your proposed method, or your consent and recruitment procedures should be reported to the Chair for Committee consideration in advance of its implementation.
3. The term of this approval is for 5 years.
4. This approval is valid for five years on the condition that a status report form is submitted annually to the Chair of the Committee. This certificate will automatically be invalidated if a status report form is not received within one month of the anniversary date. Please refer to the website for further instructions: http://www.usask.ca/research/behavrsc.shtml

I wish you a successful and informative study.

Dr. David Hay, Acting Chair
University of Saskatchewan
Behavioural Research Ethics Board

DH/scpb

Office of Research Services, University of Saskatchewan
Room 1607, 110 Gymnasium Place, Box 5000 RPO University, Saskatoon SK S7N 4J8 CANADA
Telephone: (306) 966-8576 Facsimile: (306) 966-8597

Appendix 1.2. Ethic approval for the second study

UNIVERSITY OF SASKATCHEWAN BEHAVIOURAL RESEARCH ETHICS BOARD http://www.usask.ca/research/ethics.shtml

NAME: Carol Henry (Joyce Polowski) Beh 04-165 Pharmacy & Nutrition

DATE: September 28, 2004

The University of Saskatchewan Behavioral Research Ethics Board has reviewed the Application for Ethics Approval for your study Evaluation of a Foods and Nutrition Program Aimed at Promoting Health Eating Behaviors Among High School Students (Beh 04-165).

1. Your study has been APPROVED.
2. Any significant changes to your proposed method, or your consent and recruitment procedures should be reported to the Chair for Committee consideration in advance of its implementation. 3. The term of this approval is for 5 years.
4. This approval is valid for one year. A status report form must be submitted annually to the Chair of the Committee in order to extend approval. This certificate will automatically be invalidated if a status report form is not received within one month of the anniversary date. Please refer to the website for further instructions http://www.usask.ca/research/behavrsc.shtml

I wish you a successful and informative study.

Dr. Valerie Thompson, Chair

University of Saskatchewan

Behavioral Research Ethics Board

Appendix 2. Written Consent for students

Appendix 2.1. Written Consent for Saskatoon Students

Student/Parent Consent Form

Evaluation of a Nutrition Program aimed at promoting the Consumption of Healthy Beverages in high Schools

We would like your child's assistance in a study that is being carried out at the College of Pharmacy and Nutrition, University of Saskatchewan. The goals of the study are to evaluate the knowledge, attitude and practices of high school students towards healthy beverage consumption in school, and to determine the effectiveness of a nutrition education program in helping students make healthy beverage choices. Findings from this study will provide valuable information to assist health educators, and education program planners develop future programs for encouraging healthy beverage consumption among high school aged children.

If your child decides to volunteer, his/her role as a participants will be to complete four questionnaires, each totaling approximately 45 minutes I length. The questionnaires will be completed during school hours in your child's Ethical Living class. Students from your child's Ethical Living class will also receive a nutrition education program that is integrated into the grade 9 Ethical Living curriculum. The students will be provided with the opportunity to volunteer to assist the Dietitian and university students as peer mentors. If your child decides to volunteer as a peer mentor they will attend 3 weekly meetings/sessions and assist the dietitian in peer-led activities.

It is not anticipated that this study will present any medical or social risk to your child. The decision to participated or not participated will not affect the grade of your child receives in any of his/her classes. Results are completely anonymous and only group results will published. All information provided to me throughout the study will be kept confidential and in a locked office when not in use. Both you and your child will be given a copy of the questionnaire to pursue upon request. If your child wishes he/she may opt not to complete the questionnaires without any undo consequence. Students who choose not to complete the questionnaires will be given an alternate assignment chosen in consultation with the teachers during this period.

Once the study is completed, the analyzed findings will be made available at your school. A copy of the report will also be sent to the funding body, Dairy Farmers of Canada.

If your child decides that he/she would like to participate in the study, please complete the attached form. Also, please ask your child to read this letter and indicate consent as well. Please address any questions or concerns about the research study to professor Carol Henry, researcher, or Renee Coles, research associate, at College of pharmacy and Nutrition, 966-5833.

PARENTS/GUARDIAN PLEASE READ and SIGN YOUR CONSENT

I have read and understand the goals of the study and my child's involvement I this study. I am aware that my child participation in this study is strictly voluntary and that he/she may discontinue participation at any time without prejudice. I also understand that the strictest confidentiality will be maintained throughout this study and that only the researchers will have access to the confidential information. I acknowledge that I have received a copy of the consent letter for my records. If I have any questions or concerns I can contact Professor Carol Henry (306-966-5833) or Renee Coles (Dietitian, Research Assistant). If I wish to clarify the rights of my daughter/son as a research participant, I may contact the Office of Research Services (306-966-2804).

I, ________________________________ give permission to allow __________________ to participate in the study conducted by Professor Carol Henry.

Signature ____________________________ date ________________________________

- -

STUDENTS PLEASE READ and SIGN YOUR CONSENT

I have discussed this study and consent with Professor Carol Henry, and my parents/guardians. I understand the purpose of the study and my involvement. I understand that I have the right to withdraw at any time from the project, or ask to have any information that I have given eliminated from the final document.

Signature _____________________________________ date_______________________

Appendix 2.2. Written Consent for Prince Albert students

PARENT/GUARDIAN CONSENT FORM

Title: Evaluation of a Nutrition Education Program aimed at Promoting Healthy Food and Nutrition Behaviours among High School Students

- We would like your child's assistance in a study that is being carried out at the College of Education and the College of Pharmacy and Nutrition, University of Saskatchewan.

Purpose of the Study

- The goals of the study are to evaluate the knowledge, attitude and practices of high school students towards healthy food and nutrition behaviours, and to determine the effectiveness of a food and nutrition program in helping students make healthy choices.

Relevance:

- Findings from this study will provide valuable information to assist health educators, and education program planners develop future programs for encouraging healthy food and beverage practices among school aged children.

Method:

- The program of study is called Foods Used for Effective Living (*FUEL*). Your child's school will be designated to be taught the nutrition education program or to receive the nutrition education material only. In each case the classroom teacher will help coordinate the delivery of the program.

- All students in the class will participate in the unit, as it is part of the regular Wellness 9 curriculum. Only students agreeing to the study will write three food frequency questionnaires, one prior to the beginning of the nutrition education program to assess prior knowledge, and two at the end (1 week and 3 months following) to assess learning. A member of the research team will conduct the nutrition education, and will administer the questionnaires. The regular classroom teacher will be responsible for program delivery and classroom management.

- The questionnaires will not contribute to the final grade in the class.

- We would like students to also discuss together, with research assistant (registered dietitian), what they know, what they are learning, and how they might change their life practices to consume healthy food and beverages. These small groups will be audio-recorded.

- There will be three such small group interview sessions, one at the beginning of the unit, one at the end, and one three months later. The questions addressed will be very different than the questions on the written questionnaires, and will be about changes to eating habits and becoming leaders in healthy eating.
- Each small group interview will take place in class, and will take approximately 30 minutes for a total of 1 ½ hours. Students in the small groups will be advised that they should not tell anyone else about what was said. However, they will also be advised that, due to the nature of small group discussions, confidentiality cannot be guaranteed.

- The small group interview will be transcribed. Small group participants will be shown the transcriptions of the interviews at a date and time agreed upon by the classroom teacher, and will be invited to change anything they believe misrepresents them. All changes will be made as the students' request. Then students will sign off on the transcripts.

- The researcher will undertake to safeguard the confidentiality of the discussion, but cannot guarantee that other members of the group will do so. Students will be asked to respect the confidentiality of the other members of the group by not disclosing the contents of this discussion outside the group. They will also be made aware that others within the group may not respect their confidentiality. Participants will be reminded of this at the time of the focus group.

Right to Withdraw

- Students may choose to withdraw from the stud at any time, and if they withdraw, their questionnaire results will not be used, and they need not participate in any further focus group interviews. They may withdraw just by letting Mrs. Polowski (principal investigator) or a member of the research team know that they wish to withdraw. If the student choose to withdraw it will not affect their grade for the course. Teachers will provide alternate assignments for those students wishing not to participate in any aspect of the study.

Risk/Confidentiality

- The study will be of no harm to the student it involves no risk or discomfort. All information provided by the students will be kept confidential.

- Once the study is completed, a summary report will be made available at school and will be available to students and parents. The results of this research will be shared with teachers from other schools at the Dr. Stirling McDowell Learning from Practice Conference. Also, it is possible that the results will be published in academic journals. In all publications and presentations, students and school will be anonymous.

Ethics

- The University of Saskatchewan Research Ethics Boards has approved the research.

Contact

- Please address any questions or concerns about the research study to Dr. Carol Henry, College of Pharmacy and Nutrition, (306) 966-5833, or Mrs. Polowski of Carlton High School, 922-3115, ext. 303. You may also contact the University of Saskatchewan Research Ethics Boards at (306) 966-2084.

PARENTS/GUARDIAN PLEASE READ and SIGN YOUR CONSENT

I have read and understand the goals of the study and my child's involvement I this study. I am aware that my child participation in this study is strictly voluntary and that he/she may discontinue participation at any time without prejudice. My child will be anonymous; no one will know how well my child did on this questionnaire, but all the class results will be averaged so students can learn how ell they retain this important information about their health. I acknowledge that I have received a copy of the consent letter for my records. If I have any questions or concerns I can contact Professor Carol Henry (306-966-5833) or Joyce Polowski, principal investigator (306-922-3115 x 303). If I wish to clarify the rights of my daughter/son as a research participant, I may contact the Office of Research Services (306-966-2804).

I, ______________________________ give permission to allow ________________ to participate in the final questionnaire aspect of the study conducted by the College of Pharmacy and Nutrition, University of Saskatchewan

Signature __________________________
date ______________________________

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Appendix 3. Beverage Frequency Questionnaire (Pre-test)

Initial: ___________________ Date: _________________________

Age: ____________ Female/Male: ___________________

BEVERAGE CONSUMPTION QUESTIONNAIRE

A. Check How Often

	How often do you drink:	*More than once/ day*	*Once / day*	*Once/ week*	*Seldom/ Never*
1	100% orange juice				
2	100% cranberry, apple, or grape juice				
3	Orange-juice-calcium rich				
4	Vegetable juices				
5	Soft drinks (e.g. Coke, Pepsi, seven-up)				
6	Fruit drinks and punch (e.g. Fruitopia, Sunny Delite)				
7	Coffee (any type)				
8	Ice tea				
9	Hot Tea (any type)				
10	Yogurt drink				
11	Fast-food milkshake				
12	Home-made milkshake				
13	Soy milk				
14	Whole milk				
15	2% milk				
16	1% milk				
17	Skim-milk				
18	Sports drinks				
19	Bottled Water				
20	Drink pop (soft drinks) when you are at school?				
21	Drink 100% juice when you are at school?				
22	Drink milk when you are at school?				
23	Drink water when you are at school?				

B. Do you agree or disagree?

	Statements	*Agree*	*Some what agree*	*Disagree*
24	If you were offered a choice of milk or pop, you will usually choose pop			
25	The taste of milk is acceptable to you			
26	Milk is for everybody, not just for kids			
27	There are easy ways to include milk in the diet			
28	I like the way 100% fruit juice tastes			
29	Milk is cheaper than pop			
30	Consuming one or more glasses of milk will help strengthen your bones and improve your overall health			
31	Do you think that drinking fruit juices will help you reduce the risk of cancer?			
32	Do you think that if you improve the types of beverage you drink that you would be a healthier person?			
33	Drinking one glass of milk each day will give young adults all the calcium they needs			
34	Osteoporosis is a condition of weak bones that may break easily			
35	Osteoporosis maybe prevented by getting enough calcium early in life			
36	Milk, cheese, and other dairy products are the richest source s of calcium			
37	Fruit drink has the same nutrients as fruit juice			

C. ***How Many…***

38	How many fruits and vegetables (including juices) should a person eat and/or drink each day? Circle one: 2 4 6 8 10
39	How many glasses of water (or equivalent) should a person drink each day? Circle one: 2 4 6 8 10
40	How many servings of milk and milk products should a person have each day? Circle one: 2 4 6 8 10

Appendix 4. Beverage Frequency Questionnaire (Post-test)

Name Initial: _________________ Date: ___________________

Date of birth: ___________ Female/Male: _____________

BEVERAGE CONSUMPTION QUESTIONNAIRE

A. Check How Often

	How often do you drink:	*More than once/ day*	*Once/ day*	*About once/ week*	*Seldom/ Never*
1	100% orange juice				
2	100% cranberry, apple, or grape juice				
3	Orange-juice-calcium rich				
4	Vegetable juices				
5	Soft drinks (e.g. Coke, Pepsi, seven-up)				
6	Fruit drinks and punch (e.g. Fruitopia, Sunny Delite)				
7	Coffee (any type)				
8	Ice tea				
9	Hot Tea (any type)				
10	Yogurt drink				
11	Fast-food milkshake				
12	Home-made milkshake				
13	Soy milk				
14	Whole milk				
15	2% milk				
16	1% milk				
17	Skim-milk				
18	Sports drinks				
19	Bottled Water				
20	Drink pop (soft drinks) when you are at school?				
21	Drink 100% juice when you are at school?				
22	Drink milk when you are at school?				
23	Drink water when you are at school?				

B. Do you agree or disagree?

	Statements	*Agree*	*Some what agree*	*Disagree*
24	Do you think that drinking fruit juices will help you reduce the risk of cancer?			
25	Do you think that if you improve the types of beverage you drink that you would be a healthier person?			
26	Drinking one glass of milk each day will give young adults all the calcium they needs			
27	Osteoporosis is a condition of weak bones that may break easily			
28	Osteoporosis maybe prevented by getting enough calcium early in life			
29	Milk, cheese, and other dairy products are the richest source s of calcium			
30	Fruit drink has the same nutrients as fruit juice			

C. ***How Many…***

31	How many fruits and vegetables (including juices) should a person eat and/or drink each day? Circle one: 2 4 6 8 10
32	How many glasses of water (or equivalent) should a person drink each day? Circle one: 2 4 6 8 10
33	How many servings of milk and milk products should a person have each day? Circle one: 2 4 6 8 10

D. Check yes or no

No	Questions	Yes	No
34	Have you increased your overall intake of fruit juices ?		
35	Have you increased your overall intake of vegetables and juices?		
36	Can you think of some disease conditions that may be decreased by a diet high in fruits and vegetables [juices]?		
37	Have you increased your overall intake of milk?		
38	Have you decreased your overall intake of soft drinks?		
39	Can your think of some disease conditions that may be decreased by a diet high in milk and low in pop intake?		
40	Do you drink more 100% fruit juice or fruit and vegetables because you think that they are good for you?		
41	Do you feel more strongly than before that drinking more fruit/vegetable juice will reduce the risks of diseases?		
42	Do you feel more strongly than before that consuming one or more glass of milk will help you strengthen your bones and improve your overall health?		
43	Have you tried a beverage [e.g. milk, juice] that you have never drunk before?		
44	Have you tried to follow a healthier diet?		
45	Have you made a recipe from one of the handouts?		
46	Would you consider reducing the amount of pop in your diet for the next 30 days or so?		
47	Would you consider including more nutritious (juice-100%, milk) beverages in your diet in the next 30 days?		

E. Be honest please……

46	What was you overall level of satisfaction with the *F.U.E.L. For Your Body* program/ [materials- non-treatment group]? Circle one: 1= Poor, 2-Fair, 3-Good, 4-Very Good, 5-Excellent
47	How many sessions of the nutrition education program [treatment only] did you attend?
48	What would you say you liked the **most** about the *F.U.E.L For Your Body* program?
49	What would you say you liked the **least** about the *F.U.E.L For Your Body* program?
50	What changes have you made as a result of the information you received from the *F.U.E.L. For Your Body* program?
51	Would you recommend this program to your friends? Yes No Explain :
52	What changes would you like us to make to the program to make it better for others like your self?

THANK YOU VERY MUCH FOR YOUR TIME AND EFFORT!
If you have any questions, please call me, Renee Cole at 306-966-5833
You may also reach Professor Carol Henry, principal investigator for this study, at the same number, 306-966-5833